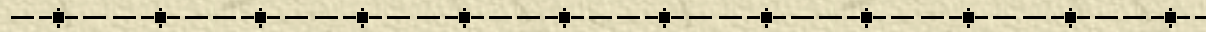


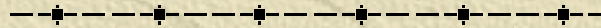
The environment toxic elements
pollution around the Muzhievo
gold-base metal deposit, Ukraine



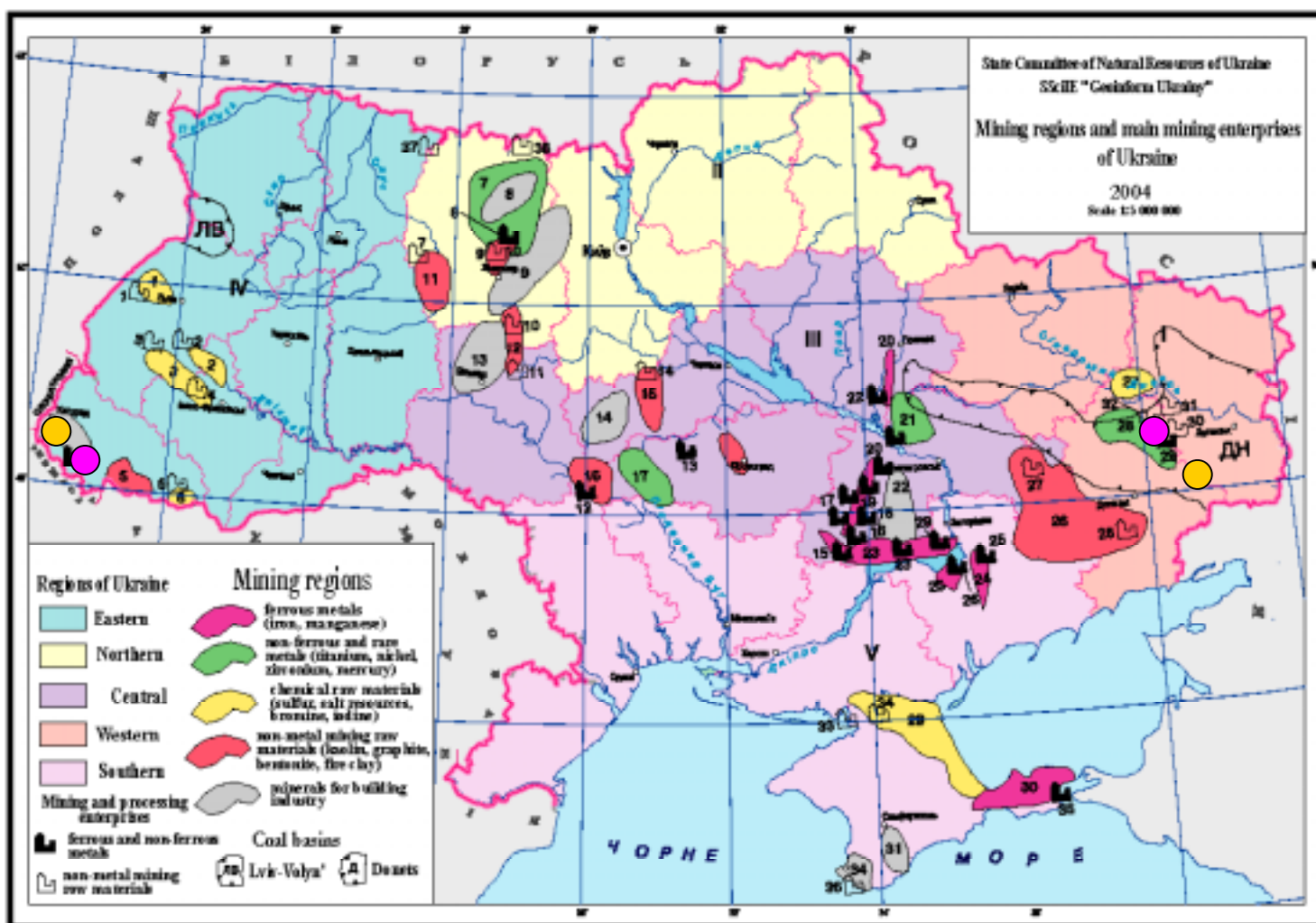
**V.Shumlyansky, O.Ivantyshyna, A.Subbotin,
M.Makarenko**

**Institute of Fundamental Studies of Ukrainian Scientific
Association**

STCU Project 1282



Mining regions and main mining enterprises of Ukraine

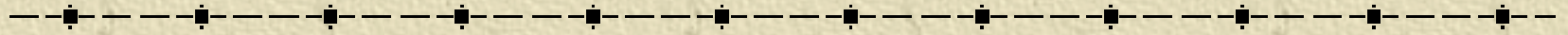


- mercury deposit
- gold-base-metal deposit



Dumps at the Muzhievo gold-base metal deposit area

Problem: to study the spread and distribution of trace toxic elements over the territory of Muzhievo gold-base metal deposit



Toxic elements risk classes

I class

As, Cd, Hg, Se,
Pb, Zn, F, Tl, Be

II class

B, Co, Ni, Mo,
Cu, Sb, Cr

III class

Ba, V, W,
Mn, Sr

The studied trace toxic elements have the Maximum Allowable Concentration (MAC) in soil of less than 10 mg/kg

The content of elements in ore samples from the active mine of the Muzhievo deposit (mg/kg)

-
- ✦ Hg – from 1.87 to 4.11;
 - ✦ Sb – from 400 to 3000;
 - ✦ As – from 500 to 10000;
 - ✦ Cd – from 4000 to 10000;
 - ✦ Tl – absent ;
 - ✦ Cu – from 600 to 1000;
 - ✦ Pb - > 1%
 - ✦ Zn - >> 1%

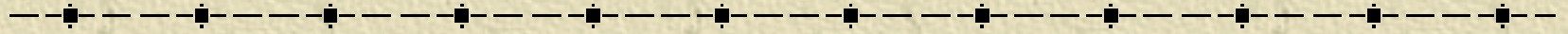
Range of content: Zn>Pb>Cd>As>Sb>Cu>Hg>Tl

Estimation criteria of the ecology-geochemical state of soil and territorial ecological conditions

As an indicator of anomaly level of toxic element in special landscape conditions the F_C (concentration factor) has been used. $F_{CGB} = C_E/C_{GB}$ or $F_{CMAC} = C_E/MAC$

Ecological conditions	Soil pollution level	Concentration factor $F_{CGB} = C_E/C_{GB}$
Comparatively satisfactory	Admissible	< 16
Stressed	Moderately dangerous	16 – 32
Critical	Dangerous	32 – 64
Extreme	Highly dangerous	64 – 128
Ecological disaster	Extremely dangerous	> 128

In relation to MAC the following *pollution levels* are used:



- ✦ 1 level – admissible - $< \text{MAC}$
- ✦ 2 level – low - from MAC to 3
- ✦ 3 level – moderate - from 3 to 5
- ✦ 4 level – high - from 5 to 19
- ✦ 5 level – very high - > 10

$$\text{✦ } F_{\text{CMAC}} = C_E / \text{MAC}$$

Toxic elements content of the Third (III) risk class in the environment around the Muzhievo gold-base metal deposit

III class of risk	Ba	V	Mn
Dumps, mg/kg	800-15000	5-40	80-800
Soil, mg/kg	300-3000	80-100	200-600
MAC for soil, mg/kg	-	150	1500

Barium was assayed at 1,5% in the dump rocks while Pb and Zn more than 1%, As – 0,8%, Sb – 0,1%. Concentrations of these elements correspond to the Muzhievo deposit ores composition: barite, galena, sphalerite, sulfosalts of As and Sb.

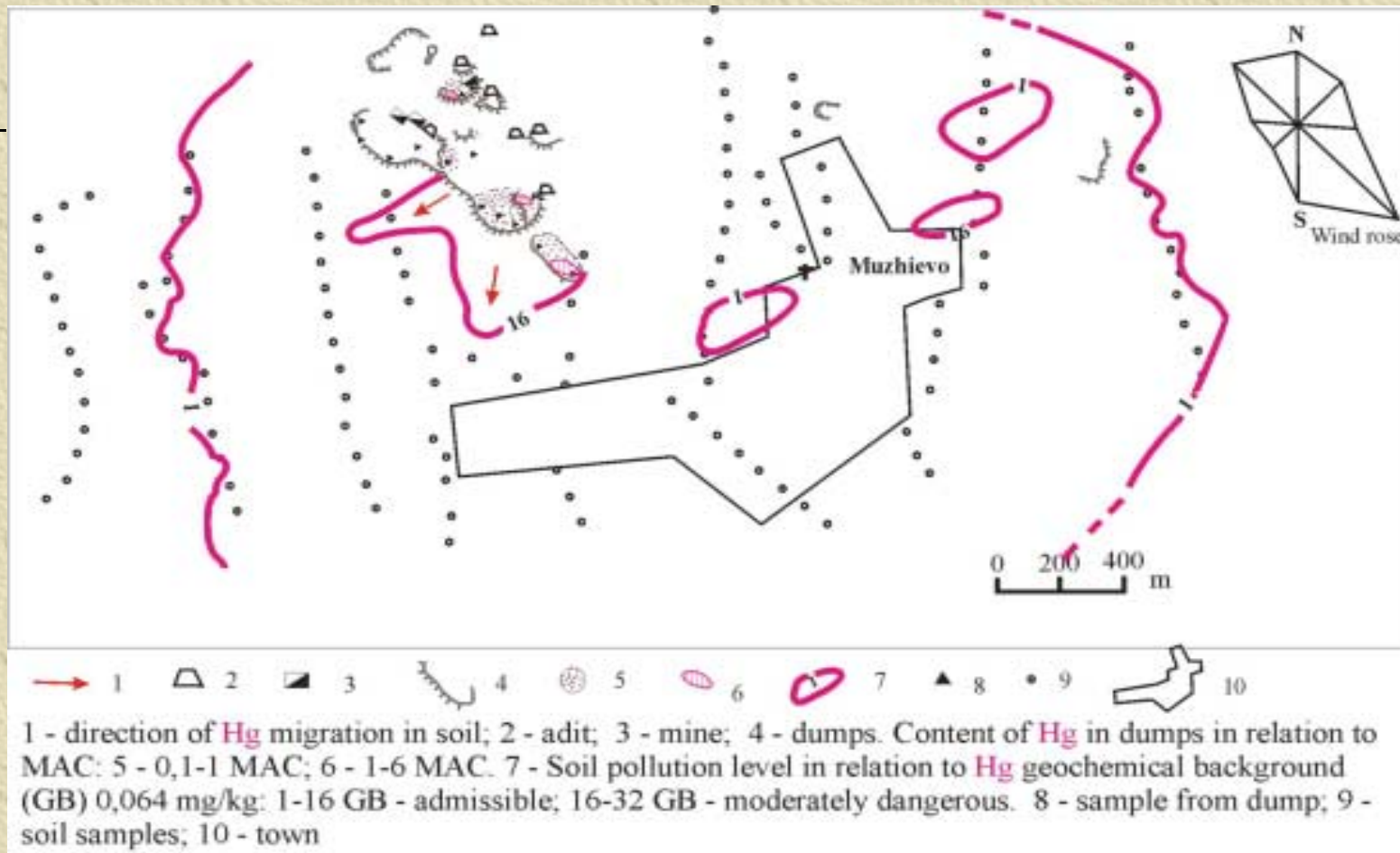
Toxic elements content of the Second (II) risk class in the environment around the Muzhievo gold-base metal deposit

II class of risk	Co	Ni	Cu	Cr
Dumps, mg/kg	0-4,0	0-8,0	30-300	5-50,0
Soil, mg/kg	6-20	20-40	30-100	40-80
MAC for soil, mg/kg	100	20	33	100

The content of trace toxic elements, Pb, and Zn on the territory of the Muzhievo gold - base metal deposit

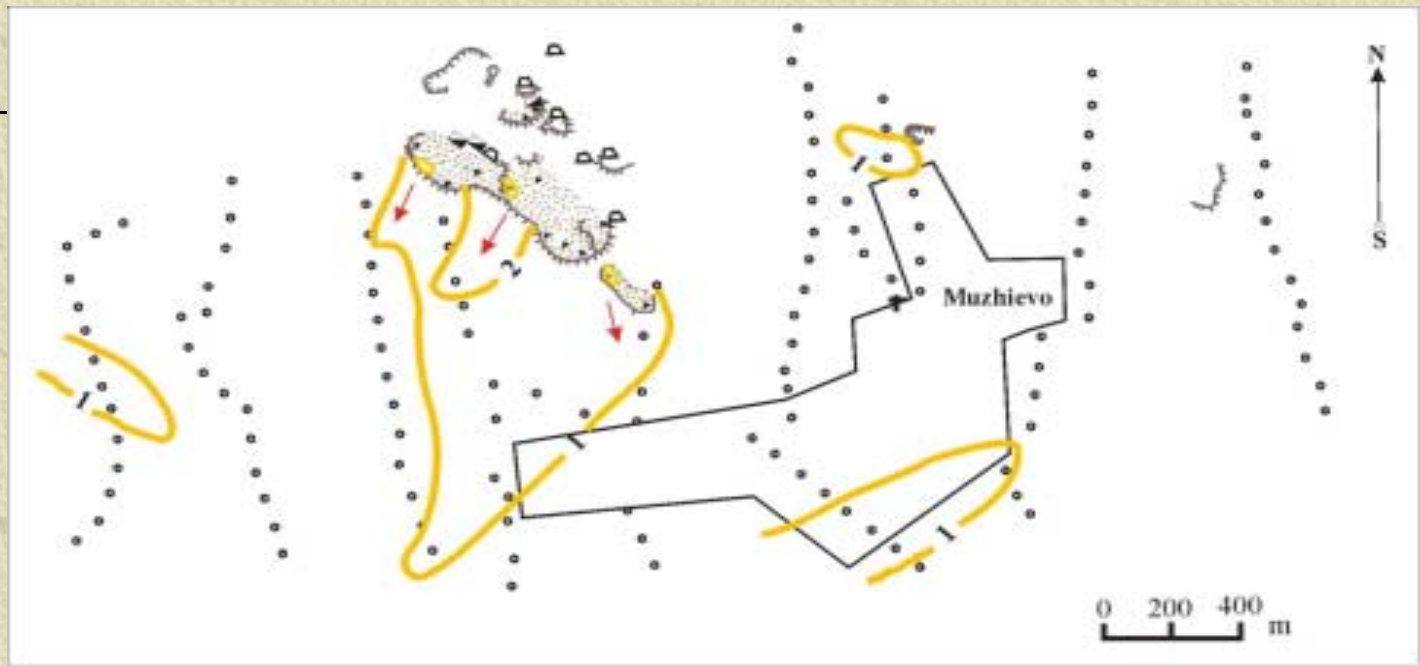
Sampled item	Toxic elements content in the waste rock dumps and soil, mg/kg;						
	Hg	Sb	As	Cd	Tl	Pb	Zn
Waste rock dumps	0,22-1,99	20-1000	1000-8000	0,0-400	0,0	50-10000	50-10000
Soil	0,034-1,522	2,1-9,9	12,0-120,0	Up to 1,5	0,0-4,5	15-300	60-200
MAC for soil, mg/kg	2,1	4,5	2,0	1,0	-	32	55

Map of soil pollution with Hg in the Muzhievo gold-base metal deposit area



In almost all area of the deposit, the mercury contents exceed the geochemical background (GB) by 0,064 mg/kg. Within the deposit area, the admissible pollution level (which is less than 16 GB) prevails. The aureole with mercury content of 22,6 BG does not reach Muzhievo town

Map of soil pollution with Sb around the Muzhievo deposit

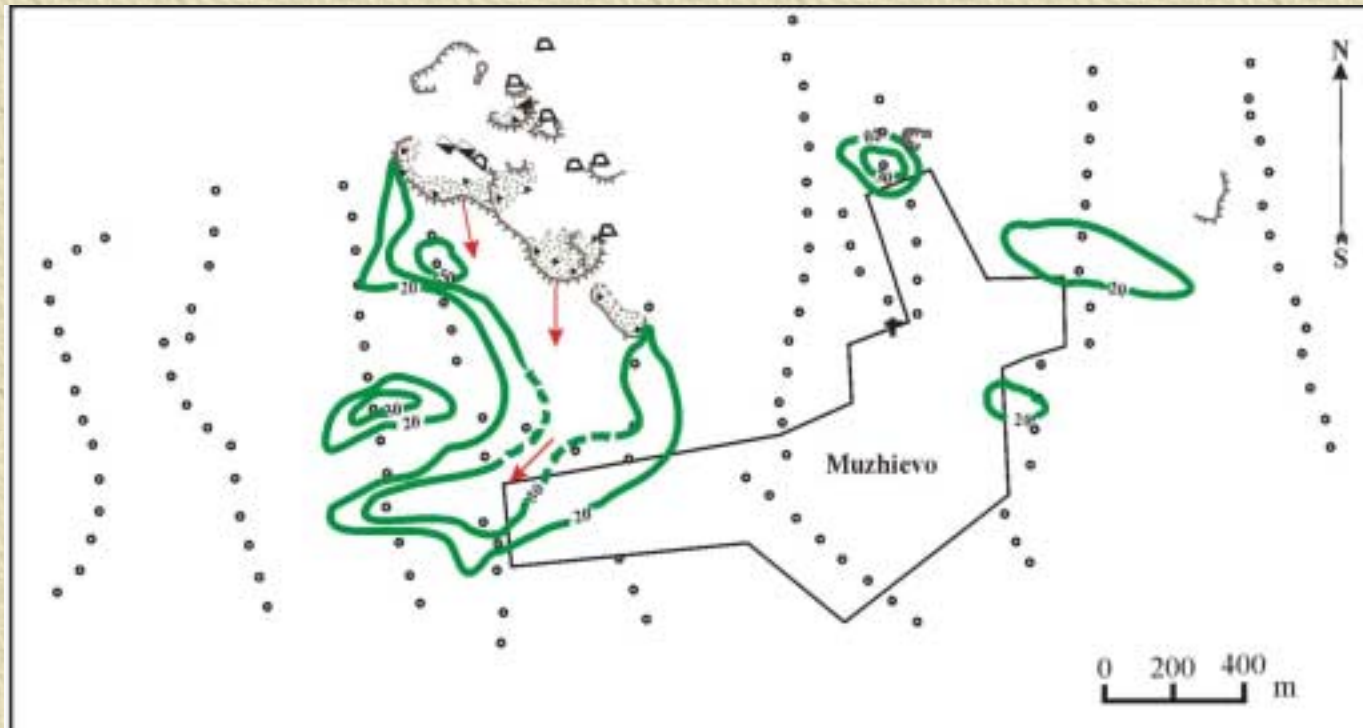


● 1 2 → 3 △ 4 ▣ 5 6 ▲ 7 • 8

Sb content in dumps: 1 - 0,008-0,1%, 2 - 0,003-0,008%; 3 - direction of Sb migration; 4 - adit; 5 - mine; 6 - isoconcentrations of Sb in soil in relation to MAC (4,5 mg/kg); 7 - samples from dumps; 8 - soil samples.

✳ It is possible, that a low (1-2,2 MAC) level of soil pollution with Sb is related to both the dumps and the secondary geochemical aureoles caused by ore zones. The area of Sb content > MAC, which spreads from dumps and covers the western part of Muzhievo is 600000 m²

Map of the soil pollution with As in the area of the Muzhievo deposit



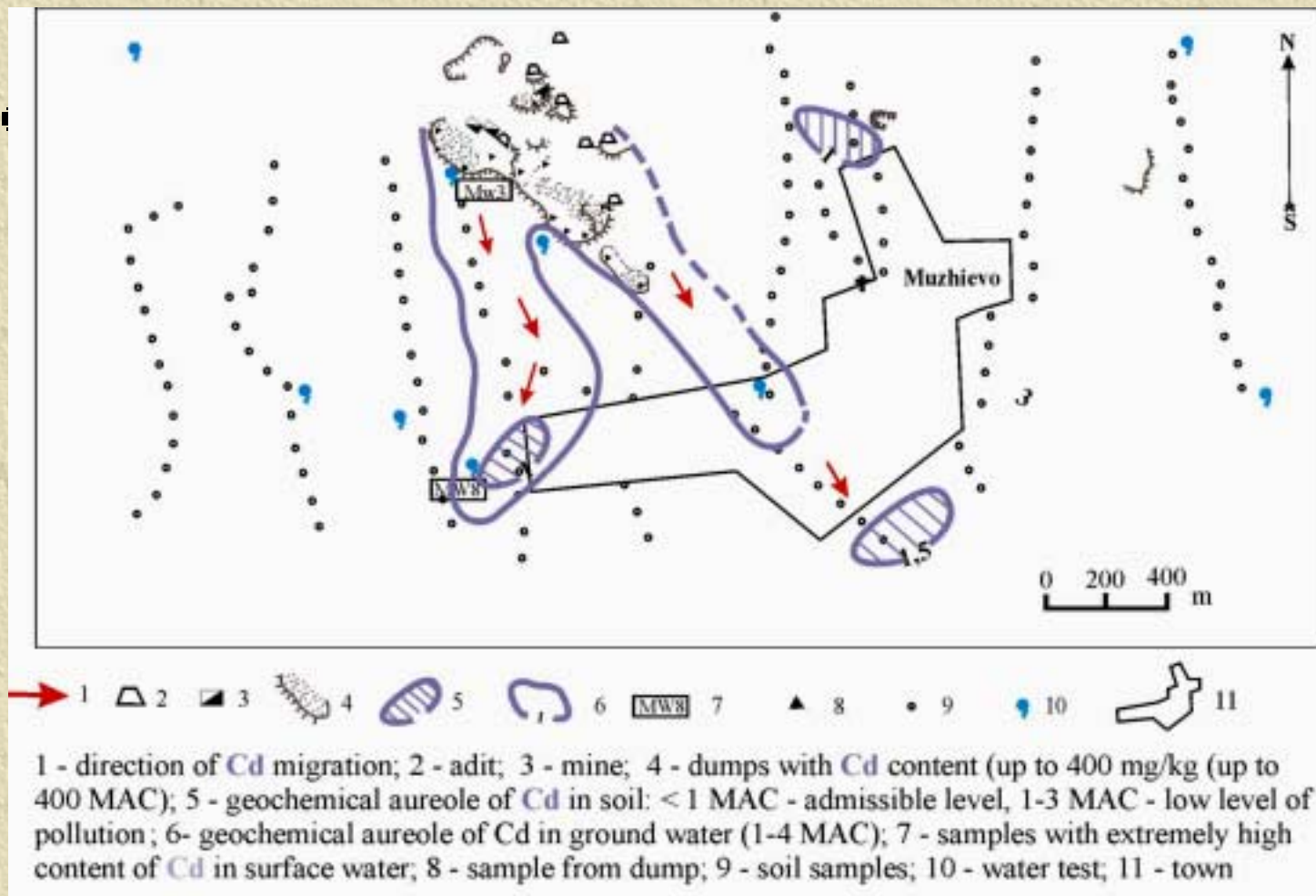
1 - direction of As migration; 2 - adit; 3 - mine; 4 - dumps with As content 0.1-0,8 % (500 - 4000 MAC); 5 - isolines of the As pollution level in soil: 1-20 MAC - low; 20-30 MAC - medium; 30-50 MAC - high; > 50 - very high. 6 - samples from dump; 7 - soil samples

Concentrations of As in soil much exceed MAC: from 12 to 83 mg/kg (from 6 to 42 MAC). The aureole of moderate and high pollution levels spreads from the dumps over the distance of 900 m and covers the western part of Muzhievo town

Toxic elements content in under-dump water of the Muzhievo deposit and migration coefficient of these elements

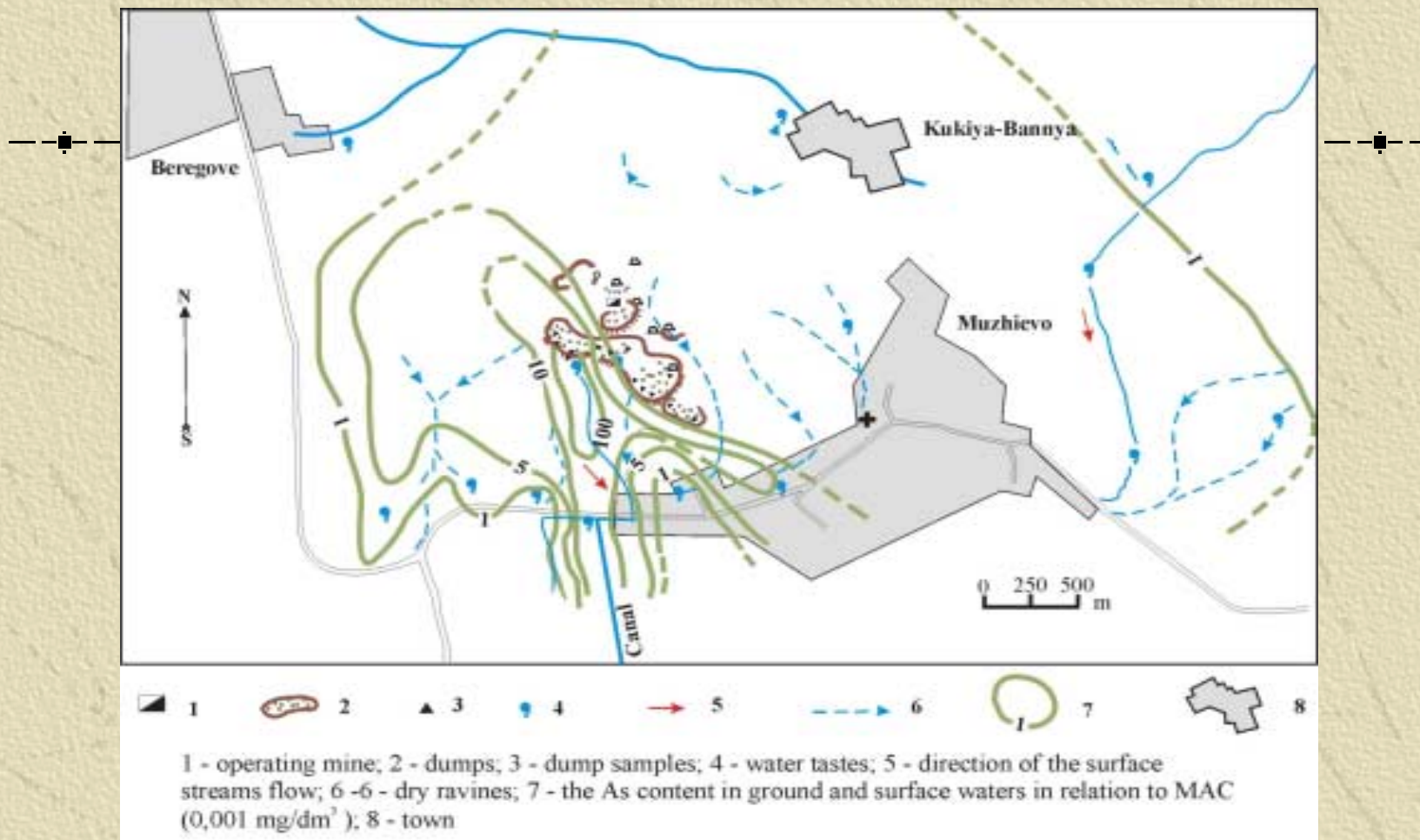
Sampled unit	Toxic elements									
	Hg	Sb	As	Cd	Be	P	Ba	Co	Li	Mo
Average content in dumps, mg/kg	1,195	127,7	3133	32,1	<1,0	6000	3920	1,7	13	7
Water test MW-3, mg/dm³	0,00005	0,0009	4,6	12,2	0,04	12	2	6	6	<0,1
MAC, mg/dm³	0,0005	0,05	0,01	0,001	0,0002	-	0,1	0,1	0,03	0,25
Exceeding MAC	-	-	460	12200	200	-	20	60	200	-
Water migration coefficient	0,002	0,0004	0,07	18,7	40,0	0,001	0,03	176,5	2,3	0,36

Map of soil and both surface and ground water pollution with Cd in the area of the Muzhievo deposit



- ✿ The content of Cd in both surface and ground waters in the most number of tests does not reach standard. High Cd content in surface water has been found in the spring at the foot of dumps (12000 standards!) and in the stream near the western part of Muzhievo (6200 standards)

Map of surface and ground waters pollution with As in the area of the Muzhievo deposit



The As technogenic pollution aureole in water spreads from the dumps, and high As content of 460 standards has been found on the dumps foot while that decreases to 5-20 standards near Muzhievo town.

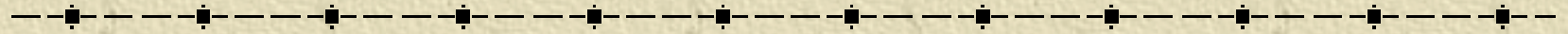
Toxic elements content in under-dump water of the Muzhievo deposit and migration coefficient of these elements

Sampled unit	Pb	Zn	Sr	V	Mn	Cu	Ni	Ti	Cr
Average content in dumps, mg/kg	2180	2990	<100	13,7	296	92	4,5	1120	17,4
Water test MW-3, mg/dm³	0,06	8	20	0.02	>200	2	1	2	2
MAC, mg/dm³	0,03	1,0	7,0	0,1	0,1	1,0	0,1	0,1	0,5
Exceeding MAC	2	8	2,9	-	>2000	2	10	20	4
Water migration coefficient	0,001	0,13	20,0	0,07	33,8	1,1	11,1	0,09	5,7

Results

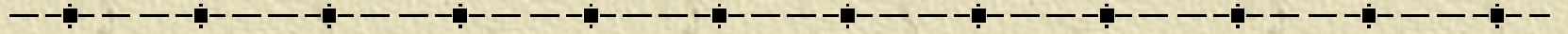
- ✦ Environment pollution with trace toxic elements in the Muzhievo deposit area has been caused by poor ore and host rock dumps, which have been heaped up during mining activity over a number of years.
- ✦ The most significant soil and water pollution practically over all deposit area is caused by arsenic. The aureoles of the moderate and high pollution levels in soil have been found around the Muzhievo deposit. Technogenic pollution aureole in water (5-20 standards) at the western part of Muzhievo town can be dangerous for inhabitants of Muzhievo.
- ✦ Cadmium content in surface (6200 standards) and ground (2 standards) waters can be especially dangerous for the environment around the Muzhievo town.
- ✦ Additional hazard comes from Mn and Ni compounds dissolved in surface and ground waters.

Recommendations



✦ 1) the wells in the western part of Muzhievo town should not be used but replaced with water pipe-line;

✦ 2) the water coming from under the dumps should be gathered into special water reservoir with subsequent sorbing valuable components using an ion exchange resin or other sorbents.



Thank you