Elvatech
Advanced XRF equipment and solutions

Archeology

The study of the physical and chemical properties of archaeological objects allows us to identify the place of the artifacts creation , the technology of their manufacture and distribution paths outside the production centers, to restore chronological information, as well as their original appearance.

However, research raises a number of problems related to the fragility and high value of archaeological artifacts.

Due to its non-destructive nature, X-ray fluorescence analysis has become an indispensable method for determining the elemental composition of such finds. XRF analysis allows to preserve the integrity of a unique archaeological site and at the same time accurately and quickly determine its composition.

Equipment

ElvaX X-ray spectrometers are widely used in laboratories of specialized institutes, museums and expert centers for analysis of the composition of archaeological objects.

Portable analyzers – ProSpector 3, ElvaX Geo, as well as mobile mini-laboratory ElvaX Mobile, due to their compact size and high accuracy, allow us to conduct elemental analysis of the samples directly at the excavation site, without transportingthem to the laboratory. The usage of these spectrometers significantly saves time and increases the research efficiency. In most cases, archaeological sites are metal or ceramic products. And if determining the metals and alloys composition is a routine operation even for the portable XRF analyzers, then the analysis of ceramics requires a special technique.

Methodology

11 standard ceramic samples with different element contents are used for calibration of ElvaX Plus spectrometers for analysis of eight following oxides: Na_2O, MgO, Al_2O_3, SiO_2, Fe_2O_3, K_2O, CaO, TiO_2. The concentration calculation is based on the fundamental parameter method with the assumption that all elements in the sample are represented as oxides. It is not possible to take into account losses on ignition (LOI) an directly by the X-ray fluorescence method, therefore, in order to increase the accuracy, LOI must be determined by another method and a correction should be added to the measurement results.

The operating modes of the x-ray tube are optimized in order to achieve maximum sensitivity analysis of the elements of interest.

Typical analysis time for achieving maximum measurement accuracy is 30-60 seconds.

Results

Figures 1-4 show comparative graphs between the concentrations certified and measured on the spectrometer ElvaX Plus for basic oxides in ceramics. The data obtained are approximated by a linear function.
R2 is the approximation reliability coefficient, which shows how accurately the measurement results correspond to the certified values. An ideal fit takes place with a value of R2 equal to one.

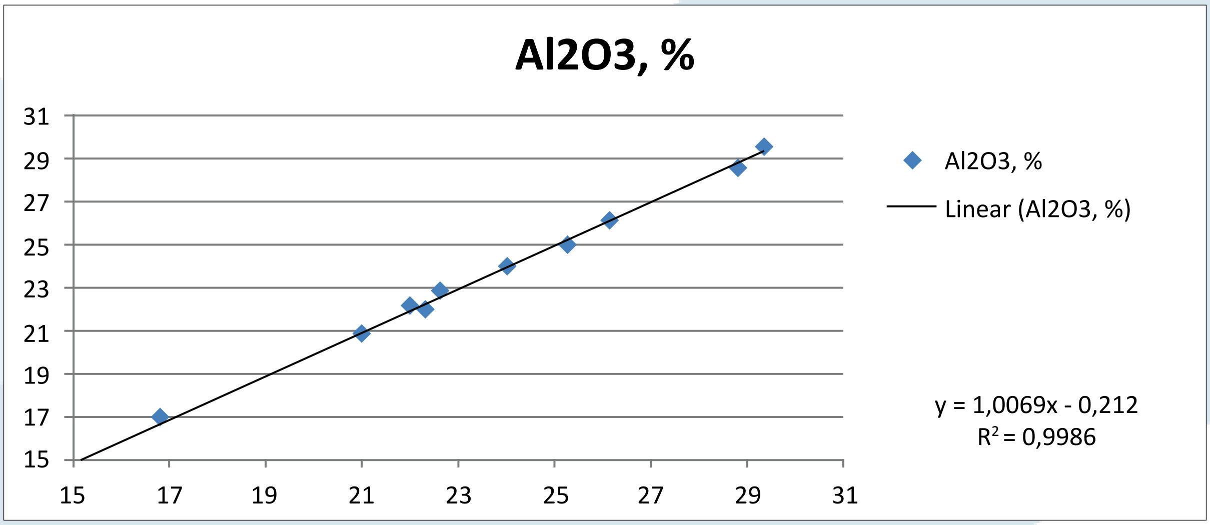

Figure 1. Compliance graph for aluminum oxide in ceramics.

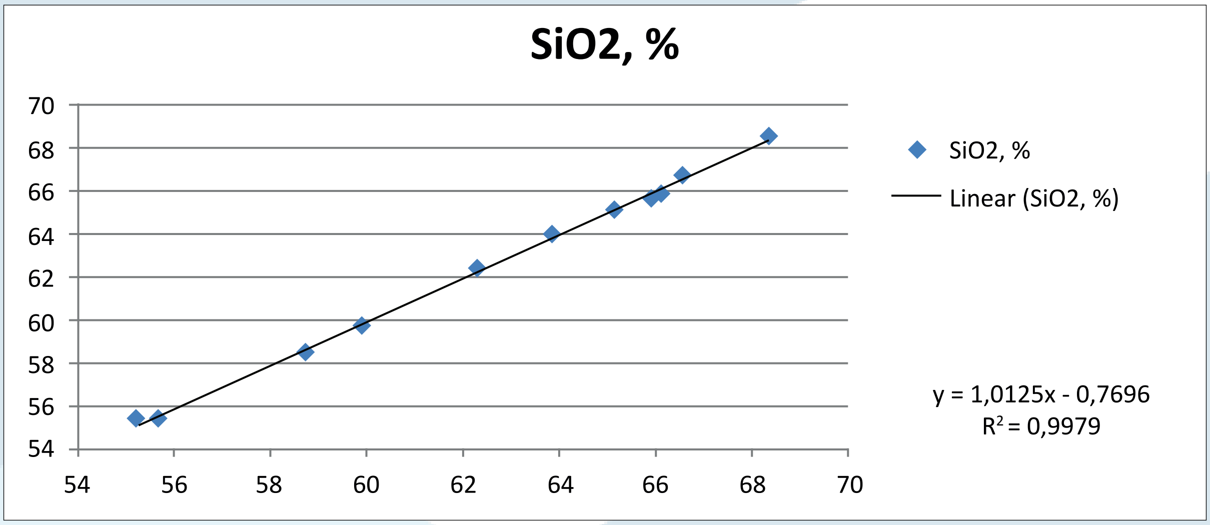

Figure 2. Compliance graph for silicon oxide in ceramics.

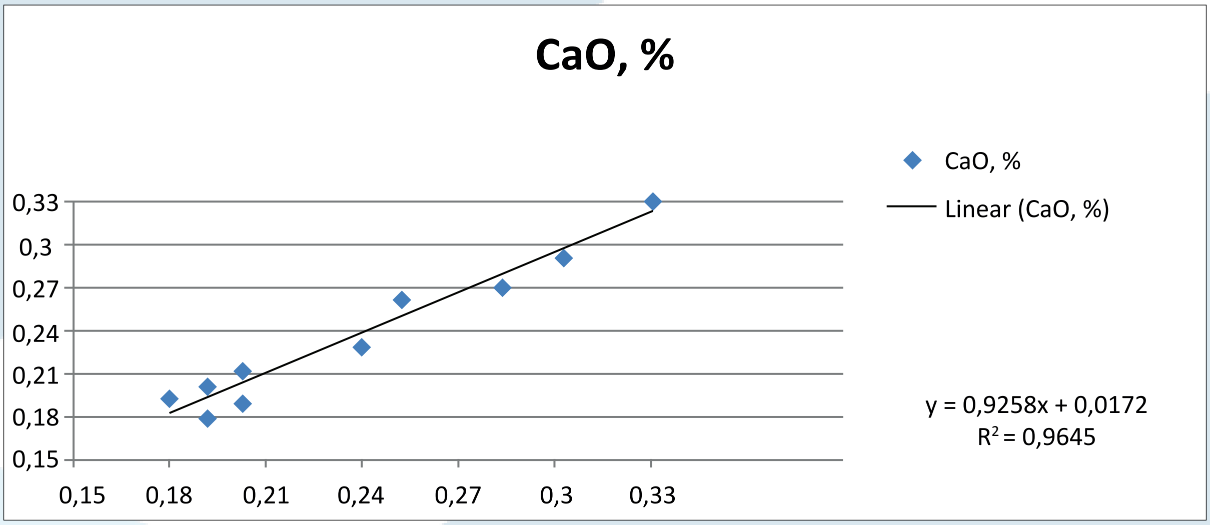

Figure 3. Compliance graph for calcium oxide in ceramics.

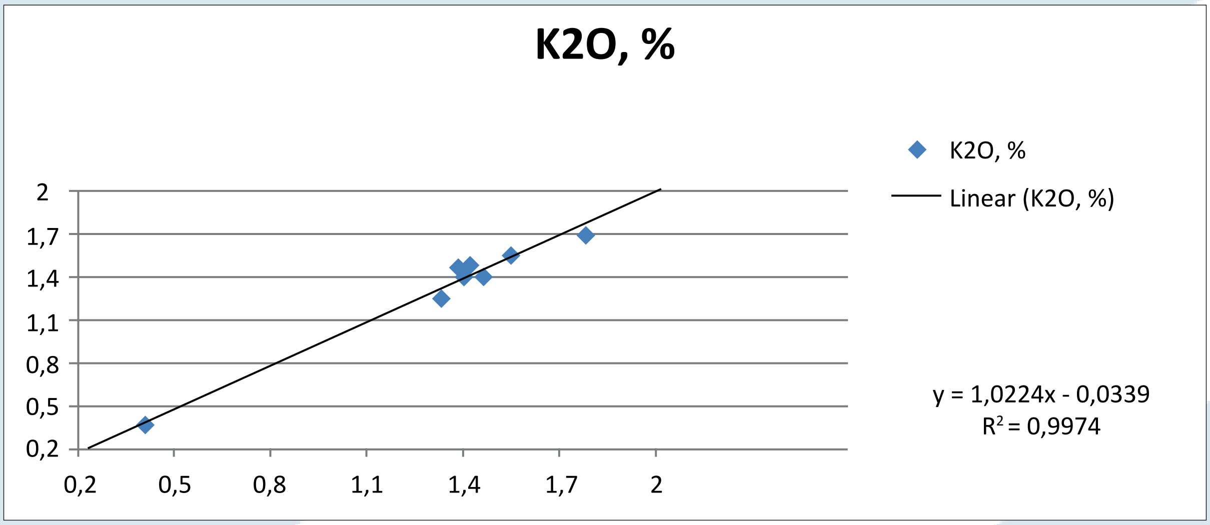

Figure 4. Potassium oxide compliance graph in ceramics.

Below you can see the test of repeatability of the results. One ceramic sample was measured 10 times per 60 seconds. The mean value, standard deviation (SD) and relative standard deviation (RSD - in percentage) for the concentrations of basic oxides were calculated. Test results are presented in the table.

Element	The average, %	RSD, %	% rRSD
Al_2O_3	14,51	0,099	0,683
SiO_2	65,21	0,114	0,175
CaO	0,05	0,0112	21,961
K_2O	3,38	0,085	2,517
TiO_2	0,02	0,0048	26,667
Fe_2O_3	6,85	0,0932	1,36

Table 1. Repeatability test for a single ceramic sample.

Conclusions

The obtained results demonstrate an excellent correlation between the certified and measured values of the basic oxides concentrations in ceramic samples. Therefore, the spectrometers ElvaX are ideally suited for fast, accurate and reproducible analysis of archaeological artifacts without damaging their integrity.