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**THE FIRST FINDING OF Ag-AMALGAMATES IN RODINGITES  
(NASŁAWICE, LOWER SILESIA, POLAND)**

INTRODUCTION

Rodingites are metasomatic rocks consisting of Ca and Mg silicates (grossular, diopside, vesuvianite, zoisite, prehnite itp.). They form in under prehnite-pumpellyite facies conditions. Their origin is connected with serpentinite formation. In Poland rodingites occur in Gogołów-Jordanów and Braszowice-Brzeźnica serpentinite massifs (Dubieńska 1995, Gunia 1996).

Native elements of the Cu-Au series – native copper and gold, intermetallic compounds – auricupride  $Cu_3Au$ , and tetraauricupride  $CuAu$  (Novgorodova 1994, Spiridonov *et al.* 1997) have been already described in rodingites. In Poland native copper was described from rodingitized metagabbro in Braszowice-Brzeźnica massif (Gunia 1986).

Compounds of silver amalgamate series: eugenite  $Ag_{11}Hg_2$ , paraschachnerite  $Ag_3Hg_2$ , schachnerite  $Ag_{1.1}Hg_{0.9}$ , moschellandsbergite  $Ag_2Hg_3$ , luanheite  $Ag_3Hg$  are known in nature. In Poland amalgamates of silver were described in Lubin copper deposits:  $Ag_7Hg_2$  (Kucha, Marcinkowski 1976), eugenite  $Ag_{11}Hg_2$  (Kucha 1986),  $Ag_{14}Hg - Ag_6Hg$  (Piestrzyński, Tylka 1992).

In the current work the authors describe amalgamates of silver in rodingites, in association with sulphides of Cu and Ag, selenides of Ag and Cu, oxides of Cu, and native copper.

MATERIALS AND METHODS

Amalgamates were collected from a garnet-vesuvianite rodingite vein within Nasławice (Gogołów-Jordanów massif). They appear as irregular grains up to 50 microns within cuprite or silicates, together with native copper, chalcocite and covellite. In reflected light amalgamates are isotropic and show yellow-white color and reflectance higher than copper, at the level of about 80%.

Microscopic observations of thick sections were performed by means of a Carl Zeiss ore microscope. BSE (back-scattered electrons) observations were performed

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using Philips/Fei ESEM XL 30 TMP scanning microscope with EDS (EDAX) detector (Sosnowiec). Electron-probe microanalyses were performed using Cameca SX 100 in the WDS-mode (Warsaw).

## RESULTS

Investigated amalgamates are attributed to  $\text{Ag}_{10}\text{Hg} - \text{Ag}_9\text{Hg}$  series (Fig. 1) on the basis of the ratio of Ag to Hg obtained by means of the microprobe analyses.

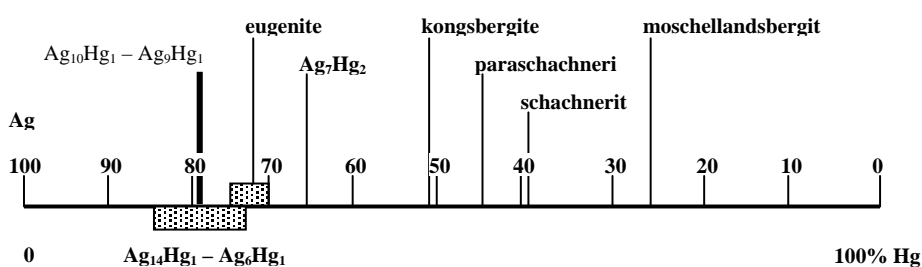


Fig. 1. Ag-Hg component system (after Kucha and Marcinkowski (1976), Kucha (1986), Piestrzyński and Tylka (1992)).

Ore association in Nasławice rodingites can be divided on three assemblages (in sequence of crystallization) – sulphides of Cu, selenides (+sulphides of Ag), and native elements Cu and Ag+Hg.

Compounds of MeS type are represented by covellite CuS, clausthalite PbSe, klockmannite CuSe (?);  $\text{Me}_2\text{S}$  – chalcocite  $\text{Cu}_2\text{S}$ , acanthite  $\text{Ag}_2\text{S}$ , naumannite  $\text{Ag}_2\text{Se}$ , eucairite  $\text{AgCuSe}$ , stromeyerite  $\text{AgCuS}$ ,  $\text{Ag}_3\text{CuSe}_2$  (analogue of jalpaite  $\text{Ag}_3\text{CuS}_2$ );  $\text{Me}_{2-x}\text{S}$  – digenite  $\text{Cu}_{1.8}\text{S}$ ;  $\text{Me}_3\text{Se}_2$  –  $\text{AgCuHgSe}_2$ , and  $\text{Hg}_2(\text{Cu,Ag})\text{Se}_2$  (analogue of  $\text{Cu}_3\text{Se}_2$  – umangite). Sulphides and selenides are rich in Cu.

In the Cu – Ag – Hg system the amalgamates of Ag ( $\text{Ag}_9\text{Hg} - \text{Ag}_{10}\text{Hg}$ ) with impurities Cu up to 2%, native silver with negligible impurities Cu, Hg, and copper with micro-impurities Au, Ag, Hg, Zn, Fe, S, Se are distinguished. Cuprite  $\text{Cu}_2\text{O}$  and other oxides of copper with the changing ratio of Cu to O are formed as secondary minerals.

Formation of ore association of minerals is connected with late stages of mineral formation under condition of zeolites facies (Philpotts 1990). Crystallization of minerals began from sulphides at temperature about  $200^\circ\text{C}$ , which under reduction of the sulfur activity were substituted by selenides. The activity of sulfur decreased as a result formation of sulphides, of which causes crystallization of native metals and amalgamates at temperature decrease. Under such conditions native Cu was substituted by oxides in the outer zone of grains, whereas precious metals Ag (+Hg) remained in native state.

As early investigations revealed (Tapała 2001), silicates could be the source of Cu, concentration of Cu reaches 0.2-0.5%. Active solution can transport Ag and Hg as chlorine compounds. Until the strong "oxidants" like sulfur or selenium are present in the system, sulphides and selenides have crystallized. After exhausting of sulfur and selenium in the hydrothermal system, native elements began to crystallize, and amalgamates – at the decrease of temperature.

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