NEUTRON ACTIVATION ANALYSIS OF THE SMALL-SIZE OBJECTS

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Chemical analysis is one of the important methods of obtaining the information about nature of objects. At present it is more claimed for determining the composition of micro samples and even nano object of natural and technogenic origin and new materials. This is due to the fact that parameter of increase in the surface to volume ratio with the decrease of sample size changes the properties of surface atoms and leads to the manifestation of their uncommon properties and properties of nano-object as a whole.

Among such objects there are unique samples of rocks, minerals, meteorites, ultra-refractory inclusions, condensates, dust, "hot" particles, and also composite materials, membranes, and the like furthermore. Furthermore, sometimes information about the composition of separate components of samples is more important than the information about its averaged total composition. In this case the effectiveness of analysis depends on the methodology of study, the methods used and procedures accepted.

The method of neutron-activation analysis is most suitable for this purpose. It has been selected for investigating of chemical composition of samples, since it is highly sensitive (to 10^{-14} g), multielement, not destructive, less depending on mass and composition of sample, on the forms of elements presence.

The number of general questions of such small size objects analysis was examined earlier [1-5]. In the present work attention is turned on the improvement of some of them. In particular - a) The methodology of systems analysis is comprised (in the diagram form, fig.1), b) INAA procedure has been improved due to the use of wider energy neutron spectrum (thermal, epithermal, fig. 2), c) are refined Optimum conditions of analysis were updated due to the improvement of spectra processing programs and estimation of measurement errors (tab. 1).

All these developments made it possible to expand the circle of the analyzed samples and to determine (for example, fig.3, tab. 2) their element composition - key to history and evolution of object.

Visual estimation of the object
↓
The attribution to the certain group/category of objects or materials by use of the identification criteria
↓
Choice of the analysis method: destructive/not destructive, absolute/relative,
↓
The selection of representative samples providing its , preparation of samples for the analysis
↓
Planning and optimization of the experiment
↓
/Model of the experiment (for estimation of influence of various factors on the analysis results)
↓
Analysis performing (measurement and identification of the signal, minimization of time and labor expenses);
↓
Obtaining the results (their metrological estimation),
↓
Discussion of the results
↓
Solution of the problems (prognosis/conclusions)

Fig.1. The scheme of total analytical cycle for the analysis of objects

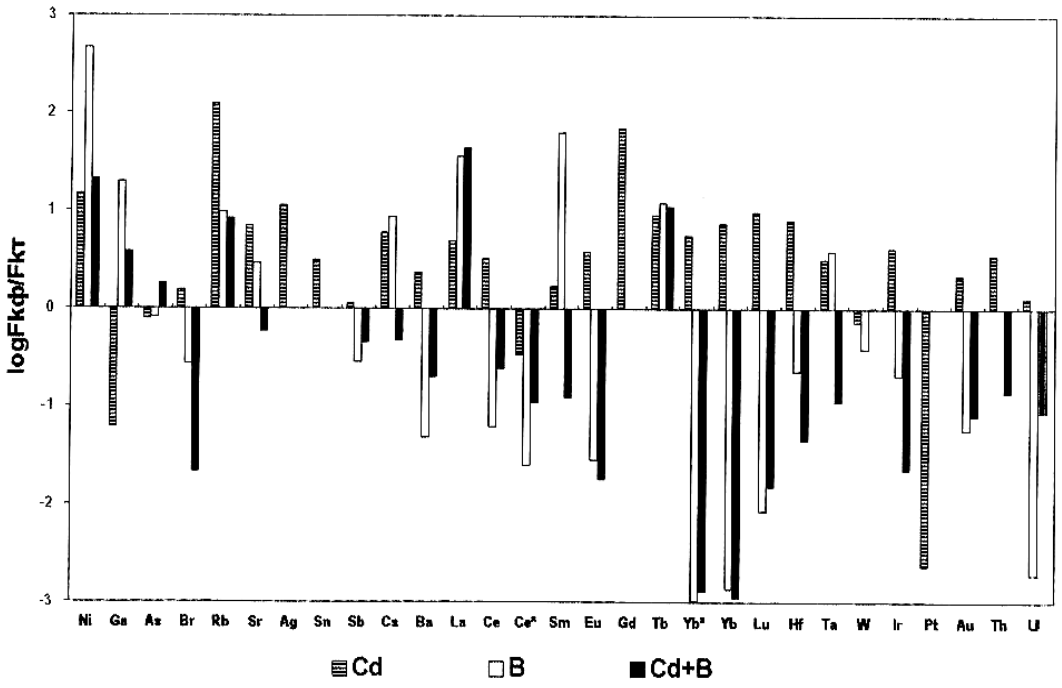

Fig.2. The $logF_k$ /*log* F_{kt} ratio as an indicator of using thermal and epithermal neutrons with cadmium, boron, and cadmium-boron filters

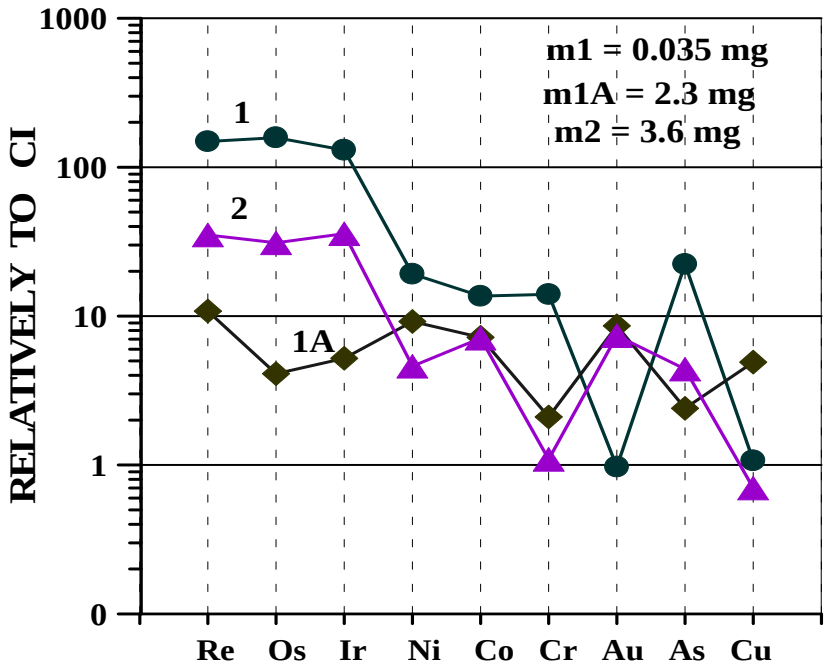

Fig.3. Relative element abundances of the metallic particles from a Ca,Al-inclusion (1) and matrix (1A) of Allende CV3 chondrite and from the Novo-Urei ureilite (2)

Table 1

Main conditions of optimized INAA analysis of some reference materials

Sample	Thermal neutrons, flux 8.6x10 ^{17} n/ s (measure time 200 –2000 s)			Epithermal neutrons, flux 4.3x10^{18} n/ s (measure time 300 –3000 s)		
	Sample mass, mg	Irradiation time, h	Cooling time min., d.	Sample mass, mg	Irradiation time, h	Cooling time min., d.
SO-1	20	15	9	90	60	7
OTL-1	50	15	6	100	60	5.5
FFA-1	10	15	10.5	40	60	9.0
JSD-1	25	15	10	100	60	7.0
JLK-1	15	.15	10.5	60	60	7.0

Table 2

Chemical composition of the metallic particles from a Ca,Al-inclusion (1) and matrix (1A) of Allende CV3 chondrite [6] and from Novo-Urei ureilite (2). Trace elements and Co in μg/g

Elements	Efremovka		Novo-Urei
	1	1A	2
Re	5.5	0.4	1.3
Os	77.4	2	15.2
Ir	60	2.4	16.4
Ni,%	20.6	9.8	4.9
Co	6900	3670	3590
Fe,%	72.3	88.2	93.8
Cr,%	3.75	0.54	0.29
Au	0.14	1.24	1.06
As	40.1	4.4	8.1
Cu	130	590	85

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