

RESEARCH METHODS AND EQUIPMENT

NEUTRON ACTIVATION ANALYSIS (NAA)

- IREN research facility and facility at the 3rd channel of the IBR-2 reactor
- elemental composition determination with a sensitivity of ppm: part per million (in some cases ppb: part per billion)
- mass multi-element analysis
- determination of mass fractions up to 30-40 elements

PROMPT-GAMMA ACTIVATION ANALYSIS (PGAA)

- facility at the 11thb channel of the IBR-2 reactor
- the possibility of studying the elemental composition of high-volume samples
- absolutely non-destructive analysis

X-RAY FLUORESCENT ANALYSIS (XRF)

- wavelength dispersive spectrometer S6 Jaguar (Bruker)
- portable energy dispersive spectrometer Tracer 5i (Bruker)
- elemental composition determination in a wide range of contents

FOURIER TRANSFORM INFRARED SPECTROSCOPY (FTIR)

- infrared spectrometer Invenio-R (Bruker), equipped with set of accessories for investigation of liquid and solid samples using transmission and attenuated total reflectance (ATR) technique
- studying of the structure of organic and inorganic substances

RAMAN SPECTROSCOPY

- portable spectrometer i-Raman Plus (BWS), equipped with videomicroscope
- studying of the structure of organic and inorganic substances

OPTICAL MICROSCOPY

- stereoscopic panoramic microscope MSP-2 (LOMO)
- polarizing microscope Polam-215 (LOMO)
- luminescent microscope Bioscope-3201 (LOMO)

STRATIGRAPHY

- preparation of polished cross sections of painting with further investigation by optical microscopy

CHEMICAL MICROANALYSIS

- a microprobe composition studying under a microscope using drop analysis based on sensitive chemical reactions

STATISTICAL ANALYSIS

- application of bivariate and multivariate statistical methods for received data processing

EQUIPMENT FOR SAMPLE PREPARATION

- water purification system Direct Q5 UV (Merk Millipore)
- planetary mono mill Pulverisette 6 (Fritsch)
- analytical balance AF 225DRCE (Vibra)
- freeze dryer FreeZone (Labconco)

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INVESTIGATION OF CULTURAL HERITAGE AND SOLVING APPLIED PROBLEMS



GROUP OF NEUTRON ACTIVATION ANALYSIS
FRANK LABORATORY OF NEUTRON PHYSICS
JOINT INSTITUTE FOR NUCLEAR RESEARCH

MEDIEVAL WALL PAINTING

SAMPLES FOR INVESTIGATION:

pigments and plasters of wall painting, mortars from Old Russian buildings

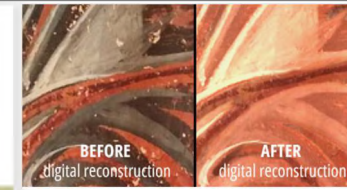
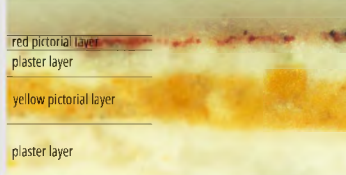
RECENT STUDIES:

a comprehensive study of wall painting cycles of the Cathedrals from Veliky Novgorod, Pskov and Moscow monasteries



OBJECTIVE: investigation of pigments composition
METHODS: *in-situ* XRF, FTIR, chemical microanalysis, stratigraphy of polished cross-sections
RESULTS: paints composition (pigments and binders) of unique pre-Mongolian paintings was studied; data will be used for the restoration of the Transfiguration Cathedral of the Mirozhsky Monastery (Pskov, 12th c.)

OBJECTIVE: studying a wall painting technique
METHODS: stratigraphy of polished cross-sections
RESULTS: on the basis number and order of the painting layers, it was concluded that mixed (fresco-secco) techniques were used in the unique pre-Mongolian painting of St. George Cathedral of the Yuriev Monastery (Veliky Novgorod, 12th c.)



OBJECTIVE: digital reconstruction of presumable original coloration of mural fragment
METHODS: XRF, digital photo processing
RESULTS: based on the pigments composition and change in coloration, presumable original view of mural fragment of the Smolensk Cathedral of the Novodevichy Convent (Moscow, 16th c.) was created

OBJECTIVE: comparative analysis of mortars
METHODS: NAA, XRF, chemical microanalysis
RESULTS: according to the components content and the ratio of some elements, an assumption was made about a later creation time of the certain building fragments from medieval Vladimir, Veliky Novgorod, Yuryev-Polsky



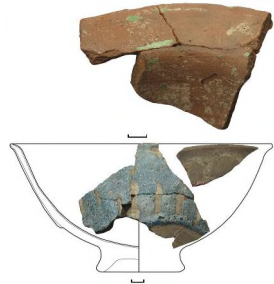
ARCHAEOLOGICAL SAMPLES

SAMPLES FOR INVESTIGATION:

ceramic, glass, and metal artifacts

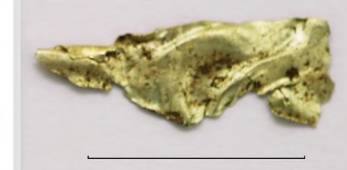
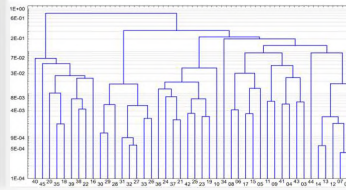
RECENT STUDIES:

the analysis of red clay and kashin ceramics, fragments of glass bracelets, and gold jewelry



OBJECTIVE: identification of raw material provenance for archaeological ceramic artifacts
METHODS: NAA, XRF
RESULTS: based on elemental content, a conclusion was made about the Apennine Peninsula source of raw material for the manufacturing of antique terracotta found during the Crimean bridge construction

OBJECTIVE: formation of reference groups for determination of red clay ceramic manufacture locations
METHODS: NAA, statistical analysis
RESULTS: criteria have been found that allow to classify unknown ceramic samples according to their provenance



OBJECTIVE: determination of the metal artifacts origin: natural or artificial
METHODS: NAA, PGAA, XRF
RESULTS: on the basis of certain trace elements mass fractions, a conclusion was made about the natural origin of the alloy under investigation - electrum

OBJECTIVE: identification of manufacturing centers for fragments of glass bracelets
METHODS: NAA
RESULTS: comparison of the obtained data with the recipes of the major glass manufactures makes it possible to conclude the Old Russian origin of artifacts



THE HUMAN REMAINS

SAMPLES FOR INVESTIGATION:

bones, hair, teeth, brain fragments, organics from skull

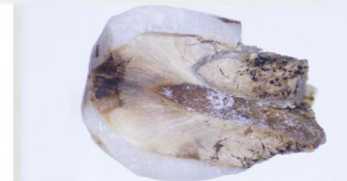
RECENT STUDIES:

the study of the remains of medieval Russian nobility, bones of ancient blacksmiths



OBJECTIVE: determination of the mercury and arsenic content - basic of medieval poisons
METHODS: NAA
RESULTS: high mercury content was found in the rib bone of Ivan Ivanovich - the son of Tsar Ivan IV the Terrible which confirms the treatment with mercury ointments

OBJECTIVE: distribution of the mercury and arsenic along the length of the hair
METHODS: NAA
RESULTS: based on the hair growth rate (1 cm per month), relations between element content and time to death of first russian Tsarina Anastasia Romanovna were plotted



OBJECTIVE: creation a database of the elemental composition of medieval nobility remains
METHODS: NAA
RESULTS: elemental analysis of various remains of ten medieval personalities was carried out, work has been initiated on the database on the medieval remains

OBJECTIVE: determination of copper content and the main trases of copper ores
METHODS: NAA, XRF
RESULTS: copper was found in the remains, which means that the person was a blacksmith, the detection of arsenic suggests a specific source of raw material



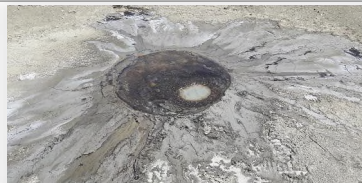
GEOLOGICAL AND ECOLOGICAL SAMPLES

SAMPLES FOR INVESTIGATION:

solid emissions from mud volcanos, solis, sediments, rocks, vegetation, air filters

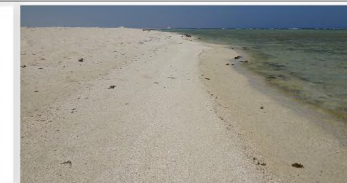
RECENT STUDIES:

analysis of geochemical characteristics of Azerbaijan mud volcanos environmental research on samples from Egypt and the Czech Republic



OBJECTIVE: determination of elemental composition, natural gamma activities, and microfauna
METHODS: NAA, XRF, gamma ray spectroscopy, microfaunal analysis
RESULTS: correlation investigation of solid emissions elemental compositions was done for mud volcanos from Shamakhi-Gobustan region of Azerbaijan

OBJECTIVE: determination of trace element composition in rocks to detect elements with increased mass fractions
METHODS: NAA, statistical analysis
RESULTS: the fact of enrichment with uranium and thorium of the rocks from Sukari and Hamash gold mines (Red Sea governorate, Egypt) was revealed



OBJECTIVE: determination of environmentally hazardous trace elements content in samples of marine sediments
METHODS: NAA, statistical analysis
RESULTS: the sources of pollution and contamination extent were identified of the marine sediments of the Egyptian Mediterranean coast

OBJECTIVE: determination of air metal pollution using air filters
METHODS: NAA, statistical analysis
RESULTS: the source of air pollution in the Czech Republic (Moravian-Silesian Region) was identified to be the transboundary transfer of combustion products of coal used for local heating in Poland

