THE INFLUENCE OF INDUSTRIAL TRUCK WASTES ON THE CHEMICAL COSUMPTION OF MORAINIC DEPOSITS

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Abstract
The general model of hypergene changes of moraine was taken into account during investigation of the descending migration of heavy metals from the 15 cm-thick layer of industrial waste occurring on the surface of the former filtration fields. According to estimations of 1991, reflecting the state of the ground of the filtration fields 10 years after their use was stopped, the main part of contaminants concentrates within upper 10 cm of sandy loam moraine underlying the waste layer. The repeated investigation of the filtration fields in 1999 made us to reject the conclusion about the equilibrium state of input/output of all the contaminants at the depth of more than 30 cm. The difference in geochemical behavior of studied elements observed during the period from 1991 to 1999 conform to the general scheme of their relative mobility under hypergene conditions: thus, in acidizing and acid–neutral geochemical environments, which are the character ones for the studied filtration fields, Cr and Pb, for example, possess correspondingly very low and low relative mobility, but Ni and Cu — the medium relative mobility. The recurrent analysing of metal content at the depth of 30—50 cm from the border surface (waste/moraine) expediently to carry out one time in 8—10 years.

Introduction
Within the former fields of filtration (total area is about 50 hectares) of clean-up facilities of the heavy trucks industry (PO «BelAZ», Zhodino, Belarus), the distribution of Cr, Ni, Cu and Pb in the 2 m-thick superficial layer of glacial till of Moscow age (Ag_2^2) has been studied. Mean granulometric composition of the till may be characterized as follows: <1—0.1 mm — 22 %, <0.1—0.01 mm — 41 %, <0.01—0.001 mm — 18 %, <0.001 mm — 13 %. Quartz, feldspars and carbonates dominate in the light mineralogical fraction (density <2.9 g/cm^3), and amphiboles, garnets and ilmenite in the heavy one (>2.9 g/cm^2). 0.3—0.5 % of the total weight of the deposits fall on the heavy fraction. The main clay mineral is illite. Kaolinite, smectite, chlorite and mixed-layered minerals are present as an admixture. Postdepositional changes of till under natural conditions cause dissolution of carbonates, decrease of glauconite content, increase of contents of the weathered biotite and opal phytoliths. Redistribution of feldspars between granulometric fractions and relative concentration of quartz are observed as well. Appearance of ferriferous and manganese authigenic phases is noted. Structural and textural features change significantly. Massive structure, psammitic-aleurithic-pelitic and pelitic-psammitic-aleurithic textures are shifted by cellular texture (1, 2). This regional model of postdepositional changes of morainic deposits was taken into account during investigation of the descending migration of the chemical elements from the 0.5—25 cm-thick layer of industrial waste occurring on the surface. The contents of the chemical elements in the waste average as follows (n = 16; ppm): Cr — 17 200 (2 400—78 800), Ni — 220 (100—730), Cu — 1 140 (670—3 940), Pb — 260 (83—1 140), in the same time, local geochemical background for till is (n = 10; ppm): Cr — 18, Ni — 13, Cu — 8, Pb — 13. The migration has been studied twice with the interval of 8 years.

Methods
Sampling and preparation of samples to an analysis have been carried out in correspondence with (3). The standard emission spectrum analysis method has been used to determine a content of chemical elements in samples of waste and morainic deposits.

Results
According to estimations of 1991, reflecting the state of the ground of the filtration fields 10 years after their use was stopped, the main part of contaminants washed out by meteoric waters concentrates within upper 5—10 cm of sandy loam till underlying the waste layer (n = 12; ppm): Cr — 59 (22—400), Ni — 15 (7—54), Cu — 10 (2.5—45), Pb — 11 (8.5—16). The following ratios of metals content in the waste and the underlying till were recorded (times): 240 (33—810) for Cr, 13 (6.9—40) for Ni, 120 (21—420) for Cu, 19 (8.9—43) for Pb.

Discussion
The main task of a study carried out in 1991 was to determine a proper, from the technical-economic and sanitary-environmental points of view, thickness of till bed which underlies a waste and is a subject of physical removal (as a rule, 10—15 cm; of about 2 000 m^3 in total), after which the area occupied by filtration fields was considered a suitable one for the construction of apartment buildings (city residential area). The exposed on the surface till bed should correspond to the following requirements: contents of Cr < 90 ppm (local geochemical background [lgb] $\times$ 5), Ni < 58 ppm (lgb + 45 ppm), Cu < 43 ppm (lgb + 35 ppm), Pb < 33 ppm (lgb + 20 ppm) (4, 5). Because of economic crisis in 1990s, affected the former Soviet Union republics, a construction at this area has not been started. A certain change in conjuncture in 1999 gave an opportunity to the PO «BelAZ» authorities to return to an implementation of this project. At that it was decided to take into account the results of studies conducted in 1991 as a kind of out of date «momentary photography», which probably does not reflect any more the real geochemical situation.

The repeated investigation of the filtration fields in 1999 made us to reject the conclusion about the equilibrium state of input/output of all the contaminants at the depth of more than 30 cm (waste + 10—15 cm of till) or at all about their complete fixation within upper 5—10 cm of till underlying the waste layer. Although the average contents (n = 14; ppm) of Cr — 28 (7—65) and 28 (12—100), Pb — 11 (9—20) and 13 (5—20) in the till at the depth of 40—50 cm below the surface did not change during 8 years, the values for Ni — 13 (6—22) and 23 (13—50), Cu — 7 (2—15) and 12 (3—25) became 1.7—1.8 times higher (Tab. 1).

The difference in geochemical behavior of studied elements observed during the period from 1991 to 1999 adjusts properly with the general scheme of their *relative mobility under hypergene conditions* (6—8): thus, in *acidizing* and *acid–neutral* geochemical environments, which are the character ones for the studied filtration fields, Cr and Pb possess correspondingly *very low* and *low* relative mobility, but Ni and Cu — the *medium* relative mobility.

Conclusions
The study carried out show that under the condition of considerable surface contamination of morainic deposits by the heavy trucks industry waste, the recurrent analysing of metal content at the depth of 30—50 cm from the border surface expediently to carry out one time in 8—10 years.

During 2003 — «Year of an order on the ground» in Belarus — the situation on the former filtration fields came into new stage at last. The PO «BelAZ» constructed the special concrete depository and started to move a waste and a polluted underlying ground into it. By the end of October 2003 we are planing to carry out the study of: 1) the geotechnics works quality (underlying ground cleaning degree etc.); and 2) the distribution of Cr, Ni, Cu, Pb in the different granulometric fractions (<1—0.5 mm, <0.5—0.25 mm, <0.25—0.1 mm, <0.1—0.05 mm, <0.05 mm, <0,001 mm) of the ground and the mobile (able to migrate) forms of these elements in the waste and ground samples from 1991, 1999 and 2003 years collection (extraction of 1 M HCl with atomic-adsorption technique (9)).

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Table 1. Content of Cr, Ni, Cu and Pb in the till at the depth 40—50 cm, ppm*

Test pit number	Cr		Ni		Cu		Pb	
	1991	1999	1991	1999	1991	1999	1991	1999
1	10	30	6	16	3	8	9	13
2	10	35	6	30	4	20	10	20
3	50	18	21	15	14	11	20	10
4	40	20	22	15	15	16	12	9
5	50	100	11	23	4	12	9	10
6	25	12	7	22	4	3	10	5
7	26	30	12	13	3	8	10	10
8	11	30	11	50	7	7	10	20
9	37	20	22	22	10	6	13	15
10	36	15	10	18	10	7	13	10
11	20	20	16	35	13	25	10	18
12	7	15	6	20	2	14	9	13
13	65	20	14	25	3	20	10	16
14	11	20	14	24	3	11	9	13
Average level	**28**	**28**	**13**	**23**	**7**	**12**	**11**	**13**

* It needs to be emphasized, that corresponding particular values of the years 1991 and 1999 *should differ,* because the values of content of chemical elements in this case depend on minimum three factors: [a] initial spatial heteregeneity of till (located together, but nevertheless different test pits); [b] errors of analytic method (approximately ±10 %); and [c] possible inflow of contaminants from the upper layer during 8 years elapsed between two samplings. Influence of factors [a] and [b] becomes insignificant while turning from specific values to the *average* ones.

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