Historic Materials and their Diagnostics in the Slovak Republic

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1. Introduction – Basic Informations about Slovakia

Slovakia is the country located in the centre of Europe, with the area of 50,000 km^2 and population of approx. 5 millions.

There are four Slovak cultural sites listed in Unesco World Heritage list (village Vlkolinec, town Banska Štiavnica, Spiš castle and associated monuments, town Bardejov).

By 31th December 2001, in the Central list of immovable cultural heritage there were recorded 12.744 objects and in the Central list of movable cultural heritage there were 30.103 objects. Besides of those there is a huge amount of works of art in galleries and museum collections, churches, in state or private ownership.

The beginnings of organized care and preservation of cultural heritage in this territory date back to 19th century, when Slovakia was a part of Austria-Hungary. The first specialized laboratory for conservation science was created in 1960 at SUPSOP („Slovak Institute for Care of Monuments and Landscape Protection", later was transformed into the Institute of Monuments). Head of laboratory was Olga Šujanová, and in that period it belonged to the best established workplaces for conservation science in central Europe.

At present, the Institute of Monuments (Pamiatkový ústav) is the central research and administrative organization of the Slovak Republic responsible for care, documentation and survey of historic and cultural monuments. This institute is directly governed by Ministry of Culture. Its tasks encompass (very briefly):

- administration of The central list of movable and immovable historic property, registration of protected areas, administration of archives of special importance
- professional activities related to protection, recovery, maintanance and presentation of the protected historical monuments and areas, including necessary surveys, research, analyses and documentation,
- conservation and restoration of selected objects and works of art
- providing professional basis for decision-taking by relevant state authorities (e.g. Government, Ministry of Culture, local state offices, ...), setting up of concepts and legislation.

Nowadays the Institute of Monuments is in process of transformation into the State Office with broader competences.

Institute of Archaeology of the Slovak Academy of Sciences (Archeologický ústav SAV) in Nitra is responsible for archaeological activities. It carries out scientific research in archaeology and provides education and post-graduate training of experts in the field of archaeology. It coordinates and conducts surveys, emergency excavations and research excavations and supervises excavations executed by other organizations (e.g. universities, museums, Institute of monuments, etc.). It carries out treatment, documentation and cataloguing of archaeological finds. The informative reports from all excavations in Slovakia in the last year are published in the year-book „Archeological Excavations and Finds in Slovakia". The results of natural-science oriented

research (anthropology, archaeobotany, archaeometallurgy, ...) are published in non-periodical monography Acta Interdisciplinaria Archaeologica.

The study training of conservation and restoration experts is provided at the Academy of Fine Arts and Design, Department of Conservation and Restoration (Katedra reštaurovania VŠVU), Bratislava. The Academy was established in 1949. Besides the classical fine arts disciplines, a specialized study of conservation and restoration was introduced in the section of the Department of Applied Arts. In 1979 it has been transformed into an independent department. At present, the Department is divided into five specialized studios: Studio of restoration of wooden and polychromed sculpture, Studio of restoration of stone sculpture and architectural elements, Studio of restoration of mural paintings, Studio of restoration of easel paintings and pannel paintings and Studio of restoration of works of art on paper.

Currently, the Academy of Fine Arts and Design Bratislava is the only fully-accredited institution of higher education in Slovakia providing complex undergraduate, graduate and postgraduate study in the field of conservation and restoration.

2. Main professional organizations involved in research of historic materials:

Despite of vast number of cultural and historic property, there are only two workplaces fully specialized in conservation science in Slovakia: one of them is Chemical and Technological Department at the Institute of Monuments, and the second is Chemical and Physical Laboratory at the Academy of Fine Arts and Design.

2.1 Chemical and Technological Department, Institute of Monuments, Bratislava.

Staff: Ing. Daniela Cebecauerová - head of Department, Eva Klučková, Mgr. Martina Stillhammerová.

The Department provides professional service to restorers, civil engineers, museums, galleries, state organizations, private owners etc. from the whole area of Slovakia.

It carries out chemical, physical and technological research on historic materials and objects (wall paintings, panel paintings, oil paintings on canvas, wood and stone sculptures, architectural elements and surfaces, furniture, construction wood, textiles, ...). According to the results of surveys and analyses, the causes of deterioration are diagnosed and consequently the technological recommendations for cleaning, conservation, long-time protection, etc ... of works of art or objects are worked out.

As I work in this department, I will describe procedures and methods used here more in detail:

The common report on physical and chemical research for the purposes of conservation or restoration usually consists of the following parts:

- The introductory section with all basic information: location, object, date, author (when known), information about sampling and methods used for analyses.
- The part containing the results of chemical and physical analysis:

  for example, oil painting on canvas:

  - stratigraphy photographs of samples, with data about thickness of layers, identification of pigments, binding media, ground materials
  - identification of textile fibres, thread count per cm^2 and weaving (tabby) of canvas.

  for wooden polychromed sculpture, pannel painting, altar architecture, ... :

  - stratigraphy with identification of pigments, binding media and ground layers, identification of wood species and present bio-deteriogents (insects, fungi, …)

for mural paintings:

- stratigraphy with identification of pigments, binding media (for secco-paintings)
- analysis of plasters (intonacco, arriccio) - wet silicate analysis and grain size distribution curves
- estimation of moisture contents in plasters or masonry, estimation of water soluble salts.

for stone architectural elements, sculptures:

- stratigraphy of colour layers (when present), with identification of pigments, binding media
- petrographical characteristics of stone, contents of water soluble salts, water absorption coefficient, ...

- The final part containing evaluation and interpretation of results, conclusions, technological recommendations for conservation, sanation, chemical preservatives, ...

Of course there is no strict, uniform plan - all research is adapted to the restorer's or owner's requests and needs.

All documentation, reports and also remains of samples after analyses are stored in the archive of the Department for future possible investigation or research. Last year they were worked out 122 reports - see Appendix 1.

Methods of analysis:

At present Slovakia has not any obligatory methodology or standardized procedures for doing research and analyses of historic materials. The tests described in Schramm-Hering „Historische Malmaterialien und ihre Identifizierung", Czech publication „Pigmenty" by Šimunková-Bayerová and in similar publications are used in research of polychromy. The procedures given in Slovak technical standards, ÖNORM, DIN and other scientific literature sources are used in research of building materials. Usually they are slightly adapted according to the amount of sample, available laboratory equipment, etc ...

Survey of polychromy, colour layers: Synthetic methymethacrylate resin (Dentacryl rapid) is used for embedding of samples for stratigraphy survey. Polished crossections are observed microscopically, in incidence normal or polarized light, subsequently the photographs for documentation purposes and for the final report are made by photocamera. The pigments are identified by microchemical tests or by observing the powder-slides of samples in transmitted polarized light microscop. Binding media are identified microchemically, or histochemically.

Optical microscopy is used also for determination of wood species – comparing thin slices (radial, tangential or cross sections) of analysed sample with wood-atlas. Similar procedure is used for textile analysis: the sample of textile is cleaned, boiled in distilled water, and separated fibres are susequently identified microscopically.

Mortars and plasters are inspected first macroscopically, when their basic characteristics (e.g. shape, colour, thickness, cohesion, homogeneity, admixtures, surface..) are described. Next step is silicate chemical analysis. The sample is dissolved in diluted hydrochloric acid 1:3, and mass-percentage contents of residual insoluble fraction, CaO, MgO, SiO_2 soluble in Na_2CO_3 („hydraulicity"), R_2O_3 (Fe-, Al-, Mn- oxides) and SO_3 are determined. When it is possible to separate small pieces of carbonated lime from mortar or plaster samples, they are analysed also separately. Insoluble part of mortar or plaster (i.e. aggregates or "sand") is dried and then grain size distribution curves are obtained using a standard set of sieves. Results of all these analyses

together with grain size distribution curves allow us to compare samples mutually, and in optimum cases (when no HCl-soluble aggregates, as limestone or dolomite, are present) also determine possible composition of mortar, binder-sand mixture ratio and type of used binder (dolomitic, white lime, gypsum, cement, ...)

Surface moisture content in construction wood is estimated using a resistance-moisturemeter. Moisture content in samples of mortars, plasters, bricks, stone, etc… is determined gravimetrically, calculated from weight loss of samples after drying at 105°C (if the samples contain gypsum, drying-temperature is 50 °C). Other laboratory tests, commonly used for characterization of porous building materials, are: water absorption by total immersion (for stone samples water absorption at room temperature, for bricks is used procedure described in Slovak technical standard, where the sample is boiled and subsequently cooled at room temperature) and hygroscopic moisture absorption test (using containers with saturated solutions of NaCl, KNO_3).

Efflorescences of water soluble salts are analysed by qualitative chemical tests. For more precise determination of water soluble salts content in murals or stone, aqueous extract of ground sample is prepared (approx. 1: 10 mass ratio). In this water extract electrical conductivity is measured, concentration of sulphates is determined gravimetrically using 5 % $BaCl_2$, chlorides are determined argentometrically with 0.1M $AgNO_3$, for nitrates, nitrites and pH measuring are used Merck tests strips.

Conductivity measurements are used also for quick control of desalination processes with paper pulp poultices during conservation/restoration.

The Department is equipped with the deep-freezer for freeze-thaw tests of building materials, with the Ultrasound device for non-destructive ultrasonic investigation of stone and with special room with two X-ray devices (RTG) and black chamber. Stationary RTG is used for surveys of all kinds of movable works of art (e.g. paintings on canvas, pannel paintings, wood sculptures, etc.) Portable RTG device is used only ocassionally, because of strict safety precautions, for surveys of larger objects – for example large pannel paintings or altarpieces in situ.

International cooperation:

Recently they have been carried out two projects in cooperation with OMvH (Hungarian State Office of Monuments Preservation), Budapest. Within the framework of the project „Research and documentation of medieval wall-paintings in Carpathian basin“ (1995-2000) there were carried out physical and chemical researches of mural paintings in the churches Leles, Rákoš, Držkovce, Koceľovce, Szentsimon, Tornaszentandrás, Abaújvár. Project „Wooden painted emporas and ceilings“ started in year 2000. So far, within the project the researches of structures in Prihradzany, Rimavská Baňa, Malé Teriakovce, and Chyžné were carried out.

For Transsylvania Trust there were done researches on medieval mural paintings in churches in Suatu and Sic, Romania.

2.2 Physical and Chemical Laboratory, Academy of Fine Arts and Design, Bratislava, Department of Restoration and Conservation

Instructor: Asst. Prof. Jana Želinská, MS

The Laboratory provides all necessary surveys, analyses and tests for the Department of Restoration and Conservation, particularly crossection and stratigraphic analyses of paintings and re-paintings, analyses of pigments, dyes, binding media, grounds, canvas and paper.

The theoretical lectures and laboratory exercises for students are focused on applied physics and chemistry, including historical technologies and materials used in conservation (e.g. binding media, solvents, solutions, pigments, dyes, synthetic materials). In addition, the Laboratory provides some special technologies, e.g. the consolidation of the wooden and stone works of art by vacuum-impregnation.

Methods of analyses:

IR, UV-light observations, stereomicroscopy, transmitted and polarized light microscopy, microchemical tests, histochemical analyses, photodocumenetation by digital camera.

Methods of analyses by cooperation:

FTIR spectrophotometry, SEM-EDS, UV-florescence microscopy, X-ray diffraction, petrographic analyses, wood analyses, X-ray photodocumentation.

3. Other organizations providing research and diagnostics of historic materials:

3.1 Department of Archival Preservation (OAO), Slovak National Archives Bratislava

The Slovak National Archives is the largest and the most important public archives in the Slovak Republic. Its aim is to acquire, preserve, professionally and scientifically process, and make archival documents originating from the activities of central government authorities of the Slovak Republic and its legal predecessors accessible. In addition, it provides storage of records of nation-wide importance, as well as those, acquired as gifts and purchases or as a result of deposit agreements. At the same time, the Slovak National Archives serves as the main scientific research and training centre in the Slovak Republic specialising in archive studies.

The Department of Archival Preservation carries out tasks connected with the complex preservation of archival documents. It is divided into two organisational units. The first one includes laboratories for the conservation and restoration of documents, where, first of all, paper and parchment documents in separate sheets or in a book form, large format documents, such as maps, plans, drawings, seals and contemporary documents are being restored. These activities are closely linked to applied research in conservation of archives and library materials, especially in the field of permanent paper and paper ageing, deacidification of acidic paper, stability and ageing resistance of printing inks, ethylene oxide sterilisation, etc. The department is equipped with a vacuum sterilisation chamber, which is used for the initial and ongoing sterilisation of microbiologically contaminated documents.

The second organisational unit is the photo laboratory, where systematic microfilming and reproductions of archival documents are produced. Its activities are aimed at the development of provision and study microfilms, as well as photocopies for public and archival research purposes.

In special tasks the Department co-operates with Faculty of Food and Chemical Technology, Slovak University of Technology, especially with Department of Chemical Technology of Wood, Pulp and Paper, Department of Printing and Applied Fotochemistry, Research Institute of Paper and Pulp, Slovak Academy of Science and other professional organizations.

3.2 The Department of Conservation and Restoration of Documents, Slovak National Library, Martin

The Department of Conservation and Restoration of Documents is the central executive, research and training centre in Slovakia in the field of conservation and research of library documents and book-materials (paper, leather, parchment, wood, metal, ...). The Department provides complex conservation and restoration of library documents which includes mechanical and chemical cleaning, disinfection, neutralisation, stabilization, surface treatment of leather and parchment bindings. It is the only workplace in Slovakia which has worked out special technology for completion of missing parts of documents (leaf-casting). Atlantis 96 device, which is used for this technology, effects software calculations of scanned areas, dyes the paperstuff to the required colour, calculates the amount of sizing-agent and paperstuff.

Research activities of the Department are focused on the study of native and modified starches and derivatives of cellulose; other research activities are aimed at the conservation of woody-paper and newsprint-paper, at the selection of the most appropriate non-aqueous

neutralization methods, at the study of influence of light on paper. In addition, the Department carries out the tasks connected with preventive preservation of the funds in deposits of the Slovak National Library.

3.3 Department of Mechanical Technology of Wood, Technical University in Zvolen, Faculty of Wood Technology.

The Department provides lecturing and research in protection of wood and wood composites against fungi, insects, fire and weather effects, in determination of degree of degradation, in identification of the causes of deterioration, in selection of the most appropriate methods of conservation and protection of wood. It carries out testing of biocides and preservatives, identification of wood species, wood destroying fungi and insects, etc …

Department carried out many research projects of wooden objects all over Slovakia, such as roof trusses, ceilings, log-cabins, etc. (For further details see L. Reinprecht: State-of-the-art report, Ariadne 8)

3.4 State Forest Research Institute, Bratislava

SFRI is institute with scientific activities (relevant to historic wood) similar to the above mentioned. Among others it provides identification of wood species, wood destroying fungi species, mechanical testing of wood constructions (including Resistograph – measurements of construction wood), provides expert recommendation for sanation, long-term protection and conservation of historic wood.

3.5 Department of Sanitary Engineering, Slovak University of Technology, Bratislava Faculty of Civil Engineering

3.6 Department of Soil Science, Commenius University, Bratislava, Faculty of Natural Science

The two above mentioned institutions provide microbiological analysis of bio-deteriogents: bacteria, algae, micro-fungi („moulds“) causing decay of historical monuments or works of art. They work out technological recommendations for sanation and protection against microbiological growth.

3.7 Department of Mineralogy and Petrology, Commenius University, Bratislava, Faculty of Natural Sciences

Department provides petrographical characterization and identification of stone samples and X-ray diffraction analysis.

Note: There may be other institutions in Slovakia who are carrying out analyses of historical materials, but their activities are not known to me.

4. Some remarks on problems in conservation science in Slovakia:

One of the biggest handicaps of further development of conservation science in Slovakia is „lack of money“ in state budget. Of course, high importance, significance and value of cultural heritage are generally accepted and there are also no doubts about the role of scientific research in preservation of cultural heritage, but the actual financial support from state funds is far behind the real needs. The situation in this field is, unfortunately, considered not to be as urgent as in other spheres (health and social service, unemployment, etc..).

Research is carried out almost exclusively in the process of conservation/restoration or in the process of the repairs of a building. Expenses for investigation and research must be paid by the

owner of the monument, who very often tends to spend as little money on research as possible. The result of this situation is that survey is not thorough enough and that the number of samples for analyses is usually minimalized to the lowest possible amount. In majority cases the expenses for physical, chemical and technological research represent only 3-5% out of the conservation/restoration budget. There are also many conservation and restoration works which are performed without any chemical and technological analysis. (On the other hand it must be said that sometimes the results of physical and chemical research have very high documentary and informative value, they are significant for „universal knowledge“, but they have only low importance for the owner of a given monument. Therefore it is unfair that the owner is the only one who bears all expenses.)

The number of workplaces and also the number of the full-time staff involved in this field of work is absolutely insufficient for the country as rich in works of art and historical monuments as Slovakia.

The technical equipment of two main existing workplaces is very poor. Except of optical microscopes and basic laboratory instruments (scales, drying owen, laboratory owen, Kofler microstage etc.) there is no further equipment for instrumental analysis. What we lack most in everyday work is the electron microscope with microprobe. Unfortunately, cooperation with other research institutes or universities carring out SEM-EDS, XRD, IRS etc. has to be limited just to a few samples a year, only for the most important monuments or precious works of art owing to insufficient financial resources for research.

And thus in such conditions it is very difficult to specialize in depht in the certain field of conservation science, to do basic research or more thorough long-term testing of conservation materials and to participate in high-level international cooperation projects.

I would like to thank to all who have provided me the informations for this report, especially to Mr. Hanus, Ms. Želinská and Ms. Maková.

Appendix 1)

Chemical-technological department, Institute of Monuments

List of physical and chemical research and surveys carried out in the year 2001

(contains case-number, locality and object of research)

Physical-chemical resarch of mural paintings, sgraffito

7/01 Banská Štiavnica, Sun-dial on burgess house, Kammerhofska st.1

103/01 Fričovce, manor house, sgraffito on faccade

112/01 Križovany, church, interior mural paintings from 15.cent.

125/01 Orava castle, chapel, mural paintings and stone burial monument

Altars, iconostasses, pulpits, ...

2/01 Košice, museum, Altar of Virgin Mary form Dúbrava

6/01 Šamorín, church, main altar

18/01 Stará Ľubovňa, St.Nicolas Church, side altar of Holy Family

19/01 Slovenská Ves, catholic church, main altar

39/01 Spišské Vlachy, church of St. John Baptist, side altar of Virgin Mary

40/01 Udiča, church of St. Matthias, pulpit

52/01 Švedlár, church, altar of St. Margaret

53/01Levoča, St.Jacob's church, side altar of Birth

130/01 Košice, evang. church, baptisery

Wooden sculptures, refiefs

43/01 Kremnica, museum, wooden sculpture of Archangel Michael

45/01 Malacky, church, Jesus Christ on the cross

51/01 Banská Štiavnica, Calvary, polychromed relief the Holding of the Cross

58/01 Kremnica, museum, sculptures of St.Stephan and St.Ladislaus

82/01 Dunajská Lužná, church, Madonna with Child, 15cent.

Pannel paintings, emporas, wooden pannels, ceilings...

18/01 Stará Ľubovňa, St.Nicolas Church, pannel painting of Holy Family

64/01 Male Teriakovce, church, polychromed empora and ceiling pannels

66/01 Prihradzany, St. Anna's chapel, polychromed ceiling pannels

68/01 Chyžné, church, polychromed empora and ceiling pannels

73/01 Závod, cemetery chapel, polychromed empora

119/01 Švedlár, church, pannel painting from the main oltar

Oilpaintings on canvas

5/01 Madonna with Child, private collection

13/01 Laying in the Tomb, private collection

16/01 two oilpaintings from SNG collections,

31/01 Still-life, private collection

36/01 Piešťany, oilpainting by A.Mucha

38/01 Prešov, theatre, oilpainting on canvas decorations from the ceilings

63/01 Bojnice castle, two oilpaintings from museum collections

102/01 Landscape, private collection

Stone sculptures, architectural elements, stucco

141/00 Trnava, Church of St. John Baptist, stucco decorations in side chapel

26/01 Banská Štiavnica, house on Kammerhofská 1, stone architectural elements

35/01 Kláštor pod Znievom, statue of St. Florian

97/01 Bojnice Castle, portal

98/01 Trenčín, Roman inscription on the castle-rock

111/01 Plavecké Podhradie, manor house, portals

Mortars, renders, plasters

17/01 Žilina, former parish church – archaeological excavation site

123/01 Hronský Beňadik, monastery, Cross corridor

Surveys, investigations, technological recommendations for sanation

36/00 Bratislava, St.Martin‘s dome, wooden bell-constructions in tower

15/01 Bratislava, SNM, collection of African art – microbiological growth

20/01 Sobotište, Haban mill, survey of construction wood elements

21/01 Veľké Leváre, Haban house, survey of construction wood elements

22/01 Horná Mičiná, church – benches and altar, wood destroying insects

37/01 Spišská Nová Ves, burgess house, wood destroying fungi

69/01 Holíč, manor house, measuring of microclimate conditions

70/01 NCM wooden churches in East Slovakia, technol. recomendations for maintenance

76/01 Krivé, wooden church, wood destroying fungi

84/01 Spišské Vlachy, burgess house, wood destrying fungi

93/01 Vyšehradné, wooden belfry

94/01 Rišňovce, church, benches and altar, wood destroying insects

Analysis of water soluble salts, moisture content in building materials

72/01 Žehra, Church of Holy Ghost, interior and exterior

83/01 Trnava, Church of St. John Baptist, stucco decorations

85/01 Kremnica, house at Štefanikova 10, renders in cellar, watersoluble salts

120/01 Bratislava, Aspremont palace, moisture and watersoluble

54 reports: estimation of moisture and water-soluble salt contents for Bayosan, Schomburg, building companies, civil engineers, investors, owners.

Appendix 2)

Addresses of organizations:

Institute of Monuments
Chemical and Technological Department
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814 06 Bratislava, SK
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Institute of Archaeology SAS
Akademická 2
949 21 Nitra, SK

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Department of Conservation and Restoration
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814 37 Bratislava, SK
contact person: Ing. Jana Želinská, rest@vsvu.afad.sk

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