Volume 19(1), 122- 125, 2015
JOURNAL of Horticulture, Forestry and Biotechnology
www.journal-hfb.usab-tm.ro

Researches regarding the analysis by atomic fluorescence X-ray of scandium content in soil

Alda S.[1*], Alda Liana Maria[1], Cristea T.[1], Gogoasa I.[1], Nita Simona[1], Negrea Adina[2], Gergen I.[1]

[1] University of Agricultural Sciences and Veterinary Medicine of Banat "King Mihai I of Romania" Timisoara; [2]"Politehnica University" -Timisoara, Romania

*Corresponding author. Email: aldasimion@yahoo.com

Abstract The concentrations of toxic metals in soils have continuously increased as a result of anthropogenic activities through inputs mainly from mining, municipal wastes, road traffic or fuel burning. In addition to their toxicity, metals persist in soil for long times and have the capacity to be transferred into the food chain, thus the assessment of their content in soil is of great interest. Scandium, the Mendeleev's hypothetical element "eka-boron" is considered one of the Rare Earth Elements (REE) group, in abundance in the earth's crust of 16 ppm. REEs are required in industry, agriculture, medicine, biotechnology and many other fields. The aim of the study was the analysis by atomic fluorescence X-ray of the scandium content in soil, in a polluted area (Tarnaveni, Mures county, Romania). Tarnaveni was an important industrial centre. Seven locations were taken into our study. The analysis of experimental data highlights high values of scandium content in the soil samples. The highest scandium concentrations were found in the locations close to the chemicals waste. The preliminary results can be used as informative data that they will be confirmed by further analysis by absorption atomic spectrometry method (FAAS).

Key words

atomic fluorescence X –ray, scandium, soil

The concentrations of toxic metals in soils have continuously increased as a result of anthropogenic activities through inputs mainly from mining, municipal wastes, road traffic or fuel burning. In addition to their toxicity, metals persist in soil for long times and have the capacity to be transferred into the food chain thus the assessment of their content in soil is of great interest [3,4,5].

Scandium, the Mendeleev's hypothetical element "eka-boron" is considered one of the Rare Earth Elements (REE) group, in abundance in the earth's crust of 16 ppm. REEs are required in industry, agriculture, medicine, biotechnology, environmental problems and many other fields.

Scandium is only the 50th most abundant element on earth, it is distributed widely, occurring in trace quantities in over 800 minerals. The blue color of the aquamarine variety of beryl is thought to be caused by scandium. Scandium is a soft, silvery transition element which occurs in rare minerals from Scandinavia. It develops a slightly yellowish or pinkish cast when exposed to air. Scandium tarnished in air and burn easily, once it has been ignited. It reacts with water to form hydrogen gas and will dissolve in many acids. Pure scandium is produced by heating scandium fluoride (ScF_3) with calcium metal [1,2,12,15].

The scandium content of surface soils ranged from 0,5 to 45 ppm. The researchers reported high concentrations of Sc in barley roots (up to 0,63 ppm DW)[14].

Some plants, called metallophytes, demonstrate tolerance–hypertolerance to heavy metals and in addition to hyperaccumulation of one or more metals. Scandium bioaccumulation was demonstrated on wheat seedlings, which show better growth parameters when compared to medium without Sc supplementation in comparison with the previous study. Analysing the behaviour of Sc in wheat seedlings grown in medium supplemented with Sc, Irina Shtangeeva, concluded that scandium bioaccumulation caused variations in concentrations of Na, K, Ca, and Zn in different parts of the seedlings [1,11].

Analysis by atomic fluorescence X -ray is a modern method of determination of mineral elements. Analyzer spectral fluorescence RX (FRX) model NITON XL3t GOLD+, is used for analysis by X-ray fluorescence, qualitative and quantitative, with precision of ppm level, for environmental samples, geological, biological without processing. Analyzer spectral fluorescence RX is used to determine heavy metals and contaminants in the ground in contaminated areas and environmental analysis.

Material and Methods

Experimental site. The soil samples were taking from Tărnaveni (Mures County, Romania)area. Seven location area were taken into our study. Tarnaveni was an important industrial centre. The chemicals waste are presented in Figure 1.

Fig. 1.Tarnaveni area (Photo: Alda Simion)

The soil samples collected from the 0-40 cm depth were air dried, crushed, passed through a 2 mm mesh sieve and stored at ambient temperature for analysis.

Determination of pH has been accomplished in watery suspension in report with the soil: water of 1:2.5(v/v).

The soil samples were ground and packed in polyethylene bags of 10 grams.

We used analyzer spectral fluorescence ray X (FRX), model NITON XL3t GOLD +, with basic features: tube miniaturized X-ray, anode silver, X-ray detector SDD-type Si, NDT specific software package operating systems.

Measurements were carried out by applying the measurement window of the device directly on the surface of the polyethylene bags of samples.

The levels of the mineral elements analyzed, expressed as ppm (mg/kg dry matter). were read directly from the screen of the device.

Results and Discussions

In Table 1 are presented geographical coordinates corresponding to the sampled sites.

Table1

Geographical coordinates corresponding to the sampled sites

Sampled Sites	***Altitude***	***North(in decimal degrees)***	***East(in decimal degrees)***
Site 1	281	46.31927	24.27191
Site 2	275	46.32141	24.27620
Site 3	369	46.33148	24.27211
Site 4	293	46.31251	24.28137
Site 5	280	46.31009	24.23339
Site 6	303	46.27626	24.19909
Site 7	267	46.24027	24.12058

The pH values of soil samples ranged between 7,61-8,03.

The amounts of heavy metals in soil, coresponding to sampled sites are presented in figure 2.

The results- as determined by atomic fluorescence X - ray analysis (FRX)- are in accord with literature[8].

We observe that the highest scandium concentrations are found in locations closest to Chemical factory (sites 1, 2, 3 and 4).

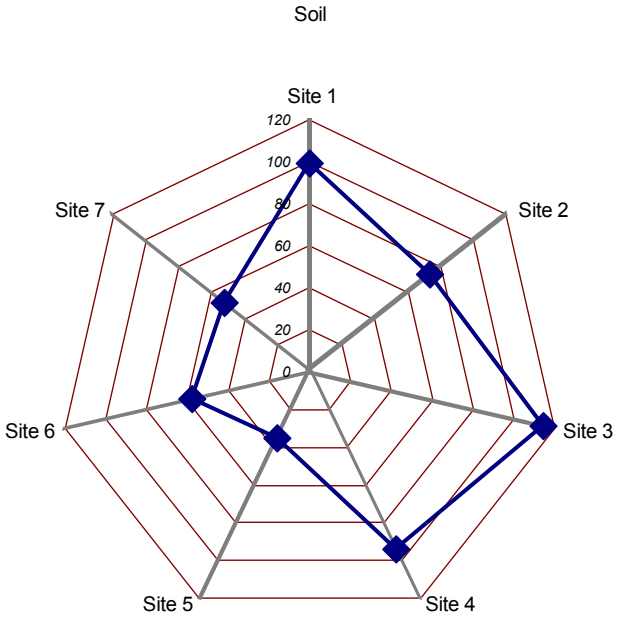

Fig. 2. Scandium contents (mg/kg dry weight) in soil samples

Conclusions

Scandium is only the 50th most abundant element on earth, it is distributed widely, occurring in trace quantities in over 800 minerals.
We find high values of scandium content in the soil studied, maybe the differences are due to the different environment conditions and the different analysis method.
The highest scandium concentrations were found in locations closest to chemical wastes.
Our results obtained by using atomic fluorescence X-ray can be used as informative data that they will be confirmed by further analysis by atomic absorption spectrometry method (FAAS).

Acknowledgments

Paper publishing was funded by the project "Teaching staff in pre-university education and the public university - promoter of lifelong learning," POSDRU/174/1.3/S/149155", co-financed by the European Social Fund through the Sectorial Operational Program for the Human Resources Development 2007–2013.

References

1.Bordean, D. M., Cojocariu, A., Horablaga, M., Cojocariu, L., Alda, S., Nica, D., Borozan, A. B., 2013,- Scandium, element of surprises, 13th SGEM GeoConference on Ecology, Economics, Education And Legislation, Volume I, 13th International Multidisciplinary Scientific Geoconference SGEM 2013, ISSN 1314-2704, Bulgaria, p:865-872;
2.Bordean Despina-Maria, 2010 -„Ecologie si protectia mediului", 175 pagini; Editura Eurobit, Timisoara, ISBN 978-973-620-675-7;
3. Cârciu G., 2006 – Eurobit, Managementul lucrărilor solului ;
4. Gal J, Markiewicz-Patkowska J, Hursthouse A, Tatner P: Metal uptake by woodlice in urban soils. Ecotox Environ Safe 2008, 69:139–149;
5. Harmanescu M, Alda LM, Bordean DM, Gogoasa I, Gergen I, 2011- Heavy metals health risk assessment for population via consumption of vegetables grown in old mining area; a case study: Banat County, Romania. Chem Cent J, 5:64;
6. Horovitz, C. T., Schock, H. H., & Horovitz-Kisimova, L. A. ,1974- The content of scandium, thorium, silver, and other trace elements in different plant species. Plant and Soil, 40(2), 397-403;
7. Hu Z.H., Richter, H., Sparovek, G., Schnug, E., 2004: Physiological and biochemical effects of rare earth elements on plants and their agricultural significance: a review. J. Plant Nutr., 27: 183—220;
8. Merian, E., Anke, M., Ihnat, M., & Stoeppler, M., 2004- Elements and their compounds in the environment: occurrence, analysis and biological relevance(No. Ed. 2) ;
9. Reid RJ, Rengel Z, Smith FA,1996- Membrane fluxes and comparative toxicities of aluminium, scandium and gallium. J Exp Bot 47:1181–1888;
10. Rogobete, Gh.; Oancea, N., 1977 -The general and ameliorative pedology (in Romanian). Ed. Did. &Ped. ;

11. Shtangeeva, I., Ayrault, S., & Jain, J., 2004- Scandium bioaccumulation and its effect on uptake of macro-and trace elements during initial phases of plant growth. Soil Science and Plant Nutrition, 50(6), 877-883;
12. Tyler, G. , 2004- Rare earth elements in soil and plant systems — a review. Plant and Soil 267: 191—206;
13. Tsafe A. I,Hassan L G, Sahabi D.M, Alhassan Y, Bala B M, 2012- Evaluation of Heavy Metals Uptake and Risk Assessment of Vegetables Grown in Yargalma of Northern Nigeria, Journal of Basic and Applied, 2(7)6708-6714;
14. http://www.petronet.ir/documents/10180/2323242/Trace_Elements_in_Soils_and_Plants;
15.http://www.lenntech.com/periodic/elements;