Geophysical Research Abstracts
Vol. 21, EGU2019-2465-1, 2019
EGU General Assembly 2019

Dynamic fractionation for the assessment of the mobility and availability of toxic elements in polluted soils

Petr Fedotov (1,2)

(1) Vernadsky Institute of Geochemistry and Analytical Chemistry, Russian Academy of Sciences, Moscow, Russia (fedotov_ps@mail.ru), (2) National University of Science and Technology "MISiS", Moscow, Russia

The impact of anthropogenic metals/metalloids on polluted soil environments cannot be evaluated by measuring merely the total concentration of individual elements, because the mobility and bioavailability strongly depend on their chemical forms and type of binding with the sample matrix. Apart from in-vivo studies on the uptake and accumulation of trace elements (TEs) by plants, in-vitro chemical fractionation of TEs in soil according to their physicochemical mobility can offer insights into their fate and behavior. Fractionation of TEs into operationally defined forms under the sequential action of given extracting reagents with increasing aggressiveness is a common approach in biogeochemical studies for distinguishing various species of TEs. Conventional batchwise sequential extraction methods have been consolidated as tools for investigation of the environmental behavior of TEs. However, the significance of the results in terms of environmental availability is, in fact, debatable because naturally occurring processes are always dynamic. Alternative methodologies relying on the continuous provision of fresh extractant volumes to the solid sample under investigation have been developed. Particulate samples are retained or fixed in a column whereas different aqueous solutions of acids, salts and complexing reagents are continuously pumped through. Dynamic (continuous flow) conditions allow one to minimize two main artifacts of batchwise extraction, namely, the phase overlapping and the re-adsorption.
An example of promising application of dynamic fractionation in a rotating coiled column is the exposure assessment of Cu, Pb, Zn, and Cd in hazardous wastes of a tungsten-molybdenum plant and soils, which had been buried under tailing dumps during seventy years [1]. Exchangeable and acid soluble fractions were separated using aqueous solutions of calcium nitrate and acetic acid, correspondingly. We show that mobility, availability, and vertical transport of metals under study are surprisingly different. There is nearly no mobile exchangeable Zn in wastes whereas all studied soil horizons are characterized by its elevated concentrations, up to 0.6 g/kg. Cd behaves like Zn. The concentration and mobility of Cu vary with depth. The upper humus horizon may contain up to 2.1 g/kg of exchangeable Cu. The behavior of Pb is quite particular. Soils are nearly free from lead, though its total concentration in wastes may reach 3.9 g/kg. To the best of our knowledge, such variations in the behavior of heavy metals have not been reported before. Studied soils present an important pool of available/bioaccessible Cu, Zn, Cd and become the source of further contamination of the environment including ground waters.

The work was supported by the Russian Science Foundation, project No 16-13-10417 (dynamic extraction, exposure assessment of heavy metals) and the Russian Foundation for Basic Research, project No 17-03-00207 (characterization of bulk samples). The equipment was purchased and maintained with the support of the Ministry of Education and Science of the Russian Federation (Program of Increasing Competitiveness of NUST "MISiS", projects No 1-2014-026, No 2-2016-070).

[1] Fedotov P.S., Dzhenloda R.Kh., Dampilova B.V., Doroshkevich S.G., Karandashev V.K. Environ. Chem. Let. 2018. V. 16. P. 637-645.