Journal of Geochemical Exploration 144 (2014) 237–240

Contents lists available at ScienceDirect

Journal of Geochemical Exploration

journal homepage: www.elsevier.com/locate/jgeoexp

The biogeochemical characteristics of the content of heavy metals in soil, plants and animals in different natural areas of Bashkortostan

N.G. Kuramshina [a], E.M. Kuramshin [b], S.V. Nikolaeva [c], Y.B. Imashev [b]

[a] Department of Environmental Protection and Rational Use of Natural Resources, Ufa State University of Economics and Service, Doctor of Biological Sciences, Chernyshevsky St., 145, 450078 Ufa, Russian Federation
[b] Department of Physical and Organic Chemistry, Ufa State Petroleum Technical University, Doctor of Chemical Sciences, Cosmonauts St., 1, 450062 Ufa, Russian Federation
[c] Ufa State University of Economics and Service, Chernyshevsky St., 145, 450078 Ufa, Russian Federation

ARTICLE INFO

Article history:
Received 3 October 2013
Received in revised form 9 January 2014
Accepted 28 January 2014
Available online 6 February 2014

Keywords:
Heavy metals (copper zinc, lead, cadmium, manganese)
Soil cover
Forage (meadow hay wheat straw, cereal fodder)
Animal products (horse meat)

ABSTRACT

The authors have investigated the process of migration of heavy metals from soil to plants and animals in the zone of influence of oil and ore deposits with the aim of biological indication of the state of ecosystem and assessment of ecological safety of production of animal products in different agricultural areas of Bashkortostan. The authors have made a careful study of the central part of the republic with dominant agricultural complex as a background territory.

1. Introduction

The importance of understanding the problems of pollution by heavy metals (HM) of the agricultural production is determined by the fact that animals are on the higher level of the food chain, used for food, and for bioindication of the state of ecosystems pollutants (Fomichev U.P., 2000; Kuramshina et al., 2010; Mosina, 2000). In this regard, the processes of migration HM in biogeochemical chain: soil → plants → animals. As objects of research are selected territory West of Bashkortostan (Tuimazinsky district) located in the conditions of exploitation of oil and gas complex and the Bashkir Zauralye (Haybullinsky district), where the mining of the mineral deposits. As background territory of selected Karmaskalinsky and Birsk areas away from the city of Ufa for a considerable distance (picture).

2. Material and methods

In each area of the study conducted selection of 16 samples of soil, on 18 samples of hay, straw and fodder grain and 8 samples horse meat. Soil sampling (16.0517.06.2011r.), fodder (01.08–15.09.2011r.) held in places of horses grazing in the period according to GOST 28168-89, GOST R ISO 6497-2011 and GOST 30692-2000, respectively. Sampling of meat of horses (01.11–20.12.2011) performed according to GOST 9959-91. The content of HM in soil samples, fodder and meat were carried out in accordance with RD 52.18.685-2006 and GOST 30178-96 using AAS instruments «Spectrum-3-P1» and «Quantum 2A».

3. Results and discussion

Receipt of HM in the soil also occurs due to anthropogenic influence with precipitation, by pesticides and fertilizers (Mosina, 2000). A significant number of the HM contain double superphosphate (zinc — 38; lead — 39; copper — 14; cadmium — 3.7 mg/kg). The main supplier of zinc compounds in the soil serves as manure (111 mg/kg) (Khaziev et al., 2000).

In the studied soil samples with different natural and agricultural zones total content HM close to existing background levels and MPC (Table 1).

Overconcentration of manganese and cadmium in comparison to MPC figures was observed in the soil probes of Trans-Ural steppe areas.

High ratio figures of HM (C_{HM}) concentration to the corresponding MPC (C_{HM}/MPC) increasing in the line: Pb:Cd:Mn:Cu:Zn = 0.47:0.52:0.63:0.80:0.88 are typical for this areas. There has been established reliable difference in zinc and cadmium concentration in the soil samples from Northern forest-steppe areas zone and Trans-Ural steppe areas.

E-mail addresses: n-kuramshina@mail.ru (N.G. Kuramshina), ens.kuramshin@mail.ru (E.M. Kuramshin), post@ugues.ru (S.V. Nikolaeva), info@rusoil.net (Y.B. Imashev).

0375-6742/$ – see front matter © 2014 Elsevier B.V. All rights reserved.
http://dx.doi.org/10.1016/j.gexplo.2014.01.027

Table 1
The total content of heavy metals in the soil of different natural and agricultural areas of Bashkortostan.

Natural and agricultural areas of the Bashkortostan (district)	HM concentration in the soil, mg/kg				
	Copper, M ± m	Zinc, M ± m	Manganese, M ± m	Lead, M ± m	Cadmium, M ± m
Northern forest-steppe areas					
Birsky[a]	14.5 ± 2.8	23.5 ± 4.7	655 ± 131	13.3 ± 2.7	0.18 ± 0.04
Southern forest-steppe areas					
Ufimsky[a]	19.7 ± 3.9	34.4 ± 6.8	765 ± 153	16.2 ± 3.2	0.38 ± 0.07
Karmaskalinsky[a]	21.8 ± 4.4	36.2 ± 7.2	740 ± 148	19.8 ± 4.0	0.21 ± 0.04
Forest-steppe areas lying to the west of the Urals					
Tuymazinsky[a]	14.2 ± 2.7	32.4 ± 6.4	790 ± 158	15.2 ± 3.0	0.34 ± 0.06
Trans-Ural steppe areas					
Khaybullinsky[a]	24.0 ± 4.6	44.0 ± 9.0[a]	940 ± 190	15.5 ± 3.0	0.52 ± 0.10
Background content	8–25	28–68	800–860	6–20	0.05–0.24
MPC [2]	30	50	1500	32	1.0

[a] Results obtained by statistical processing of the experimental data for n = 16 (Gromyko, 2003).

Table 2
Heavy metal concentration in forage produced in different areas of Bashkortostan.

Natural and agricultural zone of the Bashkortostan (district)	HM concentration in forage, mg/kg				
	Copper, M ± m	Zinc, M ± m	Manganese, M ± m	Lead, M ± m	Cadmium, M ± m
Northern forest-steppe areas					
Birsky[a]					
Hay	3.6 ± 0.8	12.8 ± 2.8	62.3 ± 12.1	2.0 ± 0.4	0.12 ± 0.04
Straw	6.7 ± 1.3	10.1 ± 2.4	47.7 ± 8.5	3.2 ± 0.6	0.10 ± 0.03
Cereal fodder	4.2 ± 0.8	5.3 ± 1.2	38.1 ± 7.5	0.5 ± 0.1	0.03 ± 0.01
Southern forest-steppe areas					
Ufimsky[a]					
Hay	3.3 ± 0.7	14.1 ± 3.0	73.4 ± 15.0	3.5 ± 0.7	0.33 ± 0.10
Straw	4.2 ± 0.8	11.4 ± 2.3	58.5 ± 12.0	4.0 ± 0.8	0.21 ± 0.06
Cereal fodder	4.7 ± 0.9	7.7 ± 1.5	46.8 ± 10.0	0.6 ± 0.1	0.07 ± 0.02
Karmaskalinsky[a]					
Hay	5.2 ± 1.1	17.2 ± 3.5	68.2 ± 14.0	3.8 ± 0.8	0.16 ± 0.05
Straw	6.8 ± 1.3	15.3 ± 3.0	61.4 ± 12.3	4.7 ± 1.0	0.12 ± 0.04
Cereal fodder	3.1 ± 1.0	7.1 ± 1.5	42.6 ± 8.5	0.8 ± 0.2	0.04 ± 0.01
Forest-steppe areas lying to the west of the Urals					
Tuymazinsky[a]					
Hay	2.6 ± 0.5	13.0 ± 2.6	56.3 ± 11.3	2.1 ± 0.4	0.26 ± 0.08
Straw	5.5 ± 1.1	10.1 ± 2.0	46.2 ± 9.2	3.4 ± 0.7	0.18 ± 0.05
Cereal fodder	3.3 ± 0.7	8.5 ± 1.7	28.8 ± 5.8	0.7 ± 0.2	0.06 ± 0.02
Trans-Ural steppe areas					
Khaybullinsky[a]					
Hay	3.8 ± 0.8	19.1 ± 4.0	81.5 ± 16.2	2.6 ± 0.5	0.41 ± 0.12
Straw	11.5 ± 2.3	35.3 ± 7.0	102.6 ± 20.5	3.6 ± 0.7	0.30 ± 0.10
Cereal fodder	5.9 ± 1.2	13.8 ± 2.7	58.9 ± 11.8	0.6 ± 0.1	0.10 ± 0.03
MPC [2]	30.0	50.0	–	5.0	0.3

[a] Results obtained by statistical processing of the experimental data for n = 18 (Gromyko, 2003).

Table 3
Heavy metal concentration in the horses' muscular tissue from different natural and agricultural areas.

Natural and agricultural zone of the Bashkortostan (district)	HM concentration in muscles, mg/kg				
	Copper, M ± m	Zinc, M ± m	Manganese, M ± m	Lead, M ± m	Cadmium, M ± m
Northern forest-steppe areas					
Birsky[a]	2.5 ± 0.2	17.4 ± 2.3	1.3 ± 0.1	0.8 ± 0.2	0.08 ± 0.01
Southern forest-steppe areas					
Ufimsky[a]	2.0 ± 0.1	20.5 ± 2.6	1.6 ± 0.3	1.2 ± 0.3	0.20 ± 0.02
Karmaskalinsky[a]	2.6 ± 0.3	24.4 ± 3.2	1.5 ± 0.2	1.4 ± 0.4	0.10 ± 0.02
Forest-steppe areas lying to the west of the Urals					
Tuymazinsky[a]	1.8 ± 0.1	19.5 ± 2.0	1.2 ± 0.1	0.9 ± 0.2	0.16 ± 0.03
Trans-Ural steppe areas					
Khaybullinsky[a]	3.6 ± 0.4	42.0 ± 4.5	2.2 ± 0.4	1.0 ± 0.3	0.24 ± 0.04
MPC [2]	0.5–5.0	10–70	0.1–2.5	0.5	0.05

[a] Results obtained by statistical processing of the experimental data for n = 8 (Gromyko, 2003).