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Trace element concentrations in needles and bark of Larix Sibirica within the Mo-W ore field (Buryat Republic, Russia)

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The present study aims to assess the changes in the trace element (TE) composition of *Larix Sibirica* species growing in the impact area of Dzhida Mo-W plant in the Zakamensk city. The objectives of the study were: (1) to reveal the biogeochemical background features and changes in the TE composition of larch needles and bark in the mining region; (2) to determine patterns of spatial distribution of TE content in larch organs; (3) to assess the ecological state of larch plantation in different land-use zones of the city.

A landscape-geochemical survey of the territory was carried out in summer of 2013. Total of 21 mixed (taken from 3-5 trees) samples of needles and bark were collected in undisturbed and different land-use areas. The bulk contents of TEs in dry plant samples were analyzed by mass spectrometry with induced coupled plasma. Sixteen priority pollutants were selected for thorough analysis, including elements of hazard classes I (Zn, As, Pb, Cd), II (Cr, Co, Ni, Cu, Mo, Sb), III (V, Sr, Ba, W), and some others (Sn, Bi).

Concentrations of TEs (C_b) in background trees were compared with the global clarks (C_g) for annual increment of terrestrial vegetation (Dobrovol'skii 2003) via calculating the global enrichment $EF_g = C_b/C_g$ and dispersion factors $DF_g = C_g/C_b$. The concentrations of the elements in the urban samples C_i were grouped depending on the type of land use and compared with the background (C_b) via calculating the local enrichment $EF_l = C_i/C_b$ and dispersion factors $DF_l = C_b/C_i$. The ecological state of the urban plants was diagnosed using three TE ratios. The Fe/Mn ratio represents photosynthetic activity with optimum value 1.5-2.5. The Pb/Mn ratio characterizes balance between technogenic and biophilic elements, its value for unpolluted terrestrial plants is 0.006. The Cu/Zn ratio determines the proportionality in the provision of enzyme synthesis with these metals, its optimum value is 0.27.

TE composition of needles of background larch is characterized by increased concentrations of Mn (EF_g=2.9) Sr (1.5), and reduced ones for Ni, Co, Pb, Mo, Sn, V (DF_l=5.1-22.1), that of Cd, Cu, Zn are close to global clarks. Ba, Pb, Cd (EF_g=3.5-2.3) are accumulated in the bark, Cu, Zn, Co, Cr, Ni, Sn dissipate (DF_g=2.1-3.7), and the content of Mn, Sr, Mo, V, As is close to Cg. In the city larch needles accumulate Cr (EF_l=37.8), W (18.9), V, Pb, Bi (8.6-11.4), Sb, Ni, Cd, Sn (6.6-2.5); Mn (DF_l=3.1) is among scattered. Changes in the TE composition of larch bark is most clearly evident in the industrial area, where high concentrations of W, Sn (EF_l=5.4-6.6), Sb, Pb, As (2.8-3.4), Mo, Cd, V, Bi, Zn (1.5-2.0) and low ones – of Cr, Ni, Co, Ba (DF_l=4.6-2.1) are observed.

As an indicator of long-term pollution, bark displays that vegetation of industrial zone has been subject previously to most intense anthropogenic impact, so, Pb/Mn=0.06 was there the highest. After plant closing residential area experiences the greatest impact according to Fe/Mn=4.7; Pb/Mn=0.04 values in the needles. This is caused by the active transport of aeolian dry material of tailings.

1. Dobrovol'skii VV (2003) Basics of biogeochemistry: the textbook for students of higher educational institutions. Moscow, "Academia" Publ., 400 p.