

## 37<sup>th</sup> IPH Congress – Oslo (Norway) – September 9-14, 2024



### ABSTRACTS

WEDNESDAY 11 SEPTEMBER 2024 THE NATIONAL MUSEUM, Brynjulf Bulls plass 3, 0250 Oslo

**Emilie Arnaud-Nguyen**  
(France)

*Multidisciplinary study of paper: key condition for a successful analysis.*

The HisTocText Project (ERC grant agreement n°. 788205) covers a corpus of Tocharian paper documents dated between the 4<sup>th</sup> and 9<sup>th</sup> CE, stored at the Bibliothèque nationale de France, and submitted to a diverse range of analyses including codicological, macroscopy, microscopy, multispectral imaging, x-Ray fluorescence, raman spectroscopy, and pyrolysis gas chromatography. This presentation will focus on the project's macroscopic and microscopic analyses which aim to identify the physical evidence left from the manufacturing, the use of the documents, and their conservation from the time of use to modern treatments. The papers were discovered in the oasis kingdom of Kucha, which was renowned for its rich cultural and religious life. The production of paper was closely related to the growth of Buddhism. Buddhism led to the adoption of a writing system and the production of writing supports. Regarding the papers in question, two competing hypotheses persisted relating to their origin: either they were manufactured locally, or they were imported from China. The multidisciplinary HisTocText project proved to be a success by emphasizing the connections between peoples across Central Asia. The resulting conclusions provided information simultaneously about the local paper technology, the formulation of inks, the use of manuscripts (including a Buddhist cult of books, medical texts, repairs undertaken, and conditions of storage) and the history of the papers' conservation since they entered the Bibliothèque nationale de France in the early 20<sup>th</sup> century.

Le projet multidisciplinaire HisTocText (financement ERC n°. 788205) étudie un corpus manuscrits papiers écrits en langue tokharienne, datés du IV<sup>ème</sup> au IX<sup>ème</sup> siècle, conservés à la Bibliothèque nationale de France. Ils furent soumis à une série d'analyses notamment codicologique, macroscopique, microscopique, imagerie multispectrale, fluorescence X, spectroscopie Raman et pyro-chromatographie en phase gazeuse. Cette présentation portera sur les analyses macroscopiques et microscopiques qui visaient à identifier les traces laissées par les étapes de fabrication du papier, l'usage des documents et leur conservation depuis l'époque de leur fabrication jusqu'à la période contemporaine. Les papiers furent découverts dans le royaume oasis de Koutcha, renommé pour sa vie culturelle et bouddhiste à la fois riche et variée. La production de papier était étroitement liée à l'essor du bouddhisme qui conduisit à l'adoption d'un système d'écriture ainsi qu'à l'usage de supports de l'écrit. En ce qui concerne le matériau papier, deux hypothèses perduraient quant à leur origine : son importation depuis la Chine ou une fabrication locale. Le projet multidisciplinaire HisTocText a permis de mettre en lumière les liens existants entre les populations d'Asie centrale. Les résultats de cette étude pluridisciplinaire renseignent à la fois sur la technologie papetière locale, la composition des encres, l'usage des manuscrits (culte des livres bouddhiques, textes médicaux, conditions de conservation) ainsi que l'histoire de leur restauration depuis leur entrée dans les collections au début du XX<sup>ème</sup> siècle.

**Keywords:** paper technology, Central Asia, paper analyses, history of conservation.

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**Arthur McClelland, Julie Werts, Debora Mayer, Penley Knipe (USA)**

*Non-invasive paper analysis: Specular Reflection Fourier Transform Infrared Spectroscopy and Chemometrics (PCA).*

Scientists and conservators at Harvard University partnered to develop and test a non-invasive technique to analyze paper fiber composition and sizing agents. The technique applies principal component analysis (PCA) modeling to specular reflection Fourier transform infrared (FTIR) data. The results from a known set of reference papers have shown this technique to be able to distinguish between fiber types and sizing with surprising accuracy, providing a plausible non-invasive method for the identification of paper materials.

Specular reflectance FTIR spectra were collected from western and Asian reference sets of papers with a Bruker LUMOS I FTIR microscope. The resulting spectra were impossible to distinguish by human eye. Correlation matching algorithms used in spectral library searches were also not helpful in classifying the different papers based on fiber type and sizing types due to the bias towards the cellulose peaks common across these objects. However, preprocessing the data with mean centering and then the application of principal component analysis (PCA) modeling allowed for the distinguishing of fiber types and paper sizing materials in the papers.

The presentation will discuss the techniques used, the building and sharing of the reference spectral data sets, and examples of using this technique to analyze Harvard collections.

PCA modeling of FTIR spectra has the potential to provide information for objects that would otherwise not be suitable for fiber analysis involving sample removal. This is a practice changer for art conservators and other museum and library professionals in the analysis of collections.

**Keywords:** non-invasive fiber analysis, PCA modeling, FTIR.

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**Silvia Hufnagel (Iceland)**

*Paper analysis with hyperspectral imaging and IR spectroscopy.*

One of the main aims of the project “Life of Paper”, funded by the Icelandic Research Fund, is to determine when and where paper used for Icelandic manuscripts was produced.

To achieve this aim, we conduct watermark research, using a hyperspectral camera from the Fraunhofer Institute for Factory Operation and Automation (IFF) in Magdeburg. This is a line camera which uses 320 spatial pixels and 256 bands in the range from ca. 1 000 to ca. 2 500 nm, ie. the spectral range in which iron-gall ink becomes invisible. Illumination is done by an off-axis halogen lamp. The scans of the watermarks will be added to the Wasserzeichen-Informationssystem database, where we can compare the scans to other watermarks providing information on the production of the paper.

In cases where we cannot use watermark research, for example because carbon ink prevents the analysis of watermarks or because we cannot find comparable, already dated and localised watermarks (such as the popular fool’s cap and Arms of Amsterdam), we will use infrared spectroscopy. This is a method that measures molecular vibrations induced by a specific amount of energy. On the basis of the resulting spectrum we can determine the chemical components and thereby the molecular decay of the material. There exist several techniques in IR spectroscopy, including MIR (Mid Infrared) spectroscopy External Reflection, which works contactless with a relative broad measuring area but a relatively lower accuracy, as well as using Attenuated Total Reflection, which is performed by softly pressing a crystal on the surface of the sample. Accuracy is higher, but a certain pressure is applied making this technique problematic for very fragile samples. Comparisons of our measurements with other, already dated material will hopefully give us a relatively precise date of paper production.

**Keywords:** Watermark analysis, infrared spectroscopy, hyperspectral imaging.

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**Margaret Holben Ellis,  
Andrea Bernardoni, William  
A. Sethares (USA)**

*Leonardo//thek@ Enhanced! An Even More Powerful Resource for the Study of Leonardo's Notebooks and their Papers.*

*Leonardo//thek@*, conceived, developed, and hosted by Museo Galileo, Florence, is a powerful online portal that allows easy access to a vast amount of scholarly research on Leonardo da Vinci's manuscripts. Recent enhancements to the website, which will be of great interest to paper historians, include the incorporation of *Leonardo//thek@-Codex Atlanticus*, *Leonardo//thek@-Royal Collection*, and *LEOcode*.

*Leonardo//thek@-Codex Atlanticus* incorporates images and transcriptions of the nearly 1,200 sheets of the Codex Atlanticus, including paleographic characteristics, watermarks, chain line intervals, and historic glass plate negatives. Representing over 150 years of study, it is the first step in an ambitious project to reconstruct the state of Leonardo's manuscripts before the disastrous intervention by Pompeo Leoni, who, at the end of XVI century, disassembled and distributed the sheets between two large albums, the Codex Atlanticus, preserved in the Ambrosiana Library, Milan, and the other in the Royal Collection, Windsor.

The inclusion in the *Leonardo//thek@* of the da Vinci sheets in the Royal Collection will make it possible to consult the two digital repositories separately and as an integrated archive.

*Leonardo//thek@* will also allow access to *LEOcode*, a computational approach to enhancing, measuring, comparing, and matching Leonardo da Vinci's papers (and a compendium of watermarks and moldmates in the Codex Arundel and the Codex Leicester) through detailed coding and visualization of their internal artifact patterns, including watermarks, chain line intervals, and laid line densities. *LEOcode* provides the tools for anyone who wants to identify physical similarities among Leonardo's papers.

These enhancements to *Leonardo//thek@* will encourage advanced research into the extremely complex universe of Leonardo manuscripts.

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**Maria Carme Sistach, José F. García, Georgios Magkanas, Eva Marín, Héctor Bagán Navarro (Spain)**

*Comparative study of analytical techniques used for the determination of H<sup>+</sup> and Fe in paper: Potentiometry, LA-ICP/MS, SEM-EDS and XRF.*

The conservation of paper, one of the most common supports in manuscripts, is essential for the preservation of the information they contain.

The degradation of paper (containing text written with iron-gall inks) through the rupture of cellulose chains follows two mechanisms: acid degradation and iron-catalyzed oxidation, both caused by iron-gall inks.

The evaluation of the advances of the two mechanisms requires analytical techniques capable of monitoring the concentration and distribution of protons and iron in the surroundings of the ink trace.

From an analytical point of view, these determinations require techniques with a very low detection limit and high spatial resolution.

In this study, the results obtained using four distinct analytical techniques are presented, along with the limitations of each method.

First, potentiometry has been used for the determination of acidity, comparing surface pH measurements (without sampling) to those obtained for the paper mass (with sampling). The results indicate that the surface pH is always more acidic than that of the paper mass, while equilibrium is reached after 1-3 h of contact.

With regards to Fe determination, three techniques have been evaluated: Laser Ablation coupled to Inductively Coupled Plasma/Mass Spectrometry (LA-ICP/MS), Scanning Electron Microscopy (SEM) and X-ray Fluorescence (XRF). The first presents high spatial resolution and an adequate detection limit, without the need for sampling. In the case of the latter two, the spatial resolution are not sufficient for a trustworthy determination.

Furthermore, the three techniques do not allow the determination of the Iron concentration and show the heterogeneity of the sample. With them it is only possible to determine relative concentrations what can be helpful to know about the conservation treatments effect.

Authors thank to R. Collantes, J. Matas, E. Aragonés, their contribution.

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**Keywords:** Paper, Iron-gall ink, LA-ICP/MS, XRF, SEM\_EDS.

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**Jos De Gelas** (Belgium)

*Historical research on paper assisted by big data.*

In 1998 at a congress on medieval paper organized in Paris I presented a lecture about the production and the watermarks of Belgian papers till the end of the 15th century. The conclusion of the effected research was as follows: "... nous n'avons pas déterminé de filigrane d'origine belge pour la période allant jusqu'à la fin du XVe siècle". Now thirty-five years later reviewing the historical knowledge on the first papermills in Belgium New discoveries were made assisted by big data available in the public domain through the internet.

The presentation I propose is to demonstrate how the availability of big data over the internet assist individual researchers in progressing on the knowledge of paper history, watermarks and paper trade and consumption through two case studies.

A first case demonstrates new views on the Briquet watermarks referenced 15894 to 15896 of his inventory. Initially estimated by the author as a production of the Belgian city of Tournay but finally allocated to the North-East region of France according to my findings attributable to the early production of the Belgian city of Huy.

The second watermark with the Briquet reference 1125 and dating from the 16th century, reviewed based on a publication issued in 1912. The publication is about a bookbinder living in the city of Kortrijk and traces of his paper use through surviving archival material. My actual study reveals a complete new conclusion on the origins of the watermark. But it also raises new questions on the potential process of papermakers producing sheets with watermarks ordered by their customers.

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**Virginia Howell** (USA)

*Dard Hunter and his Museum.*

Paper historian Dard Hunter spent the majority of his adult life writing, collecting, and sharing about paper. In 1939 he opened the Dard Hunter Paper Museum, with about 10,000 artifacts and 2,000 books. The Robert C. Williams Museum of Papermaking holds his collection, which has grown to approximately 100,000 objects and 7,000 books. Today, the mission of the museum is to "collect, preserve, and interpret the past, present, and future of paper and papermaking."

Who was Dard Hunter? How did he get involved in paper history? What did he collect and how did he organize it? How is the museum managing a collection that continues to grow?

Significant objects in the collection include historic molds from India, Korea, and England. Thousands of paper samples represent handmade and industrial papermaking. Numerous historic watermarks are represented as well. Resources in the collection include articles and books written by Hunter. In addition, other written works, ranging from articles to pamphlets, are part of the research library. Beyond the items collected by Hunter, there are other wide-ranging "paperania" to be found: 20th century paper sample books, selections from Hunter's colleague Harrison Elliott, bark papers, and an extensive fiber sample library from the Institute of Paper Chemistry.

This presentation will serve as a virtual tour of the museum, highlighting the breadth and depth of the collection. It will focus on artifacts collected by Hunter in his global travels in the first half of the 20th century. A secondary purpose of this presentation is make researchers, historians, and papermakers aware of the contents of the collection and to determine what kind of information is most useful and needed to help promote their research and understanding of papermaking and paper history.

**Keywords:** Dard Hunter, archive, museum, collection.

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**Enrico Pigorsch, Gert Meini, Matthias Hüls, Ronny Friedrich** (Germany) *Absolute dating of paper by radiocarbon measurements.*

The absolute dating of paper is of interest for many reasons. Especially, in forensic investigations of questioned documents, suspected forgeries of works of art or other problems involving paper, a precise determination of the production year of a paper could be decisive in solving criminal or legal cases. An approximate time period for the production of a paper can be determined by the analysis of the material composition and the structure of the paper in comparison to the time frame of past changes in paper-making technology. However, the intervals between significant changes were 20 to 50 years or longer and do not provide the necessary precision for an absolute dating of paper.

Radiocarbon ( $^{14}\text{C}$ ) measurement is the most used analytical method for the absolute dating of objects and artefacts in archaeology, art sciences and forensics. Usually, radiocarbon dating involves uncertainties of at least  $\pm 20$  years, for objects dating over the last 2000 years. Another situation applies to the time period after 1955, when  $^{14}\text{C}$  concentrations in the atmosphere spiked due to the above-ground nuclear tests following the Second World War and before the nuclear test ban treaty in 1963. The resulting so-called bomb peak and its steep curve progression allow a comparatively precise age estimation of within 1 to 5 years of precision for short-lived biological materials or components which are also present in paper, like starch and cellulose fibres.

The presentation will discuss and demonstrate the different aspects and possibilities of the absolute dating of modern papers produced after 1955 by radiocarbon measurements. Case studies with investigations on documents and works of art will be presented.

**Keywords:** paper, absolute age,  $^{14}\text{C}$  bomb peak, radiocarbon AMS dating.

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**Sonja Neumann** (Germany) *Lost Papers – Munich watermark papers of the former Research Center of Paper History Mainz.*

When the archive of the former Research Centre for Paper History in Mainz was transferred to the Deutsches Museum in Munich in 1974, this was linked to the hope of bringing together paper technology and paper research. After the German reunification, the large collection of watermarked papers was handed over in 1992 to the German Museum of Books and Writing in Leipzig. However, a small but fine collection of watermarked papers (c. 300) remained in the Deutsches Museum and was not officially inventoried in the object database until 15 years later. This fragmentary collection spans a period from the 16th to the 20th century and mainly covers the bavarian region. It also includes a very interesting number of papers from Munich, which represent an important documentation of the Munich paper mills. Among them is one of the oldest paper mills in Germany, the paper mill in Munich-Au in the direct neighbourhood of the Deutsches Museum. It is worth taking a closer look at the structural features and the significance of the watermarked papers for further identification and analysis in order to continue the history of the Munich paper mills. The watermark papers are also intended for the transfer to the relevant databases and will be prepared accordingly.

**Keywords:** watermark papers, Munich, Research Center of Paper History Mainz.

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**Anna-Grethe Rischel** (Denmark) *Watermarks of Technology – Watermarks of Provenance – A comparative macroscopic and microscopic paper analysis of handmade Chinese, Central Asian, Arabian and European paper.*

Macroscopic studies of ancient Chinese and Central Asian manuscripts from the Hedin Collection in Stockholm, the Stein Collection in London, the Turfan Collection in Berlin, and the Pelliot Collection in Paris have resulted in observation and registration of laid lines and chain lines in the paper, when held against light, of similar structures as in later Arabian and European manuscripts from Royal Library and National Museum in Copenhagen. These ‘watermarks of technology’ together with the European ‘watermarks of provenance’ since the 13th century are created and preserved as imprints of the mould structure in the paper, when the mould at the end of the sheet formation is lifted, and the water drains away from the new web of fibres.

According to the microscopic analysis of the manuscripts, recycled textile materials have been available for handmade paper production everywhere from China along the Silk Roads to the Mediterranean Region and to Europe. The microscopic analyses of Chinese and Central Asian paper specimens, collected only from damaged edges without texts, illustrate the development of the papermakers’ choice of recycled fibre materials from a mixture of ramie, hemp & linen materials, recycled ramie, hemp & linen materials with addition of mulberry fibres and of pure new mulberry fibres. The microscopic analysis of Arabian and of European paper specimens documents a continuation and similar use of recycled hemp & linen materials for the paper production. But without the European invention of the ‘watermark of provenance’ in Asian and Arabian paper manuscripts, it is only possible to indicate the origin and provenance of these manuscripts through macroscopic studies of the construction of the mould screen and the availability, according to the microscopic analyses of the new fibre materials used.

**Keywords:** Watermarks of technology and watermarks of provenance, Macroscopic analysis of the technology and microscopic analysis of the fibre materials.

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**Yi Yang, Ayush Kale, Yuwei Liu, Sarah Reidell, Xuan Liu** (USA) *Advancing Conservation Techniques through Deep Learning of Optical Coherence Tomography Images for Classifying Kozo-Fibered Papers.*

In this research study, we have investigated an innovative approach for obtaining cross-sectional images of 35 Kozo-fibered paper samples through the utilization of Optical Coherence Tomography (OCT). Subsequently, these acquired images were processed through Deep Convolutional Neural Networks (AlexNet), to accomplish non-invasive classification. Historically, the identification of papers and the analysis of morphological attributes pertinent to plant cultivation and craft tradition have predominantly relied upon interpretive visual observations or invasive fiber sampling techniques [1-3]. Optical coherence tomography (OCT), a non-invasive medical imaging technique, has been applied to study cultural heritage objects. OCT can capture comprehensive structural data, encompassing both surface and subsurface information. [4]. Thirty-five Kozo-Fibered paper samples were sourced from a conservation vendor specializing in Japanese handmade papers. These were selected based on their known fiber content and production methods as well as use in book and paper conservation treatments for hinging, tear repairs, and loss compensations. Cross-sectional images of the paper samples, including the light scattering information within the paper substrate, are generated by the OCT. Notably, the patterns of scattered light, while seemingly arbitrary to the human observer, were subjected to analysis through AlexNet, a pioneering convolutional neural network (CNN) introduced in 2012 for image classification [5]. A total of 35,840 OCT cross-section images were generated, of which 3,500 images (~10% of the dataset) were used for training, 8,960 images (25% of the dataset) were used for validation, and 23,380 images (~65% of the dataset) were used for testing. The AlexNet achieved a test accuracy of 98.99%, with 23 out of 35 paper samples achieving 100% accuracy in the tests. The Alexnet was able to classify the paper samples taken at the same location with high accuracy. We believe that this can be improved when images taken from a different location are also introduced to the training stage.

**Keywords:** OCT AI.

Reference:

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**Frieder Schmidt** (Germany)

*The Forschungsstelle Papiergeschichte and the formative early years of the IPH.*

The history of science is interested in the constitution of scientific communities, the common research interests of scholars, and their communication, which is reflected in committees, conferences and publications. This is about paper history and watermark research in the middle third of the 20th century.

In 1938, after several years of preparation, the Forschungsstelle Papiergeschichte was founded with significant participation from the Association of Pulp and Paper Chemists and Engineers (Zellcheming Association) as a Paper History Research Center. As early as 1937, this association had set up a subcommittee for paper history and watermarking (Unterausschuss für Papiergeschichte und Wasserzeichenkunde). The merchant Alfred Schulte from Oberhausen, who was a descendant of an old papermaking family, was commissioned to manage the facility, which was based at the Gutenberg Museum in Mainz. He died as a soldier of Hitler's army in the Soviet Union in 1944.

In 1999, on the occasion of the association's 40th anniversary, Wolfgang Schlieder, one of the twelve founding members of the IPH in 1959, explained the important role the Forschungsstelle Papiergeschichte played, particularly during the period when it was headed by Alfred Schulte's widow Toni Schulte. The role of the journal *Papiergeschichte* should be highlighted, which brought together an international circle of personalities who were also in close contact with the cell chemistry subcommittee mentioned and the Paper Publication Society initiated by Emile Joseph Labarre with its series *Monumenta chartae papyraceae historiam illustrantia*.

Another quarter of a century later, it is worth taking another look at the conditions at that time.

**Keywords:** Paper History, Filigranology, Associations and Institutions, 1930s to 1960s.

**Nil Baydar** (Turkey)

*Analysis of Papers Mentioned as 'Semerqandī' in the Endowment Deed Prepared by an Ottoman Bibliophile in the Early 18th Century: The Challenge of Identifying Islamic Papers.*

Distinguishing, dating, and precisely determining the origin and names of Islamic (Arabic) papers, in the absence of watermarks or countermarks, is inherently difficult. Conservators, art historians, and scholars dealing with Islamic manuscripts encounter a significant challenge in paper identification. This study uniquely provides an opportunity to compare the names and physical characteristics of Islamic papers with those mentioned during their usage period.

Feyzullah Efendi (d. 1703), the Sheikh ul-Islam of the time and a bibliophile, commissioned a catalog of 2136 manuscripts in his endowment deed dated 1702. The earliest dated manuscript was written in 1055, and the latest in 1702. In this invaluable endowment deed, alongside bibliographic details, he specified the type of paper used in each manuscript. The endowment deed reveals the prevalence of *Semerqandī* papers, alongside others named *Âbâdî*, *Haşebî*, or *Bosnian* papers among twelve different paper types. Although the exact criteria for identifying these paper types are not fully known, physical attributes such as paper fiber traces, thickness, light permeability, the sound produced while turning pages, paper color, and surface texture likely guided their differentiation.

Within the scope of this study, the papers of these manuscripts, currently housed in the Millet Manuscript Library in Istanbul, were examined by comparing them with the paper types outlined in the endowment deed. The physical and fiber characteristics of *Semerqandī* papers among the 810 dated manuscripts were analyzed. As a result, the common physical features of *Semerqandī* papers, characterized by their thickness, durability, and recorded values with a portable spectrophotometer device ( $L^*a^*b^*$ ), will be discussed as criteria for identifying papers in Islamic manuscripts.

**Keywords:** Islamic papers, *Semerqandī* papers.

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**Vasiliki Kokla, Agamemnon Tselikas** (Greece)

*Study of a paper support used in a post-Byzantine codex of the 18th and documents of 19th century.*

The paper support of the codex and documents are in a poor preservation state, therefore the paper study is difficult. The codex is written on handmade paper support, with religious content, dated in 18th century and it belongs to the ARETHAS Institute. The documents contents texts written in the period of the Greek Revolution during 1821-1828 that belong to the Archive of the Library of the Hellenic Parliament. They present a similar preservation state to the paper supports of 18th century codex, especially in combination with the quality and the texture of the paper. The study focuses on trying to read the watermarks and their surviving features, identifying the fibers used in its manufacture, and elemental analysis of the materials used in its manufacture.

Watermark recognition was performed by taking digital images in transmitted light in the visible region of the electromagnetic spectrum, as well as in the region where the fluorescence effect occurs between the ultraviolet and the visible region. The fluorescence effect shows that can help in cases where the images of watermarks in the visible region are poor in data. Fiber identification was performed by taking microscopic digital images in transmitted light and their image processing. Using image processing on microscopic images the fibers that make up the paper can be isolated to be studied in detail. Finally, elemental analysis was performed by Scanning electron microscopy and energy dispersive X-ray spectroscopy (SEM/EDS), providing results on the metal elements had been used in the structure of paper.

Based on the proposed methodology, a lot of important information is retrieved about the papers used as a support of the codex, such as the watermark of papers, fibers and additives used in the paper pulp.

**Keywords:** paper support, watermark, fiber, fluorescence, SEM/EDS analysis.



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**Adriaan Kardinaal, Henk Porck**  
(Netherlands)

*Comparative study of the paper in eighteenth-century herbaria:  
traditional methods and a new tool.*

In our presentation we explore the possibilities of the watermark and the overall chain- and laid line pattern, as tools of paper analysis. Our findings arise from a study of the 18th -century d'Oignies herbarium of the Naturalis Biodiversity Center, Leiden. The first objective was to establish a more precise date of the herbarium. A second question concerned its relation to a herbarium in the Stadhuismuseum in Zierikzee.

The common method of comparison by means of the physical paper characteristics, the watermark and chain- and laid lines, indicated similarity of the paper of both herbaria, but proved unsuccessful for the purpose of dating: the mark with monogram PvL (Pieter van der Ley) is present in a minority of the sheets of both herbaria but no exact match was found in the available databases. Also the pattern of mould lines in the paper was remarkable in itself: in each herbarium we discovered in addition to the normal chain- and laid lines a third system of lines, either running parallel or slanting to the regular chain lines.

Our first point of discussion concerns the explanation of these 'extra chain lines', and to what extent we can use this feature reliably in comparing paper and establishing a degree of identity between sheets of paper.

To solve our research questions more satisfactory, we could expand the traditional 'tool kit' for paper analysis with a novel instrument, using the form of the letters in the watermark. We discovered that a typical form of Roman Capitals, normally used for (stone) inscriptions, has been introduced since the 1720s in the PvL monograms and other Dutch watermarks. The potential of this new, typographical approach in watermark studies will be discussed.

Our results complement those of botanical investigations of the herbaria, and underscore the value of multi-disciplinary cooperation.

**Keywords:** watermarks, chain lines, typography, herbarium.

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**Katherine Mintie, Paul  
Messier, Damon Crockett**  
(USA)

*Characterizing Twentieth-Century Photographic Papers: A  
Multidisciplinary Approach.*

Though photography has been practiced as a paper-based medium for much of its history, little research has been done on the wide range of papers produced by photographic companies and how those papers impacted the material and aesthetic qualities of prints. The situation has been exacerbated by the rise of digital photography, which has led to a sharp decrease in the manufacture of photographic papers and a loss of knowledge about the choices available to earlier photographers. In an effort to preserve this history and to facilitate research on the materiality of photography, the Lens Media Lab (LML) is engaged in a multifaceted project to characterize and digitize a collection of over 7,000 international photographic papers, primarily silver gelatin papers, produced between 1890 and 2000.

The presentation will begin by discussing how and why Paul Messier, director of the LML, began collecting historic photographic papers. The presentation will then describe the LML's methods for characterizing the papers. To do so, the LML focuses on four key material qualities of each paper: base color, gloss, thickness, and texture. Beyond recording textual descriptions of these qualities given by manufacturers of photographic papers, the LML takes quantitative measurements using a spectrophotometer, glossmeter, micrometer, and a "texturescope" developed by the LML. Finally, the presentation will introduce Paperbase, the digital database to the collection developed by LML data scientist Damon Crockett. This portion of the presentation will show how the database can be used by a range of researchers interested in the histories of photography and paper.

By sharing our work on this topic, we hope to invite future collaborations with museums, archives, historians, and artists. By working together, we can preserve knowledge of the material qualities of twentieth-century photographic papers and better understand the working methods of earlier photographers.

**Keywords:** Photographic paper, characterization, digitization.

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**Emmanuelle Hincelin, Claire Bustarret, Nadine Dumain, Claude Laroque, Jean-Sébastien Macke, Josette Gaudriault Telford** (France) *EPSOArt project: study of artists' papers from 1830 to 1950.*

Investigating on artists' papers from 1830 to 1950 –the boom period for industrial papermaking–, is a challenge for researchers, conservators, curators and paper historians, because of the large number of papers produced during this period and the lack of directories to identify their type, origin and dates.

Gathering the disparate knowledge about this period, we need to create directories of papers – whether watermarked or not–, comparable to the ones available for hand-made paper. After mechanisation, the watermark is no longer a discriminating factor, as it used to be with hand production. The directory must therefore describe all the sheet characteristics.

In order to achieve this goal, specific tools need to be devised to classify the papers used as artistic support. The Association française pour l'histoire et l'étude du papier et des papeteries (AFHEPP) (French Association for the History and Study of Paper and Paper Mills) has set up a protocol for describing papers of the period, and initiated a project entitled EPSOArt 1830-1950 (Étude des Papiers Supports d'Œuvre d'Art, / Study of papers used as artistic support), which will generate controlled data that could be easily shared. This data will be hosted on the CNRS's "EMAN (Édition de Manuscrits et d'Archives Numériques)" platform [[https://eman-archives.org/EMAN/plateforme-eman\\_en](https://eman-archives.org/EMAN/plateforme-eman_en)].

Seven heritage institutions in Paris, interested in identifying the papers kept in their collections, are partnering to undertake the study of a specific corpus, applying the AFHEPP protocol. They agree to share the collected data.

This database will help getting a better understanding of the individual artist's practices related to paper. This will be in particular useful to locate undated sketches and studies. It will also provide a more accurate picture of the paper manufacturing and trade between 1830 and 1950 –whether paper was intended for works of art or not–, mainly, but not exclusively, in France.

**Keywords:** Paper Identification, Database, Watermarks, 1830-1950, French artists.

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**Tina Grette Poulsson** (Norway) *Visual and non-invasive analysis of Thomas Fearnley's drawing papers.*

The National Museum (NM) possesses 833 drawings by Thomas Fearnley, including 180 versos and 8 sketchbooks with altogether 255 drawings. Media include pencil, pen, wash, watercolour, gouache, pastel, charcoal, and chalk, although a large proportion (803) are made fully or partly with graphite pencil. As soft graphite is prone to smudging during handling and traveling, the artist applied a fixative to many of his drawings; a fixative which has changed appearance during aging. Fearnley's drawing paper and fixatives are currently being investigated in a PhD project, which in the first year has focused on the examination and systematic overview of Fearnley's papers.

An initial survey of Fearnley's drawings was necessary, to establish a basis which could be used for systematic grouping of this large collection and to be able to select representative works for further analysis. The papers were grouped according to type of mould, watermark, and chain lines intervals, to create a matrix to which papers of unknown origin could be compared, by visual and computer-assisted means. The presentation will describe the process and results of the initial survey and how this information may be used to gain knowledge about dating and location of Fearnley's drawings.

**Keywords:** Fearnley, drawing paper, watermark, chain lines, non-invasive analysis.

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**Birgit Reissland**  
(Netherlands)

*Paper format analysis: Reconstructing 17th-Century Paper Formats in  
Master drawings.*

Upon examining Rembrandt's drawing process, I noticed the absence of any untrimmed sheets in his entire drawing oeuvre. For inferring the original paper format, a new methodology was developed.

The "bewildering number of combinations" of paper formats and their trade names, as Emile-Joseph Labarre phrased it in 1937, often acted as a deterrent to anyone interested in studying this subject. The few scholars who have investigated historical paper formats admit that research in this area is rather sporadic. Studies on 17th-century paper formats are limited to publications by Jan-Piet Filedt Kok et al., Erik Hinterding and Frans Laurentius. This presentation addresses the significant yet often overlooked aspect of paper format analysis in the study of drawings.

A review of technical images of about 1500 17th-century drawings was carried out. Based on historical sources research, nine distinct 17th-century paper formats were identified and their relation to their predecessors was established. A methodology was elaborated that identifies decisive markers imprinted by paper-making moulds and the production process, enabling the reconstruction of original paper formats, particularly from trimmed sheets.

The pivotal nature of paper-format analysis is underscored by its application to Rembrandt's drawings. Examples where the methodology has been successfully employed, shed new light on Rembrandt's creative working process. The presentation concludes by a plea for the integration of paper format analysis as a crucial, though non-traditional, component in the broader realm of paper-related research, complementing established methods like watermark and fibre analysis.

**Keywords:** paper format, 17th century, master drawings.

**Inge Van Wegens** (Belgium) *Notes on the paper production and paper quality end 18th century in the Austrian Netherlands in “Le voyageur dans les Pays-bas autrichiens, ou Lettres sur l'état actuel de ces pays”, edited in 1783 in 6 volumes.*

The foundation of modern society is rooted in the 18th Century. The groundbreaking inventions in iron & steel ushered in the era of the industrial revolution. The period of transformative change attracted a multitude of travelers and observers. Among them, Dérival, a pseudonym for Damiens de Gomicourt, who documented the evolving society in 251 letters. The editions got published in Brussels in 6 volumes. His journey lasted 4 years and took him through the main cities of the Austrian Netherlands. During his visits he displayed a keen interest in the paper industry, consistently noting details of local paper production centers. His observations were accompanied by outspoken opinions on the quality of the papers. In this presentation, we aim to summarize and delve deeper into his insightful observations. We aim to assess the accuracy of Dérival's observations in his book, exploring the extent to which they were correct or exaggerated.

**Keywords:** 18th Century, travelers, paper production, paper quality.

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**Paul Gulewycz** (Austria) *Thermographic Digitization of Watermarks Found in the Music Manuscripts of Franz Schubert.*

Since the 1960s, the cataloguing of the works of the Viennese composer Franz Schubert (1797-1828) has been a major concern of the *New Schubert Edition* (NSE). The dating of the sources and analysis of the different paper types Schubert used have been central tasks which both provide supplementary information on the genesis of the works. Thanks to the continuous source documentation, the NSE can now draw on a stock of over 1,300 handwritten watermark tracings. Unfortunately, some tracings were created under unfavourable conditions and do not allow for a comparative overview.

Building upon the spadework of the NSE, the interdisciplinary project DRACMarkS (*Digitization, Recognition, and Automated Clustering of Watermarks in the Music Manuscripts of Franz Schubert*) is using state-of-the-art technology for a thorough investigation of watermarks: a thermographic camera system that produces images based on infrared radiation. With this method, the watermarks are made visible on so-called thermograms without any written content overlaying the symbols.

During DRACMarkS' three-year runtime, every page of each of the over 480 Schubert music manuscripts in Vienna will be scanned and published in *Schubert digital*, an online research platform made available in 2024. *Schubert digital* will provide extensive information on Schubert's works as well as prosopographical research data that also includes Italian and Bohemian paper manufacturers and distributors, who Schubert bought paper from. By combining the information made available through these new methods, it is possible to interpret Schubert's compositions by analysing the change of watermarks and paper types, which will reveal insights into his creative process.

**Keywords:** Watermarks, Music Manuscripts, Franz Schubert, Thermography, Database.

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**Veronika Giglberger,  
Benhard Lutz (Germany)**

*Papers in the early days of music printing. A thermography project of the Bavarian State Library.*

The Bavarian State Library (BSB) holds an internationally significant collection of more than 300 sources from the early days of music printing up to the middle of the 16th century.

In a project funded by the German Research Foundation, the watermarks in this collection are being systematically recorded, thermographed and catalogued. The programme started in July 2023 and is scheduled to last three years.

Following two watermark projects on music manuscripts from the late Middle Ages and Renaissance the BSB's music department is thus explicitly turning to the source type "print". Concerning the early printed sources with polyphonic music, there is currently not much evidence of the watermarks in the relevant databases. The project is primarily orientated towards the Watermark Information System database (WZIS), in which, based on the mostly dated and well located music prints, a reference collection of papers will be compiled. At the same time, the catalogue data of the relevant, already fully digitised prints will be enriched with the thermographic images of the respective watermarks. This might provide new impulses for both, filigranology as well as musicology, as the results are relevant for the study of the papermills involved and the distribution of paper in the mostly small print shops specialised in the technology of music printing.

The paper presents the first results and summarises the methods and goals of the project.

**Keywords:** Watermarks, Thermography, Music Prints, Renaissance.

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**Jess Ortegon (USA)**

*Color Under Siege: Material Analysis of Late 19th-Century Colored Papers from the Siege and Commune of Paris.*

The Charles Deering McCormick Library of Special Collections at Northwestern University Libraries holds a significant collection of original materials on the Siege and Commune of Paris (ca. 1870-1871) including over 1,000 printed posters. Over a quarter of these posters were printed on a variety of colored papers, which present unique material challenges for their conservation. By the 1860's, synthetic dyes and pigments nearly replaced natural colorants historically used in paper production as they were thought to be vastly superior in terms of vibrancy, color, and ease of use. Synthetic dyes often fade drastically when exposed to light and are sensitive to aqueous solvents, which greatly limits the types of treatment techniques that can be utilized. Twenty-eight colored posters from the collection were examined using polarized light microscopy (PLM) and X-ray fluorescence spectroscopy (XRF), while a smaller selection underwent further examination using Raman Spectroscopy and Time-of-Flight Secondary Mass Spectrometry (TOF-SIMS). While the results are yet to be evaluated at the time of writing this abstract, this investigation aims to characterize the materiality of the paper colorants to directly inform treatment decisions as well as long-term storage and display parameters.

**Keywords:** pigment identification; non-destructive analysis; 19<sup>th</sup>-century paper; conservation, materials-technology.

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**Michelle Sullivan, Leila  
Sauvage (USA-Netherlands)**

*The Technical Study of Blue Paper Supports in Old Master Drawings: Combining Traditional Methods with Instrumental Analysis.*

In preparation for the exhibition and publication "Drawing on Blue: European Drawings on Blue Paper, 1400s – 1700s," conservators and curators at the J. Paul Getty Museum and Rijksmuseum undertook a materials-focused, systematic study of drawings from their respective collections. The goal of this object-based investigation was a better understanding of the materials and historical methods of manufacture blue paper, scrutinizing historical examples rather than relying on textual sources alone. The study combined traditional modes of examination—raking illumination, transmitted illumination, microscopy—with instrumental analysis—fiber optic reflectance spectroscopy, scanning MA-XRF, and Raman spectroscopy—as well as digital microscopy.

To facilitate exchange of information and clarity in communication, the conservators agreed upon common vocabulary and used standard reference materials to aid in the description of visual observations. A blue paper sampler was developed in collaboration with a traditional papermill to recreate gradations of blue with known proportions of rags and dye (woad and indigo). This low-tech tool brought the visual description a step further, addressing questions of color, surface texture, and fiber furnish. The outcome of the study was a fruitful comparison of blue paper supports used in 17th-century Dutch drawings across two collections. The analysis confirmed the presence of woad/indigo and logwood as main sources of blue in the paper. This presentation will review the methodology of this technical study, summarize its findings, and highlight the benefits of interdisciplinary research and cross-institutional exchange.

**Keywords:** blue paper, digital microscopy, MA-XRF, FORS, Raman spectroscopy.

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**María Dolores Díaz de Miranda, Jaume Torró Torrent** (Spain)

*The Paper Employed in the Incunabular Edition of Tirant lo Blanc (Valencia, 1490): Relationship between Its Characteristics and the Printing of the Edition.*

The study of the paper of this incunabulum can contribute a new methodology to obtain information about the paper employed in a printed edition and, at the same time, the relationship between its characteristics and the printing of the book. The distribution of different kinds of paper across the edition can reveal the order in which folios and quires were printed, the moment in which a second press began to be used in the printing of the book, and the way in which quires and folios were distributed between the two presses.

To this end, we have analyzed in detail every paper sheet of the edition by applying the protocol created to compile the database *Papel y Filigranas en España (PFES)*, which describes every kind of paper and watermark by means of 117 different fields (which are grouped into 10 sections). Watermarks have been reproduced through a variety of methods that will also be discussed. The technical difficulties created by the quality of the lamp soot component of the ink and the ways in which those difficulties were overcome in photographic reproductions will also be presented. Finally, notes will be made on how the study of watermarks can help us make deductions on the commercial routes and the distribution of paper across time and space.

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**Rebecca Taldo, Marco Fagiolo, Maria Chiara Palandri** (Italy)

*Dating and localisation of a XVth century manuscript from Archivio di Stato in Turin.*

The XV<sup>th</sup> century medical manuscript J.B.VII.6., owned by the Archivio di Stato in Turin Ancient Library, underwent a thesis conservation project in Paper and Book Conservation (Brera Academy of Fine Arts) in the Institute's conservation laboratory. This opportunity has made it possible to conduct in-depth research on the materiality of the artefact, aiming to identify its production, period of use, and location.

The hypotheses regarding geographical contextualisation have been expanded through the study of watermarks and paper support. The manuscript contains two watermark motifs: the *bull's head with cross and a circle in the head* and the *crescent moon (or croissant)*, which have been photographed under transmitted light and manually processed in post-production; by digitally comparing them, it has been possible to categorise the *bull's head* motifs into four groups and the *crescent moon* motif into one group. Subsequently, historical research has been conducted using online databases, specialised literature and direct comparison with original material of the same period.

Among the two watermarks, the *bull's head* was a pivotal point of this research; it was found in materials from Turin and online databases together with the similar watermarks from the Gutenberg's bible. Subsequently, it appears to be a variant of the *bull's head* present in the Gutenberg's bible, sharing its history, dating and localisation.

The initial comparison with online databases concluded the paper to be originally from Northern Germany and dated it to the XV<sup>th</sup> century, which has been further confirmed in some cases by bibliographical research on the

format of the paper production moulds, but was denied by bibliographical research. Combined with other binding elements, it has been possible to localise the manufacture of the manuscript J.B.VII.6.

**Maria Stieglecker** (Austria) *Make one out of three. A portable system for visualizing watermarks.*

At the Institute for Medieval Research at the Austrian Academy of Sciences a group of researchers focuses on the scientific classification of medieval manuscripts. Often, we don't know when or where they were written and beside other methods-for paper manuscripts we have the advantage that the analysis of the watermarks helps us to get very good results.

The situation in Austria is the following: About half of the estimated 25.000 medieval manuscripts is held by the National Library in Vienna. The other half-different to other countries-are in situ, in public or private libraries as in monasteries. So, for research we have to visit the collections. Therefor we need portable systems for digitizing but also for paper analysis.

Since we use the mobile digitization unit *Traveller's Copy Stand TCCS4232* we asked the constructor Manfred Mayer for a combined system, so we can use it also for visualizing watermarks. Important for us is that the writing disappears and the watermark is clearly visible. The result is the *WZGFS TCCS4232 AdW*, a combination of the copy stand, a fibre optic light sheet and an IR-sensitive camera. For us a cheap and sustainable solution as we can use existing equipment and the images are immediately available in digital form.

At the moment we test it at the University and State Library of Tyrol in Innsbruck on manuscripts and fly leaves of incunabula. Experiences with this system and results will be the subject of the presentation.

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**Aurora Belli, Dionysia Christoforou, Katrien Keune, Idelette van Leeuwen, Ilona van Tuinen, Frederik Vanmeert** (Netherlands)

*The Watermarks Project: documenting watermarks from the 17th century Dutch drawings collection at the Rijksmuseum with low-energy X-ray radiography.*

The Conservation and Science Department of the Rijksmuseum is currently working on the Watermarks Project. Employing low-energy X-ray radiography, the ongoing documentation campaign focuses on the most prestigious section of the museum's drawings collection: Rembrandt, his pupils and other 17<sup>th</sup> century Dutch artists.

Low-energy X-ray radiography is combined with imaging plates as it enables the visualization of the watermark without interference from unpigmented drawings or sketches. Within the project, not only high-resolution digital images of the watermark (when it is present) are taken, but the entire sheet of paper used for the drawing is captured, unveiling the chain and laid line structure.

The X-ray unit, located within the Rijksmuseum's Paper Conservation Studio, was purchased in 2018 when the Watermarks Project was initially conceived: it is specifically designed for the analysis of paper objects and to be safe both for the user and the drawings. Due to the invaluable and fragile artworks that are handled during the analysis, the project is carried out by a paper conservator.

By being able to compare the drawing to the actual paper support, the results will offer multiple analysis approaches, so that in future research it will be possible to trace back the provenance of the paper sheets or understand if the support is a cut out of a bigger, original sheet.

Radiographs of several thousands of Dutch drawings are expected to be taken over a period of two years with the aim of making the high-resolution images available to the Watermark community and to the broader public by publishing the results online, freely available, on the museum website.

**Keywords:** watermarks, low-energy X-ray radiography, 17th century Dutch drawings, Rembrandt.



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**Maciej Pawlikowski, Pedro Maximo Rocha** (UK)     *A Comparative Study of Photographic Techniques for Paper Watermark Recognition.*

This conference paper proposal introduces an approach to watermark recognition through the application of photographic methods. Focusing on the historical samples on paper-based materials photographed for the purpose of Newton's Watermarks project, our research delves into comparison of different camera and light systems for detecting watermarks and paper features using advanced photographic techniques. The proposed process leverages the distinctive visual characteristics of watermarks acquired at different institutions using different equipment but subjected to similar photographic principles. The overarching goal is to enhance uniformity, accuracy, and efficiency in recognition processes. Employing a combination of established photography techniques with advanced image processing, the standardization of imaging principles is at the heart of this research. By addressing challenges associated with readability of paper watermarks and craft marks, this study aims to contribute significantly to the field of watermark identification. The outcome of this research holds a considerable promise for applications in creating robust datasets for further employment on machine learning techniques, watermark research, preservation, dating and study of paper based historical archives.

**Keywords:** Photographic Methods, Watermark Recognition, Imaging, Image Processing, Photographic Techniques.

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**Ramon Voges** (Germany)     *Neural Networks, Nearest Neighbours, and Coats of Arms, New Approaches to Identifying Historic Watermarks.*

The German Museum of Books and Writing of the German National Library holds one of the largest collections of historic watermarks. Identifying a watermark and locating it in its chronological and geographical context is still a tedious and time-consuming task that requires a lot of expert knowledge on heraldry and how paper was produced in early modern times.

In order to make information on watermarks more accessible, the museum asked two groups of students of the Computer Sciences to develop a prototype for identifying watermarks automatically. The proposed talk will present novel approaches to finding similar watermarks. It covers not only different ways to preprocess digitized images of the watermarks, but also how to retrace them so that computers are able to compare them. Finally, the talk will discuss several options on how the presented approaches can be further developed.

**Keywords:** Watermarks, artificial intelligence, classification.

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**Ingelise Nielsen** (Denmark)     *Analysis of paper from the early years of production at the Danish paper mill at Ørholm.*

The mill in Ørholm was one of the largest paper mills in Denmark in the 19<sup>th</sup> century. It was established by two Englishmen, Henry Nelthrop and John Joseph Harris. The mill began its production of paper in 1794.

When examining documents in the collections at the Danish National Archives it is striking that the early paper from Ørholm is easily recognizable among contemporary papers. The imprint of the paper moulds and their watermarks are clear and sharp. Furthermore, the sheets show a high degree of uniformity in their fibre distribution. The paper has a faint brownish tone which does not look like a sign of degradation. Without even looking at the watermarks, the early Ørholm paper can easily be distinguished from the nearby Strandmøllen's paper.

We know that Ørholm paper mill employed English papermakers whereas papermakers at other Danish paper mills, such as Strandmøllen, mostly came from Germany. Is Ørholm paper the result of a different papermaking tradition compared to what was generally practised in Denmark at the end of the 18<sup>th</sup> century? A new research project will examine that question through analysis of the paper and studies of written sources.

**Keywords:** papermaking in Denmark around 1800; paper analysis; English papermakers.

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**Thea Winther, Sanny Holm**  
(Sweden)

*Characterisation of Swedish handmade historic paper – analysis of papers and watermarks.*

Dating various documents has long been a problem when there is no date. Several researchers in Europe has registered and linked watermarks to a hand paper mill and year, e.g. Briquet, Piccard and Gösta Liljedahl. This information has in turn been of great value to other researchers who, among other things, looking for facts to confirm the authenticity of works of art.

This research has, however, faced challenges with the amount of paper originating from Nordic countries. In Sweden, historically there were 152 hand paper mills, and there is plenty of paper from Sweden in Europe from the 17th century onward. There has not been much research mapping watermarks and hand paper usage, the most recent, was Gösta Liljedahl working at the Swedish National Archives in the 1950s, for instance using x-ray. Gösta Liljedahl collected and gathered many historic papers in the 20<sup>th</sup> century and these were only ordered and archived to a certain extent. Out of an originally collected estimated number of 275 000 sheets, approximately 80 000 sheets have remained without investigation at the Swedish National Archives. In 2023 and 2024 these papers have been studied in order to find clear and interesting watermarks to ensure that no unique sheets are missed in documentation. About 40% of these have watermarks and about 20% are older than 1750. A system for digital photographing a selection and link these to the manufacturer/hand paper mill, and supplement with parameters that are standard within EU Bernstein, has been developed. In addition, chemical and mechanical properties have been investigated for this selection of papers with near infrared spectroscopy with the surveying tool SurveNIR. The experiences and results from this work will be presented and discussed along with reflections on these analytical protocols to characterize and analyse the papers.

**Keywords:** handmade paper, watermarks, near infrared spectroscopy.

