Contribution ID: **27** Type: **Oral**

Fifteen years of archaeometry research at the Prompt-gamma activation analysis facility of the Budapest Neutron Centre

Wednesday, 11 September 2013 13:40 (20 minutes)

In 1995, the prototype of the Budapest prompt-gamma activation analysis facility has been installed on a guided thermal neutron beam of the Budapest Research Reactor. After precise engineering of the detector- and data acquisition system, designing proper shielding and establishing our PGAA library by series of standardisation measurements, the system was ready to explore possible analytical applications by 1996. Following the installation of a Cold Neutron Source in 2000, the thermal equivalent intensity of the neutron beam has increased from 2.5•106 cm-2s-1 up to 5•107 cm-2s-1. As a consequence of further beam adjustments and installation of supermirror guides, we have reached the 1•108 cm-2s-1 intensity by now, while the beam background was simultaneously kept low at about 20 cps [1].
Recognizing the advantages of non-destructivity and the lack of sampling, one of the most promising candidates of applied research was to investigate valuable Cultural Heritage objects, i.e. unique archaeological findings, museum pieces, etc. Since 1997, we studied the possibilities in analysis of various metals, rocks and minerals, ceramics and also glass.
One of the first studies was to investigate the alloying components of late Roman (2nd to 4th c. AD) fibulae found in Hegyeshalom, Hungary. Based on the major components (Cu, Sn, Pb and Zn) we were able to define groups of objects referring to the changes of casting techniques. Besides fibulae, occasionally other bronze objects like helmets, shields, sculptures, etc. were studied, too. In another study, by determination of decreasing silver content of Roman coins, we have followed the course of inflation (decreasing Ag/Cu ratios during reigns of various emperors) [2]. Due to the complexity of bronze and silver spectra and to the phenomenon of recycling of historic metals, provenance research of metal objects is not favoured by PGAA.
PGAA proved to be the most successful in provenance of prehistoric stone tools and of some gemstones [3]. In fortunate cases, some rocks show fingerprint-like elemental composition characteristic for their provenances. In the last 10 years, we have built significant databases containing data of geological references and archaeological objects made of obsidian, flint, felsitic porphyry, greenschist, etc. Provenance study of obsidians is very successful, whereas high-silica flints and other silexes are more problematic. A special study is devoted to provenance of lapis lazuli, the most popular ancient precious stone in the Near-East [4].
Although, ceramics are considered as composite materials containing clay and temper, in some instances bulk elemental analysis can help in determination of raw material sources [5]. If possible, other –sometimes destructive –methods are often required.
Well measurable major components of glass, i.e. Si (sand), Na or K (plant- or wood ash) and Ca or Mg (flux) are characteristic for provenance or workshop and indirectly for age. Colorants like Co, Cu, Mn or Fe can be also quantified. A special attention is paid to B, which was applied on purpose since the 18th century [6].
The authors thank for the support of NMI3 and CHARISMA projects of EC, the support of OTKA (Hungarian Research Fund), as well as for the cooperation of many museums and research institutes, which are listed in the presentation.

[1] Szentmiklósi, L.; Belgya, T.; Révay, Zs.; Kis, Z.:Upgrade of the Prompt-Gamma Activation Analysis (PGAA) and the Neutron Induced Prompt-gamma Spectroscopy (NIPS) facilities at the Budapest Research Reactor, J. Nucl. Radioanal. Chem. 286 501-505 (2010).
[2] Kasztovszky, Zs., Panczyk, E., Fedorowicz, W., Révay, Zs., Sartowska, B. Comparative archaeometrical study of Roman silver coins by prompt gamma activation analysis and SEM-EDX, Journal of Radioanalytical and Nuclear Chemistry 265, No. 2 (2005) 193-199.
[3] Zs. Kasztovszky, K. T. Biró, A. Markó, V. Dobosi: Cold neutron prompt gamma activation analysis –a non-destructive method for characterisation of high silica content chipped stone tools and raw materials, Archaeometry, 2008, 50, 1, 12-29.
[4] J. Zöldföldi, Zs. Kasztovszky: Non-destructive prompt-gamma activation analysis (PGAA) in provenance study of lapis lazuli, Proceedings of the Int. Conference on Archäometrie und Denkmalpflenge, Universitate Berlin, 2003, (eds. O. Hahn, C. Goedicke, R. Fuchs, I. Horn) pp. 194-196.
[5] L. Sajo-Bohus, Ma. M. Mackowiak de Antczak, E. D. Greaves, A. Antczak, J. Bermudez, Zs. Kasztovszky, T. Poirier, A. Simonits. Incipient archaeometry in Venezuela: Provenance study of pre-Hispanic pottery figurines, Journal of Radioanalytical and Nuclear Chemistry 265, No. 2 (2005) 247-256.
[6] Kasztovszky, Zs., Kunicki-Goldfinger, J., Applicability of Prompt Gamma Activation Analysis to glass ar-

chaeometry, I. Turbanti-Memmi (ed.), Proceedings of the 37th International Symposium on Archaeometry, Springer-Verlag Berlin Heidelberg 2011 pp 83-90

Summary

Following the design, engineering, installation and standardisation procedure, the Budapest PGAA facility became ready to carry on analytical applications in 1996. Thanks to the absolutely non-destructive feature of the method, archaeometry applications seemed to be one of the most adequate topics. Since 1997, we have started to explore the capability of the method on the most frequent types of historical materials, such as metals, rocks, ceramics and glass. The most successful studies and also the limitations are presented in this paper.

Primary author: Dr KASZTOVSZKY, Zsolt (Centre for Energy Research, Hungarian Academy of Sciences)

Co-authors: Ms MARÓTI, Boglárka (Centre for Energy Research, Hungarian Academy of Sciences); Ms GMÉLING, Katalin (Centre for Energy Research, Hungarian Academy of Sciences); Dr SZENTMIKLÓSI, László (Centre for Energy Research, Hungarian Academy of Sciences); Dr BELGYA, Tamás (Centre for Energy Research, Hungarian Academy of Sciences); Dr SZILÁGYI, Veronika (Centre for Energy Research, Hungarian Academy of Sciences); Dr KIS, Zoltán (Centre for Energy Research, Hungarian Academy of Sciences); Dr REVAY, Zsolt (Centre of Energy Research, Hungarian Academy of Sciences)

Presenter: Dr KASZTOVSZKY, Zsolt (Centre for Energy Research, Hungarian Academy of Sciences)

Session Classification: Prompt Gamma Activation Analysis II

Track Classification: NINMACH