ҚАЗАҚСТАН РЕСПУБЛИКАСЫ БІЛІМ ЖӘНЕ ҒЫЛЫМ МИНИСТРЛІГІ
Л.Н. ГУМИЛЕВ АТЫНДАҒЫ ЕУРАЗИЯ ҰЛТТЫҚ УНИВЕРСИТЕТІ

ЕУРАЗИЯ ҰЛТТЫҚ УНИВЕРСИТЕТІ

ЖАС ҒАЛЫМДАР КЕҢЕСІ

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СБОРНИК МАТЕРИАЛОВ XI Международной научной конференции студентов и молодых ученых **«НАУКА И ОБРАЗОВАНИЕ - 2016»**

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3.3 Химия

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ATMOSPHERIC DEPOSITION OF TRACE ELEMENTS IN THE SOME REGIONS OF KAZAKHSTAN

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Abstract – The method of moss biomonitoring of atmospheric deposition of trace elements was applied for the first time in the Mountains of Southeastern Kazakhstan to assess the environmental situation in this region. The twenty-three moss samples were collected in summer of 2014 growth period. A total of 42 elements (Na, Mg, Al, Cl, K, Ca, Sc, Ti, V, Cr, Mn, Fe, Ni, Co, Zn, As, Se, Br, Rb, Sr, Zr, Nb, Mo, Ag, Cd, Sb, Ba, La, Ce, Nd, Sm, Eu, Gd, Tb, Dy, Tm, Hf, Ta, W, Au, Th, and U) were determined by epithermal neutron activation analysis.Multivariate statistical analysis of the results obtained was used to assess the pollution sources in the study area of the some regions of Kazakhstan.

Keywords: Air pollution, moss biomonitoring, heavy metals, trace elements, epithermal neutron activation analysis.

1. Introduction

The state of the environment and thus the health of the population largely depend on the state of the earth's atmosphere. The atmosphere basically consists of a mixture of natural gases (Baumbach et. al., 1996). The particulates pass into the air either from natural sources (soil, rocks, water bodies and living organisms) or as a result of anthropogenic activity (industry, transport, fuel, human waste, etc.). Essentially, atmosphere is an aerosol system, where solid particles are dispersed in a mixture of gases. Among the various types of pollutants, the most hazardous are heavy metals (Market and Friese, 2000; Wolterbeek and Freitas, 1999; Market et al., 2008).

The use of mosses as biomonitors of atmospheric deposition of metals on a regional scale was introduced in Scandinavia more than three decades ago (Rühling and Tyler 1973), and it is presently widely accepted as a method to assess the atmospheric deposition of metals (Harmens et al. 2015). Mosses have only a rudimentary root system and readily take up elements from the atmosphere. The main advantages of the method are the simplicity of sample collection and the relative ease of analysis compared to precipitation samples conventionally used to assess metal deposition (Rühling and Steinnes 1998).In addition, the abundance and large geographical distribution of mosses is advantageous and provides for an inexpensive and simple alternative to conventional bulk deposition analysis. Thus, a high density network of sampling sites is easily achieved. This allows for pollution distribution maps to be produced (Harmens, 2015).

2. Experimental

Study area. The Republic of Kazakhstan is a country in Central Asia, with a minor part west of the Ural River and thus in Europe. Kazakhstan is the world's largest landlocked country by land area and the ninth largest country in the world; its territory of 2,724,900 square kilometres (1,052,100 sq mi) is larger than Western Europe. It has borders with (clockwise from the north) Russia, China, Kyrgyzstan, Uzbekistan, and Turkmenistan, and also adjoins a large part of the Caspian Sea. The terrain of Kazakhstan includes flatlands, steppe, taiga, rock canyons, hills, deltas, snow-capped mountains, and deserts with an estimated 18 million people as of 2014. Kazakhstan is the 61st most populous country in the world, though its population density is among the lowest, at less than 6 people per square kilometer (15 people per sq. mi.).

Sampling and sample preparation. In compliance with the Moss Manual 2015 (Harmens and Frontasyeva, 2015; http://icpvegetation.ceh.ac.uk/) the three moss species *Hylocomium splendens*, *Pleurozium schreberi*, *Hypnum cupressiforme* were collected over the Almaty, Shymkent, Semey, Pavlodar, Kokshetau regions and near the Irtysh river during the period of summer growth period of timein 2014 and 2015.

Samples were collected in forest glades or on open heath to reduce through-fall effects from the forest canopy, and the sampling sites were located at least 300 m from main roads, 100 m from local roads, and 200 m from villages. Collected material was stored in paper bags. A separate set of disposable polyethylene gloves was used for collection of each sample.

In the laboratory the samples were cleaned from extraneous plant material and air-dried to constant weight at 30–40°C for 48 h. The samples were neither washed nor homogenized. Green–brown moss shoots representing the last 3 years' growth were subjected to analysis, as they correspond approximately to the deposition over the last 3 years. Previous experience from the use of NAA in moss biomonitoring has shown that samples of 0.3 g are sufficiently large to be used without homogenization (Steinnes et al. 1994).

Analysis

Concentrations of elements (of Na, Mg, Al, Cl, K, Ca, Sc, Ti, V, Cr, Mn, Fe, Ni, Co, Zn, As, Se, Br, Rb, Sr, Zr, Nb, Mo, Ag, Cd, Sb, Ba, La, Ce, Nd, Sm, Eu, Gd, Tb, Dy, Tm, Hf, Ta, W, Au, Th, and U) were determined by instrumental epithermal neutron activation analysis (ENAA). (Frontasyeva, 2011). ENAA of moss samples was carried out at the IBR-2 pulsed fast reactor (JINR, Dubna) as described elsewhere (Frontasyeva, 2011; Frontasyeva and Pavlov; 2000, Dmitriev and Pavlov, 2013). Concentrations of elements based on short-lived radionuclides were determined by irradiation for 3 min under a thermal neutron fluency rate of approximately 1.3·1012 n cm-2 s-1. Gamma spectra of induced activity were measured twice, for 3 min after 5–7 minutes of decay. For determination the long-lived isotopes a cadmium-screened irradiation channel under a resonance neutron fluency rate of approximately 1.6·1012 n cm-2 s-1 was used. Samples were irradiated for 90 h, repacked and then measured after 4–5 d of decay during 45 m.

Induced gamma activity was measured by HP detectors with the resolution of 1.9 keV for the 60Co 1332 keV gamma line. A software package developed at the JINR (Dmitriev and Pavlov, 2013) was used to process gamma spectra and calculate concentrations of elements based on relative method using the NIST Standard Reference Materials (SRM):1575a Pine Needles,1632b Trace Elements in Coal (Bituminous), 2710Montana Soil, and 667 Bureau Community of Reference (BCR).

3. Results and discussion

The concentrations of Na, Mg, Al, Cl, K, Ca, Sc, Ti, V, Cr, Mn, Fe, Ni, Co, Zn, As, Se, Br, Rb, Sr, Zr, Nb, Mo, Ag, Cd, Sb, Ba, La, Ce, Nd, Sm, Eu, Gd, Tb, Dy, Tm, Hf, Ta, W, Au, Th, and U determined by epithermal neutron activation analysis in the moss samples are reported. Multivariate statistical analysis of the results obtained was used to assess the pollution sources in the study areas.

The descriptive statistics of the 22 analysed elements in all collected moss samples (n=23, for Almaty region) is shown in Table 1. All values in Table 1 are given in mg kg^{-1}, dry weight. In Table 1 and median values and minimum-maximum ranges for the contents of all elements were compared with the data obtained in Republic of Macedonia (Barandovski, et al., 2010), and the data obtained from Georgia moss survey in 2014 and the data Norway considered as a pristine area of Europe (Shetekauri, et al., 2015).

A comparison of concentrations Kazakhstan-Norway showed the increased values for most of heavy metals (Fe, Mn, Ti, V, As, Mg, Al, Ca, etc) in the studied samples that apparently are due to the state of the industrial sector of Kazakhstan. The main potential sources of air pollution from the industrial sector of Kazakhstan.

Table1. Comparison of the median values and ranges of element content in moss from Kazakhstan between data of the moss survey Norway,Georgia and Macedonia (all data are given in mg kg^{-1})

	Kazakhstan moss survey 2014		Georgia moss survey 2014 (Shetekauri, et al. 2015)		Macedonia moss survey 2010 (Barandovski, et al., 2010)		Norway moss survey (Shetekauri, et al. 2015)	
No of samples	n=23		n=16		n=72		n=100	
Element	Median Range		Median Range		Median Range		Median Range	
^{27}Mg	**6060**	**1710-24800**	**4410**	**2720-11600**	**1900**	**610-4900**	**1730**	**940-2370**
^{28}Al	**9510**	**33,8-35100**	**5195**	**2450-20800**	**1900**	**540-8700**	**200**	**67-820**
^{38}Cl	**180**	**95,5-1270**	**225**	**140-465**	**-**	**-**	**nd**	**nd**
^{42}K	**10800**	**3820-23200**	**5875**	**3080-9040**	**4600**	**2100-7600**	**nd**	**nd**
^{49}Ca	**12500**	**2340-24000**	**11800**	**7140-15300**	**7100**	**2900-12000**	**2820**	**1680-5490**
^{51}Ti	**603**	**99-3920**	**547**	**216-2070**	**-**	**-**	**23.5**	**12.4-66.4**
^{52}V	**13**	**1,7-56,7**	**11.8**	**6.2-54.0**	**3.5**	**1.0-17**	**0.92**	**0.39-5.1**
^{56}Mn	**178**	**70,5-1260**	**158**	**70-592**	**130**	**30-440**	**256**	**22-750**
^{59}Fe	**4770**	**1580-25900**	**3935**	**1640-14700**	**1500**	**510-6300**	**209**	**77-1370**
^{65}Zn	**67**	**22-136**	**38.1**	**17.3-68.7**	**20**	**1.0-129**	**26.5**	**7.9-173**
^{86}Rb	**21,7**	**5,4-79,9**	**9.705**	**2.57-22.2**	**-**	**-**	**7.7**	**1.3-51.5**
^{124}Sb	**0,46**	**0,162-**	**2.795**	**1.3-5.1**	**-**	**-**	**2.5**	**0.6-41.7**

^{131}Ba	**104**	**1,11 36,6-439**	**0.19**	**0.095-0.30**	**34**	**7.1-240**	**0.033**	**0.004-0.240**

4. CONCLUSIONS

The performed preliminary investigation shows that the moss biomonitoring of atmospheric deposition of heavy metals is an efficient technique to study the environmental situation in the Kazakhstan. The experience of this study can be successfully used in the other regions of the Kazakhstan. Also, there will be maps of the spatial distribution of elements and radionuclides in the study area, based on the statistical analysis of the data created with the use of maps of the distribution of elements, will assess potential sources of pollutants into the environment.

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