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# Printing materials and technologies in the 15<sup>th</sup> – 17<sup>th</sup> century book production: an undervalued research field

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## Abstract

We present a systematic non-invasive investigation of a large corpus of early printed books, exploiting multiple techniques. This work is part of a broader project - *Argeia* - aiming to study early printing technologies, their evolution and, potentially, the identification of physical/chemical fingerprints of different manufactures and/or printing dates. We analyzed sixty volumes, part of the important collection of the Ateneo Veneto in Venice (Italy), printed between the 15<sup>th</sup> and the 17<sup>th</sup> centuries in the main European manufacturing centers.

We present here the results of the imaging analysis of the entire corpus and the X-Ray Fluorescence (XRF) investigation performed, focusing on the XRF data and their statistical treatment using a combination of Principal Component Analysis (PCA) and Logistic Regression. Thanks to the broad XRF investigation - more than 200 data points - and to the multidisciplinary approach, we were able to discriminate the provenances of the paper - in particular for the German and Venetian volumes - and we potentially identified a chemical fingerprint of Venetian papers.

**Keywords:** Early printed books, Ancient Inks and papers, Non-invasive analysis, X-Ray Fluorescence (XRF), Principal Component Analysis (PCA), Logistic Regression.

## 1. Introduction

We performed an extensive physical/chemical investigation of sixty scientific printed books, from the preliminary imaging analysis to a series of point measurements. Due to the high historical value of the objects, we used only non-invasive and non-destructive techniques such as imaging analysis and X-Ray Fluorescence (XRF) investigations.

The sixty books, part of the Ateneo Veneto collection [1] were printed between the 15<sup>th</sup> and the 17<sup>th</sup> century in some of the main early European manufacturing centers: Basel (now Switzerland); Amsterdam, Leiden and Rotterdam (now the Netherlands); Paris, Lion and Strasburg (now France); Cologne, Herbert and Frankfurt (now Germany); Florence and Venice (now Italy). The books cover a variety of topics, and they include important documents such as the astronomy text "*De*

*reuolutionibus orbium coelestium*" of Nicolaus Copernicus, printed in Basel in 1566; medical manuals such as the "*Exercitationes anatomicae, de motu cordis & sanguinis circulatione*" by William Harvey, printed in Rotterdam in 1660; physics and mathematics textbooks like "*Meditationes de natura plantarum, et Tractatus physicomathematicus de aequilibrio praesertim fluidorum*" by Giovanni Maria Ciassi, printed in 1677 in Venice.

An important fact is that all the books in the corpus were stored together for more than two centuries in Venetian convents and afterwards in the Ateneo Veneto. This unique and uniform conservation history allowed the evaluation of results without the interference of different degradation processes.

Until the early 15<sup>th</sup> century, all documents were written by hand using a variety of materials - supports, inks and binders. The invention of the "industrial" printing by Johannes Gutenberg in 1455 [2], [3] radically changed the world of texts in Europe.

The re-adaptation of the existing screw press and the use

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