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PRIMARY PB-ZN- BEARING PHASES IN PYROMETALLURGICAL SLAG FROM ŚWIĘTOCHŁOWICE (UPPER SILESIA, POLAND)

INTRODUCTION

The zinc and lead mining metallurgy caused a great deal of devastation of the natural environment in the Upper Silesia, South Poland (Verner et al. 1996, Helios Rybicka et al. 1996). Huge amounts of metallurgical wastes are deposited in this region. The studied dump, located near the town of Świętochłowice, belongs to one the greatest plants related to zinc metallurgy. Currently, it consists of pyrometallurgical Zn-Pb rich material, dominated by slag. The heap, as high as 25 m covers 15 ha. Active since 1857, it was abandoned for ca. 30 years.

The knowledge of the distribution of Zn-Pb elements in the primary phases present in the slag is essential to assess the potential environmental impact related to smelting industries (Ettler et al. 2001). Therefore, the detailed study of the chemical composition and mineralogy of slags deposited in the dump was performed. In this abstract we discuss the primary phases constituting these Zn and Pb-bearing material. The described solid phases are not minerals in the sense of IMA definition, but we use the mineral names for simplicity in the following.

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Collected samples are irregular in form, usually isometric and greyish coloured. Their size range from one to few meters. The largest are supposedly of the size close to that of the furnace (1 - 2 m in diameter). Usually, at the margins, the slag is vesicular (vesicles are from few μm to tens mm), whereas the core of the blocks is massive. Our chemical (Table 1) and petrographic (Table 2) determinations concern tens centimetres size blocks rich in Zn and Pb and they are based on combined bulk analyses, optical microscopy, SEM and microprobe analyses. They show two different mineral assemblages according to their position in the block.

Table 1. Chemical analyses of three studied samples.

	SiO_2	Al_2O_3	Fe_2O_3	MnO	MgO	CaO	K_2O	TiO_2	ZnO	PbO	FL
CH06	23,59	3,38	9,86	0,35	3,60	5,89	0,63	0,13	47,26	2,04	6,58
CH20	33,23	4,19	14,45	0,66	10,68	23,27	0,38	0,20	1,96	2,29	7,89
CH21	12,43	14,40	14,83	0,34	7,74	4,97	0,18	0,24	27,96	6,71	16,34

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The first one (I), composed of melilite, willemite, zincite, red Zn-spinel and Pb-As-Ca-phase (Fig. 1a), forms the outer part (1-10 cm thick) of the blocks whereas the second (II), consisting of kirschsteinite, leucite, diopside, olivine, green Zn-spinel, Ba-Ti-rich mica, and pyrrhotite (Fig 1b), represents the core of the blocks.

Table 2. Primary phases identified in the studied slags (weight % element concentration).

		Si	Al	Ca	Fe	Mg	Zn	Pb	Other
zincite	**	-	-	-	-	0-1	78-82	-	-
willemite	**	13-15	-	-	0-1	2-7	47-56	-	-
Zn-spinel red	**	-	1-12	-	28-49	2	24-29	-	Mn 1-6
Zn-spinel green	**	-	28-32	-	12-23	3-9	5-9	-	-
melilite	**	17-19	0-1	21-27	0-5	1-5	2-18	0-13	-
Pb-As-Ca-phase	*	1-2	-	6-12	0-1	-	1-5	46-60	As 14-19
olivine	*	17-18	-	1-2	20-22	17-19	1-2	-	-
kirschsteinite	***	15-16	-	16-19	17-26	3-9	0-1	-	Mn 1
diopside	*	20-21	5-7	17	6-7	5-6	-	-	-
leucite	*	25-27	13	-	-	-	-	0-1	K 7-9, Ba 1-5
Ba-Ti-rich mica	*	12-14	8-9	-	8-13	5-9	-	-	K 2, Ba 10-17, Ti 3-6
pyrrhotite	*	-	-	-	60-63	-	-	-	S 35-38
Description: *** abundant, ** common, *present									

Assemblage I (Fig. 1a). Zn-spinel forms euhedral (0,02-0,2 mm) red grains irregularly distributed in the slag. Small anhedral grains of the Pb-As-Ca phase (about 0,04 mm) are located in interstices among the spinel grains. Zincite occurs as anhedral oval grains about 0.1 mm or as euhedral crystals on the surface of the blocks. Willemite and melilite fill interstices between Zn-spinel and zincite.

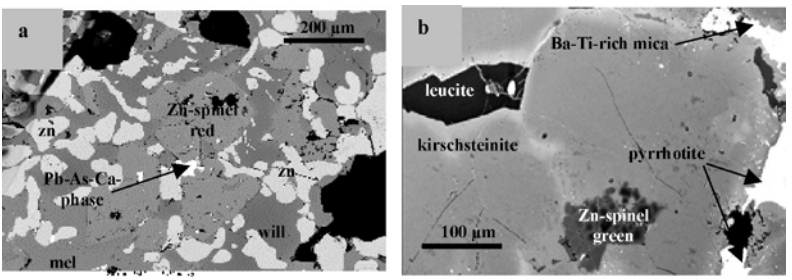

Fig. 1. BSE image of typical phase assemblages of the studied slag (mel– melilite, will– willemite, zn– zincite): a) assemblage (I), b) assemblage (II).

Assemblage II (Fig. 1b). Anhedral grains of kirschsteinite (0.5 mm) surround smaller, sparse grains of leucite, plates of Ba-Ti-rich mica and isolated grains of pyrrhotite (<0.1 mm). Zn-spinel occur as aggregates of fine green grains of size 0.05 to 50 μm. Sparse crystals of diopside, melilite and olivine occur locally in parts of slag blocks located close to the vesicles.

CONCLUDING REMARKS

Most of the primary phases constituting the studied slags contain important amounts of Zn et Pb. The phases located in the outer part of the slag blocks, are richer in zinc and lead than those occurring in the core. Water-rock interactions are favoured by the highly porous texture of the outer part of the slags and also by the presence of minerals unstable in meteoric conditions such as sulphides. Moreover, although oxide and silicate phases are known for a better stability in these conditions (e.g. Sidenko et al. 2001), part of them shows weathering evidences. These alteration processes allow a major release of heavy elements. Its importance is obvious at a macroscopic scale by the deposition of secondary phases coating primary material everywhere in the site. A detailed study of these authigenic phases is the topic of the following part of our work.

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