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MAPPING STRUCTURE AND GLOSSARY FOR WALL PAINTINGS

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Introduction to the Mapping System

The digital mapping system developed within the framework of the Raphael Project is a tool to facilitate the exchange of knowledge and the extraction of information from data collected about various aspects of the investigation, conservation and restoration monitoring of wall paintings. This communication is enabled by the establishment of a structure, where various terms and phenomena are defined, divided into groups and assigned codes. This particular approach has been created with the intention of using standard CAD software for the handling of the collected information. During the project all participants used Autodesk AutoCAD-Map 2000, but the basic method described here can also be applied to other standard CAD software products. A rectified image (black/white, colour, or special multi-spectral channel) provided the objective reproduction of the scene chosen for mapping at a resolution of 0,1mm/pixel.

In order to be able to use the method, the conservator must abstract from the traditional approaches commonly used for graphic documentation. When creating traditional, hand-drawn maps conservators are mostly fixated on recording phenomena, such as damage, or treatment connected to a particular layer, such as the plaster or paint layer, without first making an attempt to structure the information they will be recording. Among the various types of damage which figure prominently on condition maps are lacunas in the paint or plaster layer. According to the technique of handling data in geographic information systems (GIS) used in geosciences, which has been applied in the Raphael project, lacunas are not recorded, because they denote empty space. What is recorded instead is the existence of the various materials (layers) that wall paintings are composed of. Damage phenomena and various treatments provide additional information about a particular layer. A result of structuring data according to this method is the creation of a quality management system, which is an innovation in the field of conservation of wall paintings.



Germany, Königslutter, Stiftskirche. The Raphael-team is working *in situ*.

ANALYSIS, PROTECTION AND PRESERVATION OF MEDIEVAL WALL PAINTINGS

Raphael-Project 1999-2001

The philosophy behind the digital mapping system is the establishment of a flow of data by following a procedure according to a fixed sequence:

- 1) collection of data (on-site mapping).
- 2) generation of information by the transformation of the data in a structure.
- 3) creation of knowledge by handling the information.

The knowledge and information generated by this procedure can then be visualised according to the rules of thematic cartography (as, for example, the maps created in Tirsted Church – graphic documentation).

Data can only be generated by first establishing the borders of the area to be mapped, and then providing information about the location of the particular layer, i.e. the extent of the plaster on the wall, or the areas where the paint layer is present. The location of the various layers, or, in other words, the distribution of the various materials on the area to be mapped, can be provided by a special multi-spectral photographic technique. If this photographic technique is not used to supply the basic information to the system, this data must be provided by mapping the location of each layer in a separate file manually. By doing this first step, information about the missing areas (lacunas) is computed (according to mathematical set theory rules), and therefore this particular phenomenon is not present together with other damage phenomenon on the structure list.

However, before collecting the mapping data, an organised directory structure must be established.

Explanation of the Directory Structure

The directory structure proposed here provides an organised system for filing and retrieving information. Here are two examples of the structures implemented for projects in Königslutter Church and in Tirsted Church:

koenigslutter_church_st-peter-and-paul

- ___projects
 - ___1995_condition-recording
 - ___1998_test-conservation
 - ___1999-2001_raphael
 - ___2000-2001_monitoring_winter
 - ___geografical_information-system
 - ___project-files
 - ___original-drawings
 - ___mapping
 - ___westwork_ceiling
 - ___2000_damages_infotext.html
 - ___2000_materials_infotext.html
 - ___2000_photo-image-multispectral_infotext.html
 - ___2001_scene1-2_damages.dwg
 - ___2001_scene1-2_materials.dwg
 - ___2001_scene1-2_materials_damages.dwg
 - ___2000_scene1-2_pho-ima-mul.tif
 - ___photos
 - ___text
 - ___2001_monitoring_summer
 - ___database

tirsted_church

- ___projects
 - ___1999-2000_research-previous-interventions
 - ___archival-documents
 - ___archival-photographs
 - ___1999-2000_re-restoration-chancel-wallpaintings
 - ___treatment-report
 - ___photographic-documentation
 - ___1999-2001_raphael
 - ___mapping
 - ___chancel_east-wall
 - ___2000_scene22-26-29_photo_image-bw.tif
 - ___2000_scene22-26-29_materials.dwg
 - ___2000_scene22-26-29_damages.dwg
 - ___2000_scene22-26-29_materials_damages.dwg
 - ___2000_scene22-26-29_treatments.dwg
 - ___2000_scene22-26-29_materials_treatments.dwg
 - ___2000_scene22-26-29_painting-technique.dwg
 - ___2000_scene22-26-29_sampling.dwg
 - ___chancel_south-wall
 - ___correlation-measurements
 - ___3D_image

File names in the directory

In order to structure data on an operational system level it is necessary to name data files according to their content. The basic rule for building file names is as follows: year for creation of file_location of mapped area_topic of map. For example, the file **2000_scene1-2_materials.dwg** contains information about materials mapped in scene 45 carried out in the year 2000. The file **2000_scene1-2_materials_damages.dwg** is a file with information generated out of two files: **2000_scene1-2_materials.dwg** and **2000_scene1-2_damages.dwg**. In a third example, the file **2000_scene1-2_plotting.dwg** is the name of the file containing cartographic information, such as legends, map borders, etc. It is important for data security to avoid using the same file names in different directories. By using this structure it is also possible to integrate additional descriptive information via links to external multimedia files (internet, intranet), and from attached databases.

Structure and Glossary List for Mapping

This system has been developed as a tool to facilitate the exchange of information using common terminology. Simple and clear definitions of terms used by conservators of wall paintings have not been standardised to date. In order to be able to use the system definitions for all the terms have been discussed and agreed upon within the Raphael working group. A short definition of the terms are included in the structure. An attempt has been made to include terminology referring to all materials, phenomena and aspects of wall painting conservation/restoration, documentation, monitoring, research and investigation.

The structure and glossary list has been divided into 5 categories. Within each category, various types of damages are listed as groups. For example, within the category *Damage Phenomena*, one can find groups listing, for example, *salt damage*, *cracks*, *poor cohesion*, *poor adhesion*, etc. Each type of damage is assigned a particular layer code, which is a combination of the first three letters of the category name with the first three letters of the group name. For example, salt damage is assigned the code **dam-sal** (Damage phenomena - salt damage). If desired, the particular types of damages can be divided into subgroups, and the code is extended. For example, if a detailed map is to be made of the location of various types of salts within one painting, one will extend the code with the type of salt: **dam-sal-nit** (nitrates), **dam-sal-chl** (chlorides), etc. Or, if mapping the visual effects of salt damage: **dam-sal-cru** (crust), **dam-sal-pow** (powder), **dam-sal-nee** (needles).

Similarly, within the category *Treatments* (**tre**), the areas where different cleaning (**cle**) methods were applied can be mapped: chemical cleaning (**tre-cle-che**); mechanical cleaning (**tre-cle-mec**); enzymatic cleaning (**tre-cle-enz**).

ANALYSIS, PROTECTION AND PRESERVATION OF MEDIEVAL WALL PAINTINGS
Raphael-Project 1999-2001

Division of Structure and Glossary List into Categories

Several structure models are proposed, in which topics that are closely related are grouped together. Information within these groups can be combined to provide multi-faceted information about a particular area of a wall painting. At the present time, all information in the system is defined by two dimensions. In the future, the addition of the third dimension will allow for the handling of data where the thickness of a layer, or the space in a room can also be taken into account.

| | |
|---|--|
| <p><u>CATEGORY 1.</u> Materials Damage phenomena Treatments</p> | <p>The category Materials is used for creating maps indicating the presence of particular materials in the wall painting. Various damage phenomena listed in the structure can be linked to a particular material. In a similar way various conservation/restoration treatments can be linked to a particular material. In cases where historical treatments are mapped, the year, or general time period for their execution is added to the file name.</p> |
| <p><u>CATEGORY 2.</u> Photographic information</p> | <p>This category allows for the indication of specific areas in the painting that were photographed in a special way: a detail where photographs were taken in UV-fluorescent light, or raking light.</p> |
| <p><u>CATEGORY 3.</u> Environmental conditions</p> | <p>The information gathered here pertains to the mapping of climatic data on the surface of the walls, such as surface temperature, or areas particularly affected by sunlight. Also included in this group are other physical phenomena, which can affect the condition of the wall painting, such as the occurrence of vibrations.</p> |
| <p><u>CATEGORY 4.</u> Painting technique Pictorial content</p> | <p>The category Painting technique provides information about the manner in which the painting was created. This information may or may not have an influence on the condition or treatment, and can be linked to a particular material, damage phenomenon or treatment in group 1. Also included in this group is information useful for art historical studies. For example, areas of the painted decoration containing images with iconographic content can be differentiated from non-figurative decorations. The location of inscriptions can be recorded, or the participation of different artists in one decoration.</p> |
| <p><u>CATEGORY 5.</u> Sampling</p> | <p>This category includes the location of sampling sites, where the extraction of material for analysis provided information about the material, painting technique, environmental conditions (for example humidity), damage phenomena, treatments and so on.</p> |

**Mapping Structure and Glossary
for Wall Paintings**

| Cat. No. | CATEGORY 1 | Layer No. | Group | code | Description | Visual | Cad Element | Cad Colour | Cad Area Fillings |
|----------|-----------------|-----------|-------------------------------------|----------------|--|-------------|------------------------|------------|-------------------|
| A | Material | 1 | Substrate | mat-sub | The layer or structure lying below the plaster. | Area | Closed Polyline | | |
| A | Material | 1,1 | Substrate: Masonry: Brick | mat-sub-bri | Architectural surface built of brick. | Area | Closed Polyline | | |
| A | Material | 1,2 | Substrate: Masonry: Stone | mat-sub-sto | Architectural surface built of stone. | Area | Closed Polyline | | |
| A | Material | 1,3 | Substrate: Masonry: Brick and stone | mat-sub-bristo | Architectural surface built of a mixture of brick and stone. | Area | Closed Polyline | | |
| A | Material | 1,4 | Substrate: Wood | mat-sub-woo | Architectural surface built of wooden planks, timber inserts in masonry. | Area | Closed Polyline | | |
| A | Material | 2 | Plaster | mat-pla | A mortar used for coating architectural surfaces. | Area | Closed Polyline | | |
| A | Material | 2,1 | Plaster: Arriccio | mat-pla-arr | Rough preliminary plaster layer applied to the masonry. | Area | Closed Polyline | | |
| A | Material | 2,2 | Plaster: Intonaco | mat-pla-int | The plaster layer on top of the arriccio, on which the painting is executed. | Area | Closed Polyline | | |
| A | Material | 3 | Ground layer for painting | mat-gro | Layer on which the painting is executed. Can function as background for painting. | Area | Closed Polyline | | |
| A | Material | 3,1 | Ground layer for painting: Limewash | mat-gro-lim | Aqueous solution of calcium hydroxide. | Area | Closed Polyline | | |
| A | Material | 3,2 | Ground layer for painting: Other | mat-gro-oth | Ground layer with other binding medium. | Area | Closed Polyline | | |
| A | Material | 4 | Paint layer | mat-pai | A mixture of pigment and liquid that forms a thin adherent coating when spread on a surface. | Area | Closed Polyline | | |
| A | Material | 5 | Limewash | mat-lim | Covering limewash layer or remnants of limewash that were never removed from the surface of the painting. | Area | Closed Polyline | | |

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| Cat. No. | CATEGORY 1 | Layer No. | Group | code | Description | Visual | Cad Element | Cad Colour | Cad Area Fillings |
|----------|-------------------------|-----------|--|--------------------|---|-------------|------------------------|------------|-------------------|
| A | Material | 6 | Foreign | mat-for | Materials not belonging to original object, such as iron spikes, wedges, etc. | Block | Triangle | | |
| A | Material | 7 | Other | mat-oth | Other types of materials | Block | Closed Polyline | | |
| B | Damage Phenomena | 1 | Cracks | dam-cra | A narrow break or opening in a layer. | Line | Polyline | | |
| B | Damage Phenomena | 2 | Frost damage | dam-fro | Areas damaged by the expansion of water when it freezes. | Area | Closed Polyline | | |
| B | Damage Phenomena | 3 | Pitting | dam-pit | Small pits and craters form in the plaster by the expansion of bits of unslaked lime, wood, or bricks. | Area | Closed Polyline | | |
| B | Damage Phenomena | 4 | Wearing | dam-wea | Areas where the surface is mechanically damaged. | Area | Closed Polyline | | |
| B | <i>Damage Phenomena</i> | 4,1 | <i>Wearing: Erosion by human action</i> | <i>dam-wea-hum</i> | <i>Areas eroded as a result of repetitive human actions.</i> | <i>Area</i> | <i>Closed Polyline</i> | | |
| B | <i>Damage Phenomena</i> | 4,2 | <i>Wearing: Erosion by natural sources</i> | <i>dam-wea-nat</i> | <i>Areas where the surface is gradually worn away by natural causes including weathering, solution, corrosion, or transportation.</i> | <i>Area</i> | <i>Closed Polyline</i> | | |
| B | Damage Phenomena | 5 | Poor adhesion | dam-pad | The separation of a layer from the underlying layer. | Area | Closed Polyline | | |
| B | <i>Damage Phenomena</i> | 5,1 | <i>Poor adhesion: Cavity /void</i> | <i>dam-pad-cav</i> | <i>Areas where a layer is poorly adhered to underlying layer, creating an unfilled space.</i> | <i>Area</i> | <i>Closed Polyline</i> | | |
| B | <i>Damage Phenomena</i> | 5,2 | <i>Poor adhesion: Flaking</i> | <i>dam-pad-fla</i> | <i>A small loose area of the paint layer or ground layer where the surface was disrupted.</i> | <i>Area</i> | <i>Closed Polyline</i> | | |

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| Cat. No. | CATEGORY 1 | Layer No. | Group | code | Description | Visual | Cad Element | Cad Colour | Cad Area Fillings |
|-----------------|-------------------|------------------|--|-------------|---|---------------|--------------------|-------------------|--------------------------|
| B | Damage Phenomena | 5,3 | Poor adhesion: Intralaminar separation | dam-pad-int | The separation within a paint layer into two or more thinner layers. | Area | Closed Polyline | | |
| B | Damage Phenomena | 6 | Poor cohesion | dam-pco | Powdering within a layer due to deterioration or lack of binder. | Area | Closed Polyline | | |
| B | Damage Phenomena | 7 | Salt damage | dam-sal | Disintegration of material through efflorescence of salts. | Area | Closed Polyline | | |
| B | Damage Phenomena | 7,1 | Salt damage: crust | dam-sal-cru | Cauliflower-like salt deposit. | Area | Closed Polyline | | |
| B | Damage Phenomena | 7,2 | Salt damage: needles | dam-sal-nee | Salt efflorescence extruding from the surface in filament-like crystalline threads. | Area | Closed Polyline | | |
| B | Damage Phenomena | 7,3 | Salt damage: powder | dam-sal-pow | Salt deposit of fine particles. | Area | Closed Polyline | | |
| B | Damage Phenomena | 7,4 | Salt damage: veil | dam-sal-vei | Semi-transparent salt deposit, often white. | Area | Closed Polyline | | |
| B | Damage Phenomena | 7,5 | Salt damage: other | dam-sal-oth | Other types of salt crystallisation | Area | Closed Polyline | | |
| B | Damage Phenomena | 8 | Discoloration | dam-dis | An alteration in the original hue or colour, staining. | Area | Closed Polyline | | |
| B | Damage Phenomena | 8,1 | Discoloration: Change of colour | dam-dis-cha | e.g. the change of azurite to malachite. | Area | Closed Polyline | | |
| B | Damage Phenomena | 8,2 | Discoloration: Darkening | dam-dis-dar | Deepening of the tone of a material through impregnation of a foreign substance. | Area | Closed Polyline | | |
| B | Damage Phenomena | 8,3 | Discoloration: Fading | dam-dis-fad | Loss of colour strength. | Area | Closed Polyline | | |
| B | Damage Phenomena | 8,4 | Discoloration: Staining | dam-dis-sta | Formation of spots and rings due to moisture or metal corrosion. | Area | Closed Polyline | | |
| B | Damage Phenomena | 8,5 | Discoloration: Yellowing | dam-dis-yel | The staining of the material with yellow colour due to impregnation with a foreign substance. | Area | Closed Polyline | | |

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| Cat. No. | CATEGORY 1 | Layer No. | Group | code | Description | Visual | Cad Element | Cad Colour | Cad Area Fillings |
|----------|-------------------------|-------------|--|--------------------|--|-------------|------------------------|------------|-------------------|
| B | Damage Phenomena | 9 | Micro-biological growth | dam-bio | Micro-organisms such as algae, moulds, bacteria, fungi growing on architectural surfaces. | Area | Closed Polyline | | |
| <i>B</i> | <i>Damage Phenomena</i> | <i>9,1</i> | <i>Micro-biological growth: black, brown, purple spots</i> | <i>dam-bio-spo</i> | <i>Micro-biological growth catagorized by colour.</i> | <i>Area</i> | <i>Closed Polyline</i> | | |
| <i>B</i> | <i>Damage Phenomena</i> | <i>9,2</i> | <i>Micro-biological growth: green</i> | <i>dam-bio-gre</i> | <i>Micro-biological growth catagorized by colour.</i> | <i>Area</i> | <i>Closed Polyline</i> | | |
| <i>B</i> | <i>Damage Phenomena</i> | <i>9,3</i> | <i>Micro-biological growth: pink discoloration</i> | <i>dam-bio-pin</i> | <i>Micro-biological growth catagorized by colour.</i> | <i>Area</i> | <i>Closed Polyline</i> | | |
| <i>B</i> | <i>Damage Phenomena</i> | <i>9,4</i> | <i>Micro-biological growth: other</i> | <i>dam-bio-oth</i> | <i>Micro-biological growth catagorized by colour.</i> | <i>Area</i> | <i>Closed Polyline</i> | | |
| B | Damage Phenomena | 10 | Soiling | dam-soi | Superficial layer of various deposits. | Area | Closed Polyline | | |
| <i>B</i> | <i>Damage Phenomena</i> | <i>10,1</i> | <i>Soiling: Dirt</i> | <i>dam-soi-dir</i> | <i>Superficial particles of dirt, dust or soot.</i> | <i>Area</i> | <i>Closed Polyline</i> | | |
| <i>B</i> | <i>Damage Phenomena</i> | <i>10,2</i> | <i>Soiling: Other</i> | <i>dam-soi-oth</i> | <i>Superficial particles of other deposits on a layer.</i> | <i>Area</i> | <i>Closed Polyline</i> | | |
| C | Treatments | 1 | Cleaning | tre-cle | Removing dirt, impurities, surface coatings, accretions. | Area | Closed Polyline | | |
| <i>C</i> | <i>Treatments</i> | <i>1,1</i> | <i>Cleaning: Chemical</i> | <i>tre-cle-che</i> | <i>Cleaning with various solvents incl. water.</i> | <i>Area</i> | <i>Closed Polyline</i> | | |
| <i>C</i> | <i>Treatments</i> | <i>1,2</i> | <i>Cleaning: Enzymatic</i> | <i>tre-cle-enz</i> | <i>Biological degradation of proteinous substances.</i> | <i>Area</i> | <i>Closed Polyline</i> | | |
| <i>C</i> | <i>Treatments</i> | <i>1,3</i> | <i>Cleaning: Mechanical</i> | <i>tre-cle-mec</i> | <i>Dry cleaning with Wish-ab, gomma pane, scalpel.</i> | <i>Area</i> | <i>Closed Polyline</i> | | |
| <i>C</i> | <i>Treatments</i> | <i>1,4</i> | <i>Cleaning: Other</i> | <i>tre-cle-oth</i> | <i>Cleaning by other methods.</i> | <i>Area</i> | <i>Closed Polyline</i> | | |
| C | Treatments | 2 | Uncovering | tre-unc | The removal of a layer concealing a painting. | Area | Closed Polyline | | |
| C | Treatments | 3 | Consolidation | tre-con | The process of strengthening a layer by introducing or attaching a material capable of holding it together. | Area | Closed Polyline | | |
| <i>C</i> | <i>Treatments</i> | <i>3,1</i> | <i>Consolidation: Casein</i> | <i>tre-con-cas</i> | <i>Consolidation with casein.</i> | <i>Area</i> | <i>Closed Polyline</i> | | |

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| Cat. No. | CATEGORY 1 | Layer No. | Group | code | Description | Visual | Cad Element | Cad Colour | Cad Area Fillings |
|-----------------|-------------------|------------------|--|----------------|---|---------------|------------------------|-------------------|--------------------------|
| C | Treatments | 3,2 | Consolidation: Cellulose-based materials | tre-con-cel | Consolidation with cellulose-based materials. | Area | Closed Polyline | | |
| C | Treatments | 3,3 | Consolidation: Lime-based materials | tre-con-lim | Consolidation with lime-based materials. | Block | Triangle | | |
| C | Treatments | 3,4 | Consolidation: Silicone esters | tre-con-sil | Consolidation with silicone esters. | Area | Closed Polyline | | |
| C | Treatments | 3,5 | Consolidation: Synthetic resins | tre-con-res | Consolidation with synthetic resins. | Area | Closed Polyline | | |
| C | Treatments | 3,6 | Consolidation: Other | tre-con-oth | Consolidation with other materials. | Area | Closed Polyline | | |
| C | Treatments | 4 | Disinfection | tre-dis | The application of an agent that inhibits the growth of micro-organisms. | Area | Closed Polyline | | |
| C | Treatments | 5 | Impregnation | tre-imp | The process of strengthening a non-cohesive layer by the application of a penetrating substance. | Area | Closed Polyline | | |
| C | Treatments | 5,1 | Impregnation: limewater | tre-imp-lim | Impregnation with limewater. | Area | Closed Polyline | | |
| C | Treatments | 5,2 | Impregnation: silicone esters | tre-imp-sil | Impregnation with silicone esters. | Area | Closed Polyline | | |
| C | Treatments | 5,3 | Impregnation: Syntetic resins | tre-imp-res | Impregnation with synthetic resins. | Area | Closed Polyline | | |
| C | Treatments | 5,4 | Impregnation: Other | tre-imp-oth | Impregnation with other substances. | Area | Closed Polyline | | |
| C | Treatments | 6 | Repairs | tre-rep | The filling of a lacuna by adding new material. | Area | Closed Polyline | | |
| C | Treatments | 6,1 | Repairs: Filling of cracks | tre-rep-fil | The closing of fine openings with putty or other materials. | Area | Closed Polyline | | |
| C | Treatments | 7 | Limewashing | tre-lim | The application of a aqueous solution of calcium hydroxide. | Area | Closed Polyline | | |
| C | Treatments | 8 | Overpainting | tre-ove | The application of a paint layer or limewash over an underlying painting. | Area | Closed Polyline | | |

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| Cat. No. | CATEGORY 1 | Layer No. | Group | code | Description | Visual | Cad Element | Cad Colour | Cad Area Fillings |
|----------|------------|-----------|-------------------------------|-------------|---|--------|-----------------|------------|-------------------|
| C | Treatments | 9 | Reconstruction | tre-rec | The completion of losses in a painting, ground layer or plaster based on conjecture, analogy, original fragments or sampling. | Area | Closed Polyline | | |
| C | Treatments | 10 | Retouching | tre-ret | The completion of colour in the paint layer or ground layer limited to lacunae. | Area | Closed Polyline | | |
| C | Treatments | 11 | Covering | tre-cov | The process of concealing a layer in order to preserve it. | Area | Closed Polyline | | |
| C | Treatments | 11,1 | Covering: Limewash | tre-cov-lim | Covering with limewash. | Area | Closed Polyline | | |
| C | Treatments | 11,2 | Covering: Mortar | tre-cov-mor | Covering with mortar. | Area | Closed Polyline | | |
| C | Treatments | 11,3 | Covering: Other | tre-cov-oth | Covering with other materials. | Area | Closed Polyline | | |
| C | Treatments | 12 | Finishing coat | tre-fin | The application of a transparent substance as a final superficial treatment, for example varnish. | Area | Closed Polyline | | |
| C | Treatments | 13 | Desalination | tre-des | The reduction of salts in an architectural surface by application of poultice or compress. | Area | Closed Polyline | | |
| C | Treatments | 13,1 | Desalination: Japanese tissue | tre-des-jap | Compress consisting of Japanese tissue. | Area | Closed Polyline | | |
| C | Treatments | 13,2 | Desalination: Mortar | tre-des-mor | Compress consisting of mortar, sacrificial plaster layer. | Area | Closed Polyline | | |
| C | Treatments | 13,3 | Desalination: Paper pulp | tre-des-pap | Compress consisting of e.g. Arbocel. | Area | Closed Polyline | | |
| C | Treatments | 13,4 | Desalination: Other | tre-des-oth | Compress consisting of other materials. | Area | Closed Polyline | | |
| C | Treatments | 14 | Transfer | tre-tra | The separation of the painting from its original support. | Area | Closed Polyline | | |

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| Cat. No. | CATEGORY 1 | Layer No. | Group | code | Description | Visual | Cad Element | Cad Colour | Cad Area Fillings |
|-----------------|-------------------|------------------|---|----------------|---|---------------|------------------------|-------------------|--------------------------|
| C | Treatments | 14,1 | Transfer: Stacco | tre-tra-sta | Detachment of painting together with underlying plaster . | Area | Closed Polyline | | |
| C | Treatments | 14,2 | Transfer: Stacco a massello | tre-tra-sam | Detachment of painting together with underlying plaster and masonry. | Area | Closed Polyline | | |
| C | Treatments | 14,3 | Transfer: Strappo | tre-tra-str | Detachment of paint layer only. | Area | Closed Polyline | | |
| C | Treatments | 15 | Moisture regulation | tre-moi | Treatment to stabilize or eliminated the presence and movement of moisture in walls/substrates. | Area | Closed Polyline | | |
| C | Treatments | 15,1 | Moisture regulation: Hydrophobizing | tre-moi-hyd | The application of a chemical substance to create a material with no affinity to water (on a molecular level) resulting in a barrier reducing the amount of liquid water entering the wall. | Area | Closed Polyline | | |
| C | Treatments | 15,2 | Moisture regulation: Horizontal isolation layer | tre-moi-hor | The insertion of a barrier consisting of a water-impermeable substance. | Area | Closed Polyline | | |
| C | Treatments | 15,3 | Moisture regulation: Vertical isolation layer | tre-moi-ver | The application of a water-impermeable substance to the surface of the wall. | Area | Closed Polyline | | |
| C | Treatments | 15,4 | Moisture regulation: Other | tre-moi-oth | Other methods for moisture regulation. | Area | Closed Polyline | | |

**Mapping Structure and Glossary
for Wall Paintings**

| Cat. No. | CATEGORY 2 | Layer No. | Group | code | Description | Visual | Cad Element | Cad Colour | Cad Area Fillings |
|-----------------|---------------------------------|------------------|---|------------------------|---|---------------------------------------|------------------------|-------------------|--------------------------|
| D | Photographic Information | 1 | Image details | pho_ima | Photographed areas which are defined as squares or trapezoids. | Rectangle, Trapezoid with text | Closed Polyline | | |
| <i>D</i> | <i>Photographic Information</i> | <i>1,1</i> | <i>Image details: Multispectral</i> | <i>pho_ima-mul</i> | <i>Black/white photos taken with special filters.</i> | <i>Rectangle, Trapezoid with text</i> | <i>Closed Polyline</i> | | |
| <i>D</i> | <i>Photographic Information</i> | <i>1,2</i> | <i>Image details: normal light: black/white</i> | <i>pho_ima-bw</i> | <i>Black/white photos taken with light directed perpendicularly to the surface.</i> | <i>Rectangle, Trapezoid with text</i> | <i>Closed Polyline</i> | | |
| <i>D</i> | <i>Photographic Information</i> | <i>1,3</i> | <i>Image details: normal light: colour</i> | <i>pho_ima-col</i> | <i>Colour photos taken with light directed perpendicularly to the surface.</i> | <i>Rectangle, Trapezoid with text</i> | <i>Closed Polyline</i> | | |
| <i>D</i> | <i>Photographic Information</i> | <i>1,4</i> | <i>Image details: raking light: black/white</i> | <i>pho_ima-rak-bw</i> | <i>Black/white photos taken with light directed at an angle less than 45° to the surface.</i> | <i>Rectangle, Trapezoid with text</i> | <i>Closed Polyline</i> | | |
| <i>D</i> | <i>Photographic Information</i> | <i>1,5</i> | <i>Image details: raking light: colour</i> | <i>pho_ima-rak-col</i> | <i>Colour photos taken with light directed at an angle less than 45° to the surface.</i> | <i>Rectangle, Trapezoid with text</i> | <i>Closed Polyline</i> | | |
| <i>D</i> | <i>Photographic Information</i> | <i>1,6</i> | <i>Image details: Ultraviolet: black/white</i> | <i>pho_ima-uv-bw</i> | <i>Black/white photos taken with UV-lights and special filters.</i> | <i>Rectangle, Trapezoid with text</i> | <i>Closed Polyline</i> | | |
| <i>D</i> | <i>Photographic Information</i> | <i>1,7</i> | <i>Image details: Ultraviolet: colour</i> | <i>pho_ima-uv-col</i> | <i>Colour photos taken with UV-lights and special filters.</i> | <i>Rectangle, Trapezoid with text</i> | <i>Closed Polyline</i> | | |

**Mapping Structure and Glossary
for Wall Paintings**

| Cat. No. | CATEGORY 3 | Layer No. | Group | code | Description | Visual | Cad Element | Cad Colour | Cad Area Fillings |
|-----------------|---------------------------------|------------------|-----------------------------|--------------------|--|---------------|------------------------|-------------------|--------------------------|
| E | Environmental Conditions | 1 | Airflow | env_air | The recording of the direction of the air currents adjacent to the architectural surface. | | | | |
| E | Environmental Conditions | 2 | Humidity | env_hum | Mapping of the moisture. | Symbol | Block nn | | |
| <i>E</i> | <i>Environmental Conditions</i> | <i>2,1</i> | <i>Humidity: Material</i> | <i>env_hum-mat</i> | <i>Mapping of the moisture content (mass percent) within the wall.</i> | <i>Symbol</i> | <i>Block nn</i> | | |
| <i>E</i> | <i>Environmental Conditions</i> | <i>2,2</i> | <i>Humidity: Space</i> | <i>env_hum-spa</i> | <i>Mapping of the amount of atmospheric moisture (RH).</i> | | | | |
| <i>E</i> | <i>Environmental Conditions</i> | <i>2,3</i> | <i>Humidity: Surface</i> | <i>env_hum-sur</i> | <i>Mapping of the moisture on the architectural surface (RH).</i> | <i>Symbol</i> | <i>Block nn</i> | | |
| E | Environmental Conditions | 3 | Temperature | env_tem | Mapping of the temperature. | Symbol | Block nn | | |
| <i>E</i> | <i>Environmental Conditions</i> | <i>3,1</i> | <i>Temperature: Space</i> | <i>env_tem-spa</i> | <i>Mapping of the atmospheric temperature.</i> | | | | |
| <i>E</i> | <i>Environmental Conditions</i> | <i>3,2</i> | <i>Temperature: Surface</i> | <i>env_tem-sur</i> | <i>Mapping of the surface temperature.</i> | <i>Symbol</i> | <i>Block nn</i> | | |
| E | Environmental Conditions | 4 | Light | env_lig | Mapping of the surface affected by light. | Area | Closed Polyline | | |
| <i>E</i> | <i>Environmental Conditions</i> | <i>4,1</i> | <i>Light: Artificial</i> | <i>env_lig-art</i> | <i>Mapping of areas particularly affected by artificial illumination.</i> | <i>Area</i> | <i>Closed Polyline</i> | | |
| <i>E</i> | <i>Environmental Conditions</i> | <i>4,2</i> | <i>Light: Sunlight</i> | <i>env_lig-sun</i> | <i>Mapping of areas particularly affected by sunlight.</i> | <i>Area</i> | <i>Closed Polyline</i> | | |
| E | Environmental Conditions | 5 | Vibrations | env_vib | Mapping of areas of the architectural surface affected by rapid motion sequences. | Symbol | Block nn | | |

**Mapping Structure and Glossary
for Wall Paintings**

| Cat. No. | CATEGORY 4 | Layer No. | Group | code | Description | Visual | Cad Element | Cad Colour | Cad Area Fillings |
|----------|--------------------|-----------|------------------------------|------------|--|--------|-----------------|------------|-------------------|
| F | Painting Technique | 1 | Giornata | pai_gio | The portion of a fresco painting that can be completed in one sitting, while the plaster is still fresh. | Line | Polyline | | |
| F | Painting Technique | 2 | Pontata | pai_pon | The division of the plaster into areas corresponding to the height of the scaffolding. | Line | Polyline | | |
| F | Painting Technique | 3 | Plaster borders | pai_pla | plaster borders, head | Line | Polyline | | |
| F | Painting Technique | 4 | Stucco applications | pai_stu | Three-dimensional decorations, such as haloes, executed with plaster. | Area | Closed Polyline | | |
| F | Painting Technique | 5 | Fresco | pai_fre | Painting done on freshly spread plaster with pigments mixed with limewater. | Area | Closed Polyline | | |
| F | Painting Technique | 6 | Secco | pai_sec | Painting done on a dry plaster requiring a binding medium, such as slaked lime or organic binding mediums. | Area | Closed Polyline | | |
| F | Painting Technique | 7 | Finger and hand prints | pai_finhan | Original materials marked by finger and hand prints. | Area | Closed Polyline | | |
| F | Painting Technique | 8 | Incisions and compass points | pai_inc | Surface of layer cut by sharp instrument to facilitate the composition of the painting. | Line | Closed Polyline | | |
| F | Painting Technique | 9 | Preliminary drawings | pai_pre | Drawing executed on ground layer or plaster as a guide for the final painting. | Line | Closed Polyline | | |
| F | Painting Technique | 10 | Snapstring line | pai_sna | Construction lines created by snapping a taunt string against a surface to be decorated. | Line | Polyline | | |

**Mapping Structure and Glossary
for Wall Paintings**

| Cat. No. | CATEGORY 4 | Layer No. | Group | code | Description | Visual | Cad Element | Cad Colour | Cad Area Fillings |
|----------|---------------------------|-----------|--|-----------------------|--|-------------|------------------------|------------|-------------------|
| F | Painting Technique | 11 | Stencil (template) | pai_ste | Repeating pattern made by a thin perforated material through which paint is applied. | Area | Closed Polyline | | |
| F | Painting Technique | 12 | Tool marks | pai_too | Local three-dimensional impressions of tools in a layer. | Area | Closed Polyline | | |
| F | Painting Technique | 13 | Glossy areas of paint layer | pai_glo | Area of painting with shiny surface. | Area | Closed Polyline | | |
| F | Painting Technique | 14 | Matt areas of paint layer | pai_mat | Area of painting non-glossy surface. | Area | Closed Polyline | | |
| F | Painting Technique | 15 | Surface plasticity | pai_sur | Irregularities of surface caused by unevenness of substrate. | Area | Closed Polyline | | |
| F | Painting Technique | 16 | Texture | pai_tex | Superficial overall characteristics of a layer, such as smooth or rough plaster. | Area | Closed Polyline | | |
| F | <i>Painting Technique</i> | 16,1 | <i>Texture: brushstrokes</i> | <i>pai_tex-bru</i> | <i>Patterns created by bristles of a brush.</i> | <i>Area</i> | <i>Closed Polyline</i> | | |
| F | <i>Painting Technique</i> | 16,2 | <i>Texture: grainy plaster surface</i> | <i>pai_tex-grapla</i> | <i>Toothed surface created by a wooden hawk.</i> | <i>Area</i> | <i>Closed Polyline</i> | | |
| F | <i>Painting Technique</i> | 16,3 | <i>Texture: polished plaster surface</i> | <i>pai_tex-polpla</i> | <i>Smooth surface created by a metal trowel.</i> | <i>Area</i> | <i>Closed Polyline</i> | | |
| F | <i>Painting Technique</i> | 16,4 | <i>Texture: Other</i> | <i>pai_tex-oth</i> | <i>Texture created by other means, such as a paint roller, weave imprint, etc.</i> | <i>Area</i> | <i>Closed Polyline</i> | | |
| F | Painting Technique | 17 | Varnish | pai_var | Final transparent coating on paint layer. | Area | Closed Polyline | | |
| F | Painting Technique | 18 | Pigments | pai_pig | Colouring substances. | Area | Closed Polyline | | |
| F | Painting Technique | 19 | Gilding | pai_gil | Areas covered by gold leaf. | Area | Closed Polyline | | |

**Mapping Structure and Glossary
for Wall Paintings**

| Cat. No. | CATEGORY 4 | Layer No. | Group | code | Description | Visual | Cad Element | Cad Colour | Cad Area Fillings |
|----------|-------------------|-----------|--------------------------|---------|--|--------|-----------------|------------|-------------------|
| G | Pictorial Content | 1 | Periods | pic_per | The roughly specified interval or a historic time in which the painting was created. | Area | Closed Polyline | | |
| G | Pictorial Content | 2 | Ornamental decorations | pic_orn | Repetitive ornament friezes or borders. | Area | Closed Polyline | | |
| G | Pictorial Content | 3 | Figurative decorations | pic_fig | Areas of the painted decoration with an iconographic content. | Area | Closed Polyline | | |
| G | Pictorial Content | 4 | Inscriptions | pic_ins | Parts of the painting containing letters, symbols or numbers. | Area | Closed Polyline | | |
| G | Pictorial Content | 5 | Artists' characteristics | pic_art | Areas defined by the personal style of the painter. | Area | Closed Polyline | | |

**Mapping Structure and Glossary List
for Wall Paintings**

| Cat. No. | CATEGORY 5 | Layer No. | Group | code | Description | Visual | Cad Element | Cad Colour | Cad Area Fillings |
|----------|-----------------|-----------|--|--------------------|---|--------------|-----------------|------------|-------------------|
| H | Sampling | 1 | Chemical components | sam_che | Area where material was sampled for identification of the chemical composition. | Block | Triangle | | |
| H | <i>Sampling</i> | 1,1 | <i>Chemical components: Plaster</i> | <i>sam_che-pla</i> | <i>Area where material was sampled for identification of plaster content and composition.</i> | <i>Block</i> | <i>Triangle</i> | | |
| H | <i>Sampling</i> | 1,2 | <i>Chemical components: Pigment</i> | <i>sam_che-pig</i> | <i>Area where material was sampled for identification of the chemical composition of the pigment.</i> | <i>Block</i> | <i>Triangle</i> | | |
| H | <i>Sampling</i> | 1,3 | <i>Chemical components: Binding Media</i> | <i>sam_che-bin</i> | <i>Area where material was sampled for identification of the chemical composition of the binding media.</i> | <i>Block</i> | <i>Triangle</i> | | |
| H | <i>Sampling</i> | 1,4 | <i>Chemical components: Salt Content</i> | <i>sam_che-sal</i> | <i>Area where material was sampled for identification of salt content.</i> | <i>Block</i> | <i>Triangle</i> | | |
| H | <i>Sampling</i> | 1,5 | <i>Chemical components: Foreign Substances</i> | <i>sam_che-for</i> | <i>Area where material was sampled for identification of foreign substances, e.g., impregnating and consolidating agents.</i> | <i>Block</i> | <i>Triangle</i> | | |
| H | Sampling | 2 | Physical and mechanical analysis | sam_phy | Area where material was sampled for identification of physical and mechanical properties | Block | Triangle | | |
| H | <i>Sampling</i> | 2,1 | <i>Physical and mechanical analysis: Masonry</i> | <i>sam_phy-mas</i> | <i>Area where material was sampled for identification of physical and mechanical properties, such as porosity, pore density, water content, water vapour permeability, etc.</i> | <i>Block</i> | <i>Triangle</i> | | |

**Mapping Structure and Glossary List
for Wall Paintings**

| Cat. No. | CATEGORY 5 | Layer No. | Group | code | Description | Visual | Cad Element | Cad Colour | Cad Area Fillings |
|-----------------|-------------------|------------------|--|--------------------|---|---------------|--------------------|-------------------|--------------------------|
| <i>H</i> | <i>Sampling</i> | <i>2,2</i> | <i>Physical and mechanical analysis: Plaster</i> | <i>sam_phy-pla</i> | <i>Area where material was sampled for identification of physical and mechanical properties, such as porosity, pore density, water content, water vapour permeability, etc.</i> | <i>Block</i> | <i>Triangle</i> | | |
| <i>H</i> | <i>Sampling</i> | <i>2,3</i> | <i>Physical and mechanical analysis: Paint Layer</i> | <i>sam_phy-pai</i> | <i>Area where material was sampled for identification of physical and mechanical properties, such as water vapour permeability, cohesive strength, etc.</i> | <i>Block</i> | <i>Triangle</i> | | |
| <i>H</i> | <i>Sampling</i> | <i>2,4</i> | <i>Other type of analyses</i> | <i>sam-oth</i> | <i>Area where material was extracted for other type of anylises</i> | <i>Block</i> | <i>Triangle</i> | | |

Using the Layer Codes to Map Specific Data

In order to extract data by mathematical computation the mapping structure requires that layers are coded by the rules. The codes for the categories are combined with the groups in the category, together with the year pertaining to the data that is being recorded. The information from two categories can be combined, but the file name must be constructed according to the following rules.

The first element in the layer name is a year – **2000**, for example, will denote that the condition in this year was being recorded in the mapping. In the case of recording the location of previous interventions, the year of that intervention may be used, or if this is unknown, term such as **pre2000** can be used. The second element in the layer name is separated from the year with an underscore (_). This is the code that is a combination of the category and the group (**mat-pla**), which is the code for *Materials* and *Plaster*. A file with the name **2000_mat-pla** will contain information about the distribution of the plaster within the field being mapped. If the purpose of the mapping is to monitor the condition of the plaster, another map can be made in, say, ten years with the file name **2010_mat-pla**, and these two maps can be compared.

It is possible to combine data from two categories to generate more specific information. The layer with the code **2000_mat-pla_tre-rep** contains information about the repairs (rep), which are a group in the category treatments (tre), that were carried out in the plaster layer (pla), which is a group in the category materials (mat) in the year 2000. Other examples:

2000_mat-pai_dam-pad-fla (material-paint layer_damage phenomena-poor adhesion-flaking)

2000_mat-pla_tre-con-sil (material-plaster_treatment-consolidation-silicone esters)

2000_mat-pla_sam-che-sal (material-plaster_sampling-chemical analysis-salt content)



Germany, Königsutter Stiftskirche. Medieval wall painting in the lower storey of the westwork, detail of the Tree of Jesse. Original AutoCAD-mapping of damage phenomena on the base of a rectified color image. Foto: Deutsches Bergbau-Museum Bochum

Guidelines for Visualisation

Specific colours have not been assigned to the mapping of different phenomena. This is due to the creation of an open system, where numerous combinations between groups and categories are possible. Depending on the type of information one wants to extract from the mapped data different colours, hatching and symbols must be chosen in each individual case. When choosing these visual elements it is important to be aware which colour combinations work well together optically, resulting in an easily understood map. For example, when a thematic map for the visualisation of damage phenomena on plaster is planned, one could choose orange lines for cracks; green hatched areas for cavities, pink hatched areas for mechanical abrasions, and blue hatched areas for areas deteriorated by salts. If a more detailed study of the different types of salt efflorescence in one area is planned, it would be necessary to assign a different colour to each type of salt.

It is advantageous to create one layer for mapping the outlines and another for the mapping of hatching that will fill these areas. For example, information about the location of salt damage in the plaster layer will be placed in two layers: **2000_mat-pla_dam-sal** will be the layer name where the outlines will be mapped; **2000_mat-pla_dam-sal_hat** will be the layer where the hatching will be done. The separation of the outlines and the filling allows the visualisation of an area where the boundary is not very sharp. This is done by freezing the outline layer and plotting the hatching.