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**NONCONSOLIDATED, HYPERGENIC OXYHYDROXIDES OF IRON  
FROM STARA GÓRA - MINERALOGY AND GEOCHEMISTRY**

Owing to an exploitation stop of over 50 years relating to the polymetallic deposit of Stara Góra at the locality Radzimowice (Kaczawskie Mountains) it was possible to develop and collect in great quantities of loose and weakly consolidated ochre sediments connected with the oxidation process of the rich sulphide mineralization. For the first time the ochre deposits of Stara Góra formations have been described by Stauffacher (1914) as being smallish stalactites occurring on the surface of rhyolites in Wilhelm mine. Presently this type of formations is generally appearing in great quantities on all mine levels. Iron oxyhydroxides occur in the form of stalactites, stalagmites, glazes, hangings, and the so-called rice fields which by their forms are reminding carbonate dripstones which occur inside karstic caves. They are very often forming a loose sediment deposited at the bottom of galleries. At some places they may be over 2 meters thick.

For phase identification purpose the X-ray diffraction, differential X-ray diffraction (DXRD) and infrared spectroscopy has been used (Schwertmann, Schultze, Murad 1982). Chemical analyses of mine waters and sediments have been realised by using of the IPC MS method (the Measurement Laboratory of the Faculty of Chemistry at the Warsaw University). The basic physical and chemical parameters of water (temperature, pH) have been defined during the field sampling.

Based on investigations it has been stated that these formations are generally composed of amorphous Fe oxyhydroxides, ferrihydrites, goethites, lepidocrocites and small quantities of schwertmannite. Apart from iron oxyhydroxides jarosite and the amorphous phases rich in copper form similar forms of dripstones and sediment accumulation. Besides, within the reach of those ochre formations occur native copper, aragonite, malachite, gypsum, brochantite, devilline, posniakite, langite, azurite, chrysocolla, and amorphous silica.

Ferrihydrite is the most popular mineral in investigated ochre formations. It forms dripstones and loose sediments filling the galleries. On the base of XRD and DXRD investigations it has been stated that it is a 2-line ferrihydrite and 6-line ferrihydrite. The IR spectra of investigated ferrihydrite samples are in line with Goethite, after ferrihydrite, is the second component of ochre formations at Stara Góra. Generally, it occurs as small, hard, crusted dripstones on the adit walls, standard spectra of synthetically gained ferrihydrite (Schwertmann, Cornell 2000).

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and as thin (of up to 0.3 cm diameter) and long (up to 0.1 m) stalactites. Very often they form a loose mixture with ferrihydrite.

Within the reach of dripstone formations smallish quantities of lepidocrocite have been found. This mineral does not form independent concentrations, but it is always dispersed within ferrihydrite.

Schwertmannite is the most rare component of the investigated ochre sediments. Its occurrence is closely connected with oxidation of a narrow zone (up to 2 meters of width) of dispersed pyrite mineralization being developed within the reach of rhyolites which are uncovering on the middle mine level. Following the oxidation process of pyrites comes to form of melanterite which is passing to the mine waters with a very low pH (3.5). Within the mixing zone of those waters with neutral mine waters comes to the precipitation of weakly consolidated Fe oxyhydroxide sediments of schwertmannite composition. This mineral has not been described on the territory of Poland yet.

Table 1. Geochemistry of waters from Wilhelm mine (Stara Góra deposit).

ppm	s10w	s12w	s14w	s16w	s17w
Al	11.08	0.777	0.229	0.005	2.452
Ba	0.004	0.006	0.034	0.026	0.038
Ca	267.9	350.051	44.811	231.497	227.447
Cd	0.033	0.025	0.01	0	0
Co	0.616	0.339	0.172	0.117	0.314
Cu	38.373	8.971	4.667	0.048	4.63
K	4.436	4.543	2.191	3.131	3.997
Mg	102.789	121.243	13.033	76.707	46.852
Mn	3.289	2.399	0.708	2.606	0.94
Mo	0	0.004	0	0.027	0
Na	4.024	3.971	2.969	3.877	5.138
Ni	0.536	0.371	0.068	0.114	0.161
Pb	0.012	0.002	0.004	0.001	0.003
Sr	0.489	0.581	0.145	0.304	0.415
U	0.033	0.007	0	0.012	0.006
V	0	0	0	0	0
Zn	1.687	1.245	0.691	0.3853	0.516
Cr	0.004	0	0	0	0
Zr	0	0	0	0.007	0
W	0	0.022	0	0.002	0
Sb	0	0	0.001	0	0
Sn	0.003	0	0	0	0
T °C	8.7	8.7	8.7	8.7	8.7
pH	7.07	6.95	6.7	7.02	6.95

Chemical composition of waters present in old adit of Wilhelm mine is closely connected with composition of ore mineralization. On the basis of geochemical

investigations two types of waters were distinguished. The first type is not in close contact with weathering ore veins. The second type present waters with increasing concentrations of metals (Table 1). These waters have contact with ore veins.

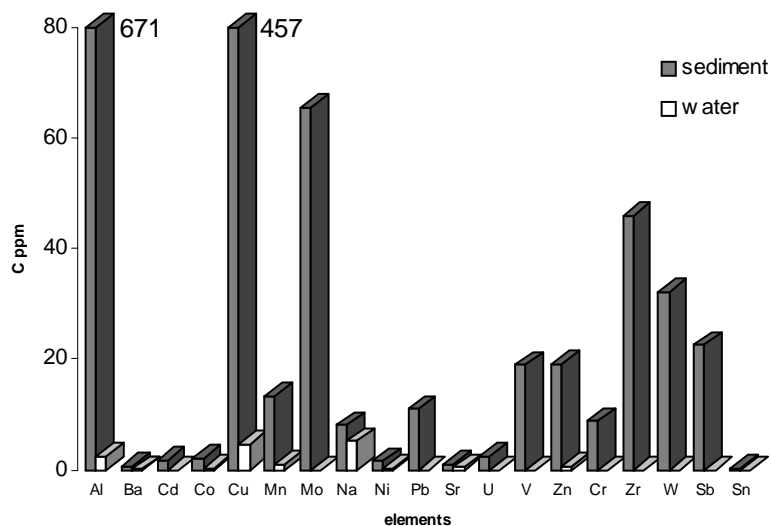


Fig. 1. Content of selected elements in waters and sediments from Wilhelm mine.

From these waters precipitated hydroxyoxides of iron. These phases are enriched in heavy metals in proportion to waters (Fig. 1). To the elements which occur in the biggest quantity belong aluminium, copper, molybdenum, manganese and zirconium. These metals can be adsorbed on the surface or they substitute iron in the structure.

Value of these processes depends on the temperature and pH (Schwertmann, Cornell 2000). Substitution and absorption of ions are very intensive in low temperature and slightly acid or alkaline conditions. These conditions occur in old adits of Wilhelm mine. Probably this fact is responsible for suspension of heavy metals in weathering zone of ore veins.

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