Improved Damage Assessment of Parchment, IDAP: micro and non-destructive analysis and diagnosis for proper storage and treatment

René LARSEN

Summary

The general progression of the deterioration of parchment collagen from a fibrous to a gelatine-like state was a major subject of study in the European joint project 'Methods in the Micro-Analysis of Parchment'. The analytical results from this project strongly indicate that a correlation between physical properties at macroscopic and microscopic levels can be made. The new European joint project 'Improved Damage Assessment of Parchment' aims to assess damage in historical parchments at the macro, micro and molecular levels with the objective of establishing a Parchment Damage Assessment Programme (PDAP), an Early Warning System (EWS) and a Digitised User-friendly Parchment Damage Atlas (DUPDA), all made available on the Internet.

Introduction

Parchments in the form of manuscripts, scrolls, charters, book covers, and substrates for artwork belong to the most valuable objects of European cultural heritage, for they are bearers of the history which has shaped the development of European society over a period of many centuries. Large collections exist in public and private libraries, archives, museums and in diverse religious foundations in varying degrees of preservation. Damage assessment, including an early warning system based on a proven analytical protocol, would contribute to extending the lifetime of these documents as well as improving methods used for their conservation.

Parchment has a predominantly organic composition, mainly based on collagen. Beginning with an intact fibre structure of high hydrothermal stability, a parchment's degradation tends to develop through different stages of change in the fibre structure. There is a resulting decrease in hydro-thermal stability, leading to a terminal stage with a considerably disintegrated fibre structure that is transformed into a gelatinous substance by contact with water or storage in moist conditions (Figures 1 and 2).

The MAP project

The general progress of the deterioration of parchment collagen from a fibrous state to a gelatine-like state, as revealed in details in the European joint project 'Methods in the Micro-Analysis of Parchment' (MAP), is a conclusion of essential importance to practical conservation (LARSEN, 2002). The pre-gelatine state of the parchment fibres is not detectable in the dry state at the macroscopic level. This transformation process, as detected by observation of the parchment fibres in water under a microscope or in transmission electron microscope (TEM) analysis, may in many cases lead to irreversible damage of historical parchment manuscripts and objects by humid treatment and storage.

In the MAP project several micro-analytical, test and sampling methods were developed and/or modified to improve damage assessment of historic parchment. The work in this project provided a set of markers for damage assessment of parchments, in particular the degree of gelatinisation of the collagen matrix, its physico-chemical state and degree of crystallinity. The

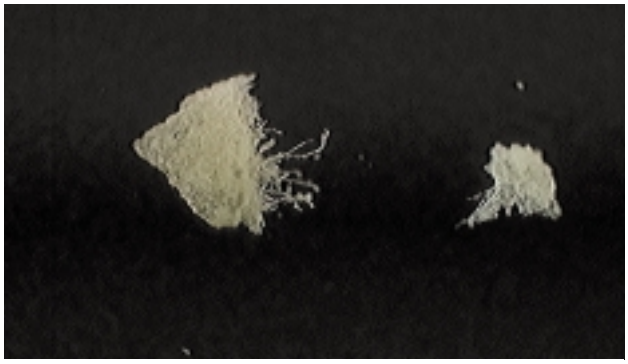

Figure 1. Parchment fragments in dry state (fibres seem intact).

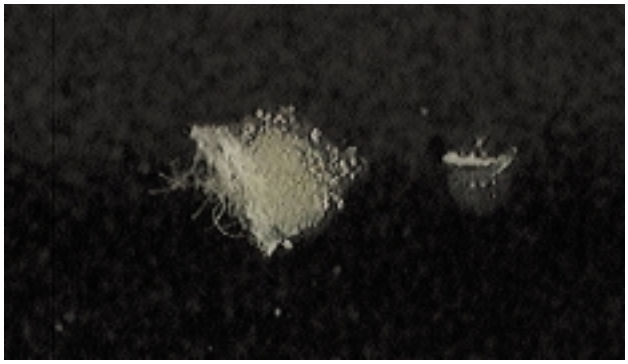

Figure 2. Same parchment fragments immediately after contact with water (fibres dissolve into a sticky, gelatinous mass).

analytical results obtained in the MAP project strongly indicate that a correlation between physical properties at the macroscopic and microscopic levels can be made. Thus, the observed characteristics, such as gelatinisation and the stiffness of fibres and samples, can in several cases be explained by the specific features observed in the chemical and thermal data. In general, these observations provide important information to end-users in connection with practical conservation, restoration and storage of parchment.

The preliminary results of the MAP project call for a more intensive study and collection of data in order to provide a more solid basis for applied assessment and conservation activities. However, some of the sampling techniques and micro-analytical methods developed in the project provide very useful tools for obtaining additional information, to give a more complete picture of the deterioration of parchment manuscripts.

Currently the condition of parchment documents is assessed by conservator-restorers in terms of their visual appearance and mechanical strength, some times together with shrinkage temperature measurements. Deterioration, however, takes place at several levels and damage cannot always be readily assessed through visual means.

The IDAP project

The new European joint project 'Improved Damage Assessment of Parchment' (IDAP, 2002) involves 8 research partners in 7 European countries (Table 1).

The aim of the project is to assess damage in historical parchments at the macroscopic, microscopic, mesoscopic, nanoscopic and molecular levels (Figure 3).

For this purpose, a number of parchments will be selected by conservator-restorers participating in this project. These will be analysed according to the protocol developed in the previous MAP project, as well as by new, simple, visual and advanced assessment methods with the objective of establishing and making available on the Internet:

- A Parchment Damage Assessment Programme (PDAP)
- An Early Warning System (EWS)
- A Digitised User-friendly Parchment Damage Atlas (DUPDA)

The Parchment Damage Assessment Programme (PDAP)

The PDAP will provide conservators with detailed information on testing methodology for identifying the condition of parchment. It will be established on the basis of comprehensive analysis, assessment and observation of a significant number of parchments in collections representative of all of Europe (Figures 4 and 5) as well as of new, non-aged and artificially aged parchments. It will consist of various simple, visual, non-destructive and micro-sample assessment methods and techniques for routine damage assessment of parchment on the macro-level (visual and microscopical). The methods and techniques of the PDAP will be supported by the results of correlation analysis as well as results from advanced chemical, structural and thermochemical studies of parchment deterioration on the micro-level. The PDAP is intended to be used by professional end-users working in the assessment, conservation and restoration of parchment.

In addition to the assessment of historic parchment samples, accelerated ageing tests will be performed on new reference parchments. The tests will include stress cycling to study the impact of changes in temperature and relative humidity during storage, expo-

Table 1. Partners in the IDAP project.

DK	School of Conservation, The Royal Danish Academy of Fine Arts, Co-ordinator. In cooperation with the Department of Biochemistry and Nutrition (DBN), Technical University of Denmark
GR	Foundation for Research & Technology – Hellas, Institute of Chemical Engineering & High Temperature Chemical Processes
UK	University of London, Birkbeck College
F	Centre de Recherches sur la Conservation des Documents Graphiques (CRCDG)
UK	University of Stirling, Department of Biological and Molecular Science
I	University of Turin, Department of Chemistry. In co-operation with the Department of Food Science and Microbiology, the University of Milan
DK	The Royal Library
CZ	National Library of the Czech Republic, Conservation Department
EU	European Commission, DG RTD-I5 – 'The City of Tomorrow and Cultural Heritage'

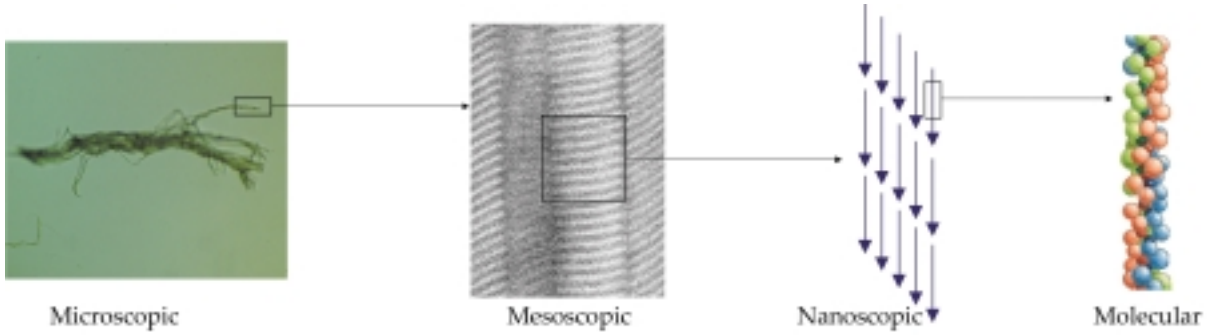

Figure 3. The microscopic, mesoscopic, nanoscopic and molecular levels of parchment.

Figure 4. Parchment manuscripts, The Royal Library, Denmark.

Figure 5. Illumination on parchment, The National Library of the Czech Republic.

sure of samples of peptides and enzymatic digested collagen to SO_2 and NO_2 in varying concentrations, studies of the effect of light, temperature and humidity as well as combinations of the different parameters in order to study the interaction of these. The samples of parchment aged through acceleration will be analysed and compared to analytical results from naturally deteriorated historic parchment samples.

The systematic description and quantification of the condition of parchments artificially aged by means of virtually non- or micro-destructive sampling, combined with observational assessment and scientific analysis of large collections, is a novel and vital contribution of this project to parchment preservation.

The Early Warning System (EWS)

In an attempt to select the most effective methods of treatment and storage conditions, the ability to identify the condition of parchment and to detect an early state of pre-gelatinisation by means of an EWS will be studied. The EWS will consist of a limited number of simple damage assessment methods and techniques. These methods should detect the most important degradation features (e.g. gelatinisation of the parchment fibres) and indicate them in the earliest possible stage in a 'sensor' made from parchment. The parchment 'sensor' may be placed in storage rooms, show-cases, etc. together with historic parchment objects, and tested frequently to reveal changes due to deterioration.

The Digitised User-friendly Parchment Damage Atlas (DUPDA)

The systematic description and quantification of the condition and damage of parchments by means of virtually non- or micro-destructive sampling, combined with observational assessment and scientific analysis of large collections, will be made available via the DUPDA. It will be developed as a user-friendly database containing all necessary descriptions in text and photos of the parchment damage evolution. It will provide conservator-restorers access to the assessment methodology described in the PDAP. In addition, it will contain precautions and recommendations for storage and treatment of the parchment in different stages of deterioration. Moreover, it will have links to all relevant data from the advanced micro-level chemical, structural, thermochemical and physical analysis.

The working methodology and strategy

The overall methodology and strategy for achieving the objectives are the continuous use of simple and advanced complementary assessment methods, ap-

plied to a large number of samples in different states of deterioration. Extensive cooperation between both the end-users and scientists guarantees the successful outcome of the work. In addition, the number of historical parchment objects from the collections of the involved end-user institutions ensures a significant amount of data and observations for the correlation analysis. These parchments represent both similarities and variations with respect to origin, object type, storage conditions, treatment conditions and geographical distribution (Central, Northern and Southern Europe). The tasks to be executed are distributed in the following 6 work packages given in Table 2.

Structure of the work

The project work follows four parallel and interactive lines, of which three will produce the results and methods leading to the project goals. The structure, flow and interconnection of work, data and results of the work are illustrated in Figure 6.

Conclusions

Scientific analysis of parchments must reveal their actual state of degradation as well as their state of preservation as a function of their storage and conservation history as demonstrated in the previous MAP parchment project. In the new joint European IDAP project, more sophisticated methods of analysis will be used to expand the visual assessment methods, to attempt to quantify the results and subsequently try to correlate the data to the results obtained by the visual assessment methods and the more sophisticated methods. To obtain a better understanding of the very complicated process of parchment degradation, available techniques and concerted actions will be used. Tests will also be done with high level analytical equipment for its applicability to the analysis of micro-samples, in the assessment and analysis of specific and correlated degradation features. This will also overcome the general problem of sample size. The estimation, measurement and systematic description of the alteration and preservation condition of objects of cultural value by means of non-destructive or micro-sampling, observational assessment and scientific analysis of large collections and experimental samples is new with respect to parchments. Formerly, only visual aspects were used to describe the condition of manuscripts, charters, scrolls and book covers. Another innovation is the strategy of comparative and correlation analysis of the various simple, visual, non-destructive and micro-sample assessment methods (techniques for routine damage assessment of parchment on the macro-level, visual and microscopical) with the advanced chemical, structural and thermochemical studies of parchment deterioration conducted on the micro-level.

Table 2. Work packages (WP) in the IDAP project.

WP1. Establishment of the damage assessment system

A. Visual damage assessment (macro-, micro- and end-user systems).

B. Assessment of hydrothermal, thermochemical and thermophysical properties.

C. Assessment of the chemical compositional and structural damage.

All methods in systems A, B and C are complementary and ensure comparative information on the molecular, nano-, meso-, micro- as well as the macro-structural level.

WP2: Establishment of a central data base

Data collection and circulation, statistics, basis for design of PDAP, EWS and DUPDA.

WP3: Artificial ageing experiments

Ageing experiments on new parchments to supplement damage studies on historical materials.

WP4: Assessment campaign 1

Using the three assessment systems (A,B,C) established in WP1.

WP5. Assessment campaign 2

Using the same assessment systems as in WP4 eventually modified on the basis of comparative and correlation analysis. The information, data, detailed description of methods etc. leads to the final goals in WP6.

WP6: Establishment of PDAP, EWS and DUPDA

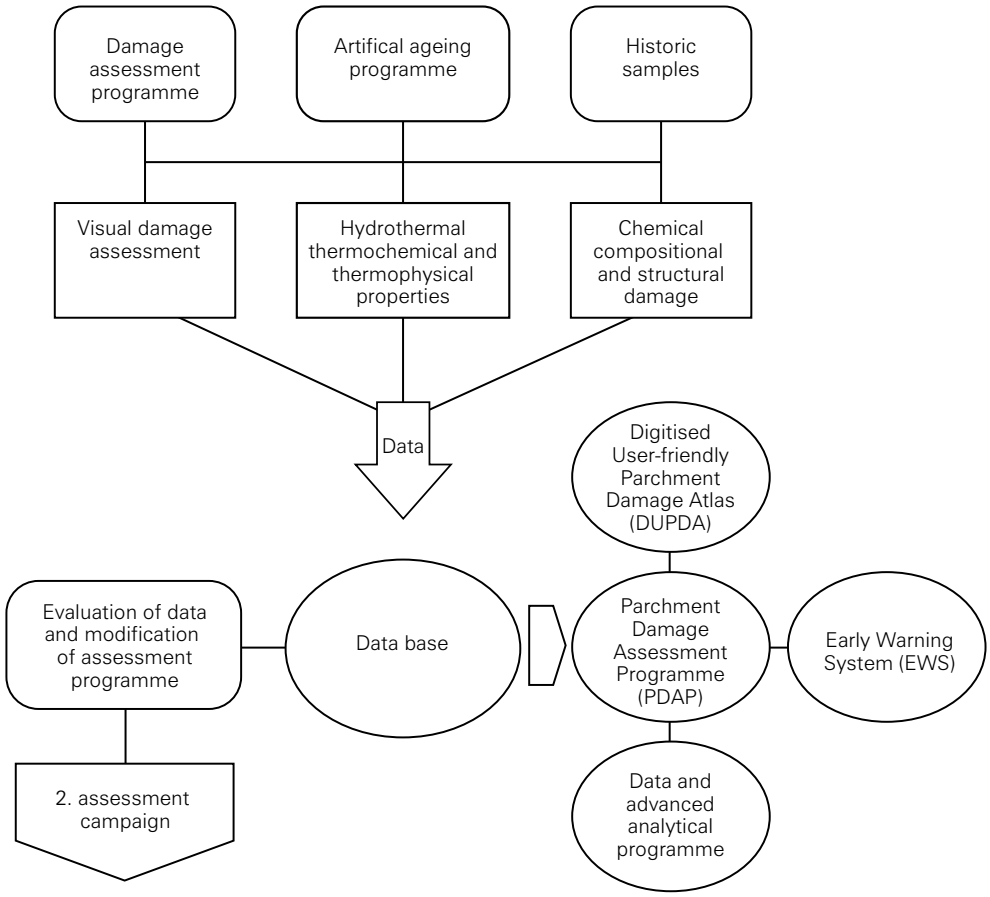

Figure 6. The structure, flow and interconnection of work, data and results of the work.

The creation of a Parchment Damage Assessment Programme (PDAP), an Early Warning System (EWS) and a Digitised User-friendly Parchment Damage Atlas (DUPDA) are all new and innovative. The availability of these for end-users on the Internet is also innovative. For the first time researchers and end-users in Europe will be collaborating to establish a complete programme of research based on tools aiming to improve damage assessment of cultural heritage objects.

References

LARSEN R. et al., *Microanalysis of Parchment*, Archetype Publications, London, 2002.

IDAP, The IDAP project (EVK4-CT-2001-00061) is funded by the EC under the 5th Framework Programme: Energy, Environment and Sustainable Development, Key action 4: The City of Tomorrow and Cultural Heritage, subsection 4.2.1 Improved damage assessment of cultural heritage. More information on the project and the project partners can be found on www.idap-parchment.dk.

René Larsen

School of Conservation,
The Royal Academy of Fine Arts
Esplanaden 34, 1263 Copenhagen, Denmark
e-mail: rl@kons.dk

Professional Bookbinder; Master in the Science of Conservation (School of Conservation, DK); Ph.D. in Biochemistry (University of Copenhagen, DK). Since 1986 teacher/scientist at and since 1996 Rector of School of Conservation, The Royal Danish Academy of Fine Arts, DK. Co-founder 1997 and from 1998 Chairman of the Board of the European Network for Conservation – Restoration Education 'ENCoRE'. Co-ordinator of 4 European EC joint research projects on leather and parchment and of 1 EC Advanced Study Course on collagen based materials.