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Technogenic fallout of Uranium and Thorium in the vicinity of Novosibirsk (Russia, West Siberia)

Svetlana Yu. Artamonova*

V.S. Sobolev Institute of Geology and Mineralogy SB RAS, Novosibirsk, 630090, Russia

Abstract

Evaluation of the contribution of definite pollution sources among many others is rather complicated scientific challenge, but its solution may become decisive for the realization of measures aimed at ecological remediation of the territories. Element composition of aerosol particles accumulated during winter in the snow cover of Novosibirsk was determined by means of X-ray fluorescence measurements with synchrotron radiation at the "Siberian Synchrotron and Terahertz Radiation Center" based on VEPP-3 of the Budker Institute of Nuclear Physics SB RAS. Means of ICP-MS and scanning electron microscopy were used additionally. These studies allowed revealing the contribution of separate industrial enterprises into the general technogenic pollution of the megapolis with uranium and thorium.

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Keywords: XFA-SR, geochemistry of technogenesis**,** emission from power plants, emission from nuclear fuel plants, technogenic aerosol, natural radionuclides, uranium isotopes, ecological risk

1. Introduction.

Air pollution in industrial cities had become an urgent problem long ago. Investigation of uranium and thorium content in technogenic aerosol is especially urgent because of the risk for human health. Under the conditions of Siberia, snow cover is an ideal object to study geochemistry of technogenesis because of accumulation of aerosol particles and gaseous compounds in it.

* Corresponding author- Svetlana Yu. Artamonova. Tel.: +7-913-700-32-91 fax: +7-383-333-27-91.
E-mail address: artam@igm.nsc.ru

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It is known that snow crystals in winter (and raindrops in summer) passing through the air capture solid aerosol particles and gaseous compounds. Also, there is fallout of heavy aerosol particles under gravity.

The goal of the work was evaluation of the radioactive uranium-thorium content of technogenic aerosol pollution of Novosibirsk vicinity.

Objects of investigation. There are 4 heat-electric generating plants (HEPP) in Novosibirsk (рис.1, *a*); two of them (HEPP-2 and HEPP-3) are situated at the left bank of the Ob. The nuclear fuel plant – Novosibirsk Chemical Concentrates Plant (NCCP) – produces fuel elements for atomic stations and has its own HEPP-4 similar in parameters with HEPP-3 (see Fig. 1, *b*). The fuel used at HEPP-2 is mainly black oil, while HEPP-3 and HEPP-4 use natural gas. Only the most powerful (by a factor of 2.5) plant HEPP-5 uses brown coal as fuel: the amount burnt every day is 10000 t by http://news.ngs.ru/photo/2372183/ (2016). Coal is known to be a natural sorbent; it can contain substantial amounts of U and Th, so emission from power plants can also contain these radionuclides. There is also a Tin Plant (NTP) in Novosibirsk; its emission pollutes urban air with As, Sn and a number of other chalcophilic elements by Artamonova et al. (2007, 2011)(see Fig.1, *c*).

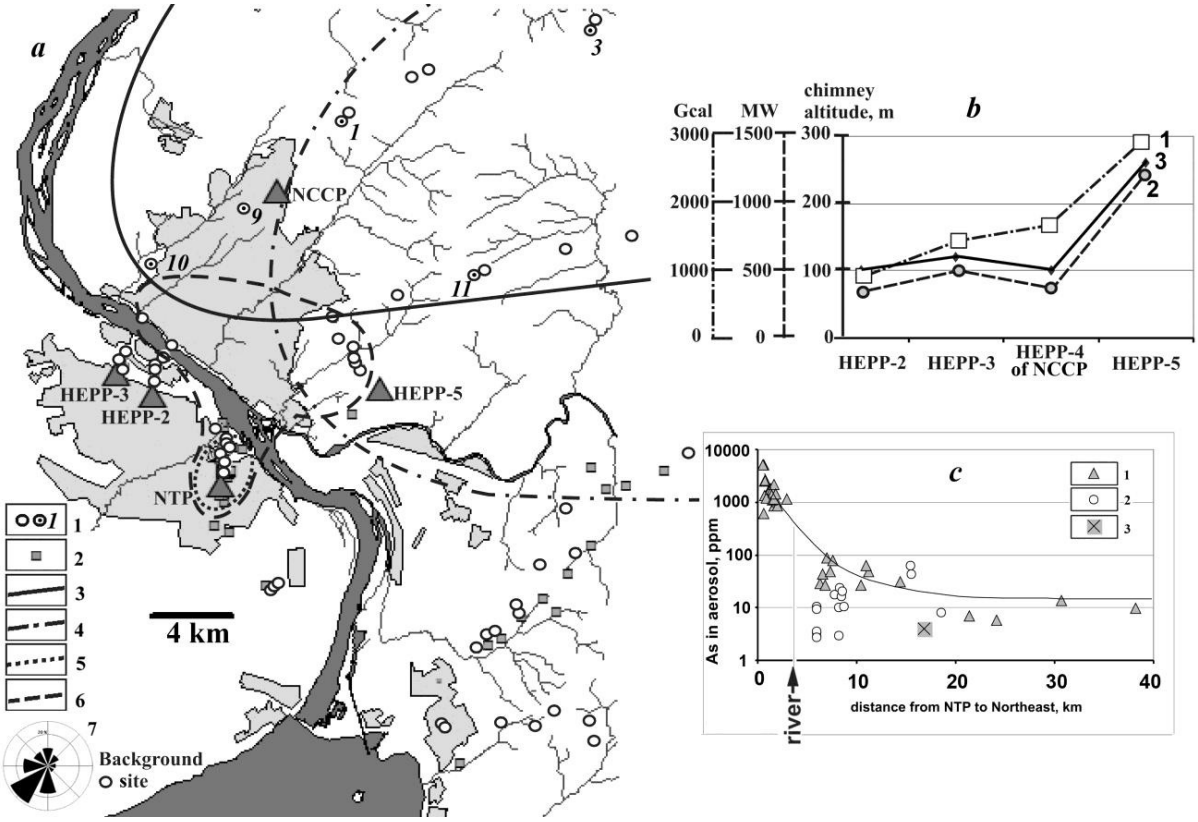

Fig. 1. (*a*) Location of the industrial enterprises of Novosibirsk. Designations: sampling points: 1 – snow (number), 2 – soil; diffuse aureole of aerosol pollution: 3 – from NCCP, 4 – from HEPP-5, 5 – from NTP, 6 – trace pollution from NTP, 7 – wind rose; (*b*) The diagram shows the major parameters of HEPP facilities in Novosibirsk: thermal power, Gcal (1), electric power, MW (2), and chimney height, m (3); (*c*) Dynamics of a decrease in As content in the diffuse aureole of aerosol pollution with an increase in the distance in the north-eastern direction (according to the wind rose) (1), in other directions (2); the content of As in aerosol in the background site (3) (the line shows the trend of changes).

Experimental. The winds of southern and south-western direction dominate in the region under investigation in winter by The climate of Novosibirsk (1979), so the main directions of snow cover sampling were to the north-east of the plants at a distance up to 110 km from the city (Fig. 1, *a*). The background site was chosen at the windward side at a distance of 12 km in the southwestern direction from the city.