

**SEASONAL CHANGES OF WATER- AND ACID-SOLUBLE COMPOUNDS OF DUST AEROSOL
ACCORDING TO PASSIVE SAMPLING**

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The problem of air pollution is one of the most serious ecological problems. There are a lot of different types of pollutants from natural and technogenic sources. The main part of them are harmful for human health and can be a cause for different diseases, that is why it is necessary to control air quality. Scientists use different methods of investigations to collect information about it.

Increasing industrial activities and use of motor vehicles in urban environments led to many health and environmental problems. Monitoring of inorganic and organic environmental pollutants is performed in order to establish the quality of different components of our environment (atmosphere, indoor air, water basins, soil, and biota) and represents an ongoing challenge. Environmental monitoring systems are characterized by usage of different methods to accumulate aerosols.

A relatively large number of samples must be taken from a given location over the entire duration of sampling when the method of active sampling is applied. This type of approach to sampling is time-consuming and can be very costly.

The aim of research is to evaluate seasonal composition changes of dust aerosol according to passive sampling and analyze the differences in the ratios of metals between the water- and acid-soluble fractions are revealed.

The site for the passive aerosol monitoring was arranged in September 2016 at the Fonovaya Observatory, Institute of Atmospheric Optics, Siberian Branch, Russian Academy of Sciences (60 km west of Tomsk) (fig. 1). First results of these simultaneous field studies, obtained from September to November 2016, the second – from November 2016 to March 2017 and the last – from March to June 2017.

Aerosols were collected passively within the same near-ground air layer at specially arranged aerosol sites in the immediate (within 10 m) vicinity of the instruments of active sampling. Aerosols were deposited on chemically inert sorption substrate. Special devices, impulverators [1], were used to expose the aerosol. The construction of the impulverator ensures the natural mechanism of dry deposition of aerosols from the atmosphere.



Fig.1 The site for the passive aerosol sampling

In all, 160 impulverators were mounted at the site. Ash-free paper filters (“white strip”) 18 cm in diameter are used for depositing the chemically-inert sorption substrate. Four filters were placed in each impulverator, the exposure interval being from September 6 to November 8, 2016 (autumn period), from November 8, 2016 to March 4, 2017 (winter period) and from March 4 to June 1, 2017 (spring period).

After removing from impulverators, filters were used to prepare water and acid extracts $\omega(\text{HNO}_3) = 5\%$. Filters were aged in acid solution for 24 h. The chemical inhomogeneity of sorbent was accounted for by including in each specimen of material analyzed the “idle” (control) samples, i.e., clean filters from the same packet as the filters mounted in devices. The quantitative chemical analysis of water and acid extracts was also performed using inductively coupled plasma mass spectroscopy (ICP-MS) [2]. The index, characterizing the ratio of mass concentration of metal in solution ($\mu\text{g dm}^{-3}$), recalculated per 1 g of filters, was chosen as a parameter for comparison.

However, elements in the sample widely varied in the content ($n \times 10^2 - n \times 10^{-5}$) so that they could not be shown in a single picture. Therefore, normalized values or, more specifically, the coefficient (A_i) (1) and the modulus of aerosol enrichment (M_i) (2).

$$A = \frac{c_i}{C_i} \quad (1)$$

c_i – concentration of the element in sample; C_i – middle average of the element in clean filter

$$M^w = \frac{A^w}{A^a} \quad (2)$$

$$\text{or } M^a = \frac{A^a}{A^w} \quad (3)$$

M – modulus of aerosol enrichment, A^w – coefficient of aerosol accumulation in water extract, A^a – coefficient of aerosol accumulation in acid extract

According to coefficients values, each type of extracts is characterized by seasonal changes of elemental composition and filters are enriched by some elements during all seasons (fig.2). It allows us to suppose elements' effluence as in water-soluble, as in acid-soluble fractions. Water extract enriched by Al, Mn, Fe, Zn, Ga, Se, Y, Cd, In, Ba, La, Ce, Sm, Pr, Nd, Sm, Eu, Tb, Dy, Ho, Tl, Bi, Th, acid - Al, Ni, Zn, Se, Cd, Sb, La, Tl, Pb, Bi.

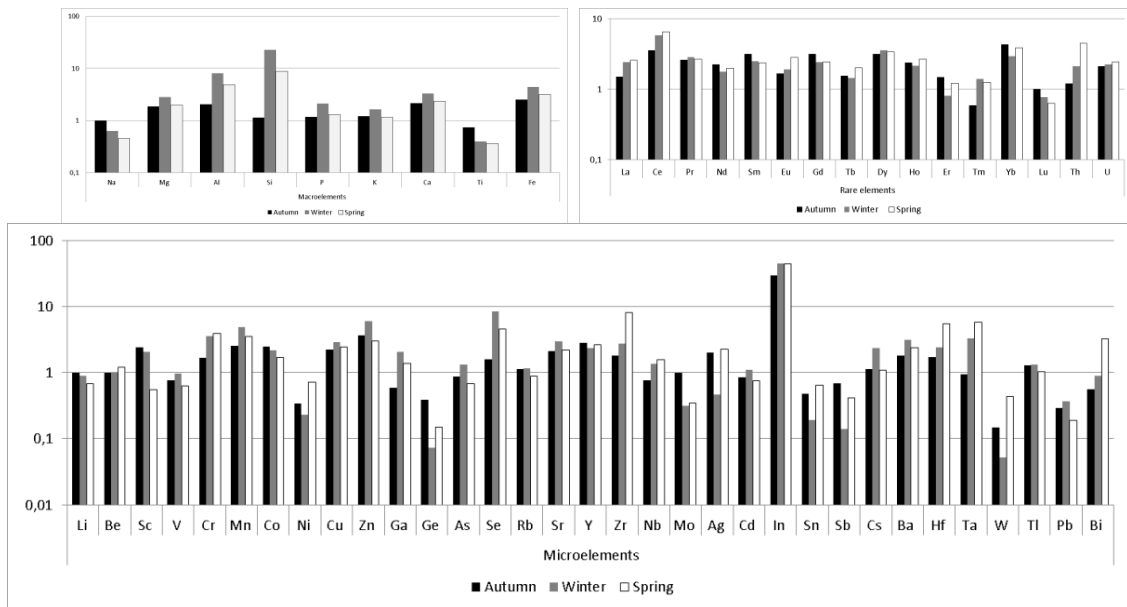


Fig.2 Coefficients of aerosol accumulation (a – macroelements; b – rare elements; c – microelements)

Aerosol enrichment' modulus during autumn describe by high values for Na, Sm, Gd, Yb, Sc; in winter there are microelements and also Dy, Mn, Zn, Ga, Se, Sr, In, Cs, Ba; and La, Ce, Eu, Th, U, Zr, Hf, Ta, Bi in spring period.

Acid extracts in autumn are characterized by high modulus' values for Al, La, Ce, Pr, Eu, Tb, Tm, Th, Ni, Nb, Sn W; in winter Si, P, K, Ca, Yb, U, Li, Cr, Cu, Sr, Zr, In, Hf, Ta; and in spring Na, Ti, Nd, Er, Lu, Sc, V, Ge, As, Mo, Sb, Pb. Comparison of modulus for both extracts shows us, that chemical elements are mainly accumulated in water extracts, at the same time, the largest values for Na, Li, Ni, Ge and W characterize acid extracts.

According to our results, water- and acid-soluble fractions of aerosol have differences in chemical composition during three seasons. Comparison of the coefficients of aerosol accumulation and modulus of aerosol enrichment shows us predominant accumulation of water-soluble fractions of the chemical elements. Furthermore, each fraction is characterized by its own seasonal changes of both fractions. Most of chemical elements accumulate in winter and spring seasons, that can cause by activity of heat power industry [3].

References

1. RF Patent No. 72844, Publ. November 16, 2009.
2. RF Patent No. 2459191, Byull. Izobret., No. 23 (2008).
3. Yazikov E.G., Avtoref. of Doctoral Dissertation in Geology and Mineralogy (Tomsk, Tomsk Polytechnic Univ., 2006, 47p.).