

Michaëlle Biddle

New Strategies in Using Watermarks to Date Sub-Saharan Islamic Manuscripts

Abstract: The paper used in all but a handful of surviving sub-Saharan manuscripts in Arabic script is European in origin. The majority of these manuscripts are undated. From the beginning of European paper production watermarks have been used to indicate a paper's origin. For several centuries these European watermarks have been used to date and authenticate manuscripts by matching a watermark found in undated manuscripts with an identical or similar watermark found in a dated source, usually European, or sometimes Ottoman. Because very few of the watermarks found in sub-Saharan manuscripts appear in these European and Ottoman sources, this approach has been of limited use in dating African manuscripts. Using recent field research on northern Nigerian manuscripts, this paper explores how a holistic interdisciplinary approach combining traditional techniques with those of material cultural analysis and with historical archaeology can provide mill source and dating information. These strategies led to the identification of several mills that produced previously unidentified watermarks and the development of a chronology for Galvani mill papers.



Fig. 1: 'Andrea Galvani Pordenone' countermark — AGmm6. (Private collection) (All photographs in this article ©Michaëlle Biddle).

1 Introduction

For more than a century watermarks have been used as an important component in cataloging, dating, and authenticating books, manuscripts, art work, musical scores, financial instruments and other paper items. The original procedure was to trace watermarks found in European and American printed books and legal documents, some from Ottoman controlled areas, where the date in the book or document could be trusted. In the past these tracings, and later photographs, were then published in books and now increasingly are online, such as the Piccard database.¹ With few exceptions the emphasis has been on pre-1800 watermarks, that is watermarks on hand-made paper, with the majority of those published pre-1700. Whilst the discovery of a watermark very similar to one which a scholar might be trying to date will be helpful, the discovery of a dated, precisely identical mark is analogous to the precise matching of two strings of DNA, and is far rarer. Although thousands of watermarks have been published that number is only a very small part of the total number ever created and used in the production of paper.

Sheets made on the same mould can exhibit enormous variations in marks and in most mills paper was made with a pair of matching moulds. Fiber choices, beating details, couching method, drying times, and how many sheets are dried together in a spur can affect the finished product, as much as does the expertise of the person casting the sheet. This means that no two watermarked paper sheets will ever be identical. Fuzzy logic deals with reasoning that is approximate rather than fixed and exact. With watermarks we are dealing with fuzzy matching — matching that is approximate rather than fixed and exact.

In 2008 I was asked to survey northern Nigerian manuscript collections in order to develop a conservation and preservation strategy. To prepare I reread the pertinent literature — Babinger, Tapiero, paying particular attention to Walz' seminal article on the paper trade of Egypt and the Sudan, Bivar's 'Dated Koran', Brockett's article on the two Leeds' Qurans and others, making note of the watermarks and the manuscripts examined.² Walz, who exclusively used countermarks in identifying mills, stated that the majority of northern Nigerian manuscripts 'would appear to date largely from the last quarter of the nineteenth and early part of the twentieth centuries'.³ However, after my survey of twenty collections from Sokoto to Yola, Kaduna to Katsina, my impression based on a holistic analysis of the paper

1 Hauptstaatsarchiv, Composition J 340, Watermark collection Piccard, Stuttgart. <http://www.piccard.de/ergebnis1.php>.

2 Babinger 1931; Tapiero 1968; Walz 1985; Bivar 1960; Brockett 1987.

3 Walz 1985, 41.

sheets, countermarks and watermarks, was that this was not the case. The Jos collection is in disarray⁴ and therefore I was unable to locate all of the manuscripts Walz cited, but one of the things I noticed was that, of the manuscripts cited as having the ‘Andrea Galvani Pordenone’ countermark⁵, some of the paper was hand-made, and some of it was machine-made. I was also troubled by the fact that every sheet I saw countermarked with CL, many with the crooked middle moon, was machine-made on a cylinder machine although Brockett had made no mention of that fact in his article on the Leeds’ Qurans. This distinction of whether paper is made by hand or by machine has dating implications, all the more important when there is a dearth of securely dated manuscripts which can be used for purposes of comparison.

As only a small number of the northern Nigerian manuscripts have dates a perennial question has been ‘How old are they?’. After completing a work on inks in northern Nigerian manuscripts⁶, of primary importance in developing conservation protocols, I decided to pursue this question of dating. Walz’ sources — Fedrigoni, Eineder, Heawood, and others — proved to be somewhat unhelpful as many of the watermarks and countermarks I recorded were not to be found in these sources.⁷ Online sources were just as uninformative. I am a practicing paper and book conservator and archaeologist of material culture and in particular, an archaeologist of paper and the materials and processes that go into the making of books. In order to preserve and conserve, we conservators find it necessary to learn as much as we can about the details of how materials are created and how they were used. This means that the item — in my case everything that goes into making a book, of which paper is the primary component — is central to our investigations. A basic tenant is that we can understand an object only when we understand how it was made, and we must understand an object before we will conserve it. Bidwell’s and Van der Horst’s articles on the limitations of watermarks, but most particularly Peter Bower’s ‘The White Art: The Importance of Interpretation in the Analysis of Paper’ have shaped and informed my forensic paper analysis and this of course includes watermarks, even with all their limitations.⁸

Each object, each sheet of paper has a story to tell. Within each cover, each book bag, each sheet of a manuscript are traces of their making — in a particular way, at a specific time, by a determinate group. Much of the evidence is visible or

⁴ For details see <http://works.bepress.com/mbiddle/11/>.

⁵ Walz 1985, 47.

⁶ Biddle 2011.

⁷ Fedrigoni 1966; Eineder 1960; Heawood 1950.

⁸ Bidwell 1992; Van der Horst 1989; Bower 1999.

is discernible through disciplined analysis – an exploration of the hidden. Other evidence must be gleaned from a wide variety of sources – traditional techniques of recording laid and chain lines, reproducing watermark designs by tracing them, technical paper analysis such as polarized light microscopy and chemical analysis, as well as tracking economic and industrial developments, political conventions, local town and individual paper mill histories.

Replication is another powerful tool. Making sheets of paper from linen and cotton rags with the eleventh century Ibn Badis⁹ or a seventeenth century Genoese instruction manual as a guide¹⁰ and watching and working with master papermakers – both European and Japanese – is beyond enlightening. Replication hammers home the necessity of placing the details of measurement, microscopic analysis and any other forms of testing within the context of actual papermaking practice, of industrial developments, and of mill and papermakers' history; otherwise all one will have, is data, or interesting pictures, that tell us only part of the story – or even lead us astray. Making paper by hand was a craft and regardless of all the conventions of the craft we must be aware that there were also atypical practices. Combining scientific data with historical, economic and contextual interpretation can result in crucial and illuminating insights. The stories these sheets of paper can tell us are more than just their dates or where they were made. They reveal aspects of technological evolution, economic infrastructures and state policies interwoven into human networks that literally cross continents.

In the last few decades Italian economic and industrial historians, and archaeologists, have produced a large body of work based on their extensive research into Italian archives and landscape. There is also a considerable quantity of nineteenth and early twentieth century Italian governmental publications and paper/printing sector reports available. When combining technical paper analysis with this information, a holistic historical archaeological approach, I was able to sort out a chronological framework of the various Galvani watermarks/countermark combinations and discovered that there are multiple distinctly different 'Andrea Galvani Pordenone' marks, each with its own date range and each with its own paper sheet characteristics. Such a discovery would not be possible if one only used the marks, but by placing them in the context of evidence from contemporary sources, from industrial history and archaeological investigations, the evidence permits the establishment of a watermark chronology, each with different date-ranges extending over several centuries of paper production.

⁹ Levey 1962.

¹⁰ Fahy 2004.

A narrow focus on countermarks and/or watermarks does not take into account the evidence in the sheets or that paper makers used different watermarks to denote differing qualities of paper; different markets received different papers and that over time, different papermakers used the same marks. For instance, beginning in the late eighteenth century Galvani used the carta *tre lune* with VG or AG to mark lower quality paper and a crest with moon face — *carta reali* — with VG or AG to mark higher quality paper. Relying on countermarks, without consulting archival records, could also lead one to mistakenly identify the BG countermark as Giovanni Berti of Treviso (c.1789–1828), who is recorded in Veneto archives as using GB and GIO BERT but not BG¹¹. The BG I found in Jos 83, 257, cited by Walz as Giovanni Berti, is the countermark of the mills of Benedetto Gentile of Ceneda/Serravalle (active 1830–1908), who is barely mentioned in Fedrigoni¹² and does not appear in either Eineder or Nikolaev, but was nonetheless a major exporter to what the Italians called the Levant.¹³

The gains can be immense if watermarks and countermarks, not as singletons but in combination, are studied as only one aspect of a paper sheet and that examination is combined with study extending across many disciplines. My field research has concentrated on manuscripts created in or preserved in the area of West Africa now called northern Nigeria¹⁴ and has been enhanced by a careful examination of western university and library collections dedicated to Africana (Herskovits Library of African Studies — Northwestern University, Boston Museum of Fine Arts, Library of Congress, British Library) — 65,000 sheets in just under thirteen hundred manuscripts, out of which fewer than four dozen have colophon dates that can be accepted as valid — that is, where the paper does not contradict the colophon date. For example, Muhammad Bello (1781–1837) could not have written on machine-made Galvani watermarked paper when the Galvani did not start making machine-made paper until the 1890s.

The paper used in all but a handful of surviving northern Nigerian manuscripts in Arabic script is European in origin and much of it is not of the highest quality. In these manuscripts I have found papers dating from the 1650s to the mid-twentieth century whilst the bulk are from the second half of the eighteenth to early decades of the twentieth. More than 90% of these examined papers are of Italian manufacture and of these the majority are from an area north of Venice — the regions of Veneto, Friuli-Venezia Giulia, Trentino and to a lesser extent Lombardy. Producing

¹¹ Walz 1985, 41, 47 n. 48, n. 49, 100 n. 66; Mattozzi 1996, 332; Mattozzi 2001, 162.

¹² Fedrigoni 1966, 241.

¹³ Eineder 1960; Nikolaev 1954; Tranchini 1991, 40,43; Tomasi/Tomasi 2012, 178–182.

¹⁴ Listed in Biddle 2008.

paper for export to the Levant, sub-Saharan Africa, the Yemen¹⁵ or Malaysia¹⁶ was a niche business and one that was profitable, and therefore sustainable, only by tight fiscal control over raw materials, labor, equipment and fabrication methods. From the evidence in the paper only a small number of these papermakers were able to sustain this for more than a few decades. In order to minimize transport costs, the ideal for export would have been a thin sheet — requiring a minimum of pulp — an increasingly scarce item — produced quickly.¹⁷

An important point to remember about Italian papers is that before 1870, what we today call Italy was made up of different polities, each with its own economic history and each with its own papermaking traditions and technological arc. Mid-twentieth century paper from Amalfi, Kingdom of Two Sicilies, is distinctly different from that of Pordenone, then part of the Austrian Empire.

2 How paper is made

If we understand how paper is made, we can more accurately use the information we find in paper sheets. Before the advent of machine-made paper in the early nineteenth century, European paper was usually produced by a two or three-person team using a pair of wooden and wire moulds working at a single vat.

From the earliest days in European paper production, watermarks were used to indicate a paper's origin, quality or size. The earliest watermarks, all Italian, are dated to the late thirteenth century.¹⁸ The designs we call watermarks are left in a sheet of paper by wire profiles, twisted into shapes and then sewn on top of the wires, the cover, that make up a paper mould. These moulds were woven by hand, but from the end of the seventeenth century they were woven on a specialized mouldmakers' loom by specialists. The wires that made up watermarks were tied down by other wires onto the mould's cover. In the sixteenth century countermarks began to appear. These were initials or other symbols placed opposite or under the principal watermark. For centuries these marks were personal or trademarks of individual papermakers and mills, but by the late nineteenth century custom-made watermarks were also being used by paper merchants, hotels, corporations and department stores. Neither watermarks nor countermarks were used in oriental or Islamic papermaking.

¹⁵ Regourd 2008, 2015.

¹⁶ Zakaria/De Guise/Abdul Latif 2008.

¹⁷ Rosa 2004, 9.

¹⁸ Ruckert et al 2009, 29.



Fig. 2: A typical Italian vat and laid mould in the Cartiera Milano in Amalfi. This paper mill closed in 1969 and was reopened by Nicola Milano in 1971 as the Museo della Carta. His family had been paper makers since the late thirteenth century. (Amalfi, Museo della Carta, 2008).



Fig. 3: A sheet of early nineteenth century hand-made laid Italian paper showing a typical layout of an Italian mould with watermark and countermark centred on the mould. (Private collection).

By 1250 the European paper-making mould would typically consist of a rigid wood frame with a surface of fine metal wires running parallel to the longer side of the mould. These fine wires, which produced laid lines on the paper sheet, were tied down with heavier, more widely spaced wires crossing them perpendicularly. These heavier wires produced chain lines on the paper sheet. The wooden frame with the wire mesh was topped with another wooden frame, the deckle. The deckle stopped the pulp from running back into the vat and created a wavy or fringed, thinned edge on the paper's four sides. This fringed edge on a sheet is also called a deckle. Paper made on this type of mould is called laid paper. Recording the precise position of a watermark in relation to the chain and laid lines is important since placement was as much a trademark as the watermark and countermark.¹⁹

These moulds, and the watermark wires attached to them, deteriorated rapidly as they were constantly in water for ten to twelve hour days, six days a week. In addition, the mould was scrubbed daily to remove fiber residue, resulting in a gradual change in the shape of the mark. There are various estimates of how long moulds might last but the actual length of time a mould will last is determined by how it is used. I own a paper mould with a 'Government of India' watermark/countermark that dates to the twentieth century and, having been used in a limited way, it is in pristine condition. However, two to three years is commonly cited as the life of a common-sized (480 × 340 mm) paper mould²⁰ but, given the number of drifting or cocked watermarks appearing in African manuscripts, it is not unreasonable to assume that they were used for more than two years.

Until the nineteenth century European paper was made of pulp derived from cut-up rags, ropes, sails — primarily linen, cotton and hemp — macerated and beaten into fibrillated cellulose fibers. These fibers were added to water — the foremost requirement of papermaking is vast quantities of clear, soft water — creating a pulp which was scooped from a vat with the rigid hand-held mould. The resulting mat of fibres was then transferred from the rigid mould to a wool felt or couched. When a number of quires, six quires or 144 sheets is a common number but this varied by region, were on felts, the post was then pressed free of water. The sheets were then separated from the felts and hung to dry on strings or wooden racks in a spur, often bundles of six or eight sheets. After drying the sheets, still in bundles of six or eight, were dipped into thin glue made from animal or fish scraps, called sizing, and then dried again. It was possible for two workers at one vat to make up several thousand sheets of paper during a twelve-

¹⁹ Loeber 1982.

²⁰ Ruckert et al 2009, 13.

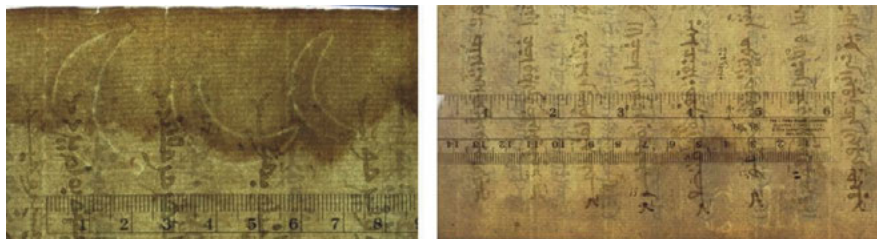


Fig. 4: This c.1890s Carl Lustig of Pordenone sheet (Falke 2623), made on a cylinder machine, illustrates a cocked watermark. The middle lune is drifting as the tie-down wires have come loose through use.

hour workingday.²¹ Depending on their quality the sheets might be pressed or polished or not. The paper I have found in manuscripts created in northern Nigeria is rarely polished and, when it has been polished, it is usually roughly or incompletely done, with no trace of *ahar*, a coating that was used extensively in the Islamic heartlands, which seals a sheet's pores and takes a high, glossy polish.

This division of paper into multiples of six or eight reflects the ease with which the human hand can easily manipulate the sheets. We see traces of this in African manuscripts in that the watermarked paper is often found in groups reflecting that a single sheet was cut into four pieces. The result is four, eight, twelve, sixteen or twenty-four sheets that can be matched up to recreate the original single sheets and sometimes even the original bundles of six or eight. This fact tells us that the paper sheets were transported folded and not flat and is also another indication that at least some of the paper was not subject to sheet-by-sheet quality control, not surprising given the uneven and sometimes very poor quality of the paper in these manuscripts.

In 1757 another type of mould, made of finely woven wire mesh, began to appear.²² This type of paper is called wove paper and in time it too was often watermarked. It has no laid lines although in early sheets a mesh pattern may be found (Fig. 5). There is also an early nineteenth century transitional paper – wove with chain lines – that was popular with Italian papermakers.

²¹ Ruckert et al 2009, 13.

²² Loeber 1982, 23.

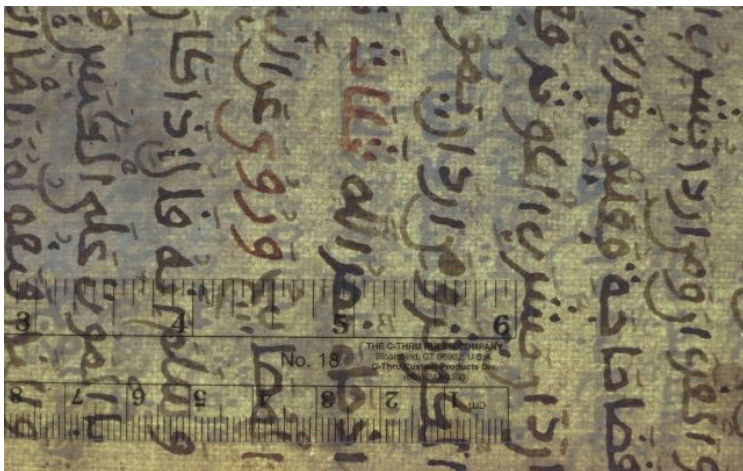


Fig. 5: Wove paper (Private collection).



Fig. 6: Shadow zones adjacent to chain lines disappear by c.1800. This sheet is French c.1740. (Private collection).

Between 1750–1800, papermakers separated the wooden supports that lie a few millimeters behind the mould’s wire cover, causing the common shadow zones on both sides of the chain lines to disappear by c.1800. This was sufficient to create a uniformly good sheet. Paper formation or lookthrough is said to be good or closed when the paper is regular with a uniform surface and good opacity. It is cloudy or wild when the fibers are unevenly distributed and produce shadows. A cloudy sheet is the result of a paper mill either not doing a precise job of separating its rags

or of incomplete maceration. Flocs are clumps of fibers inadequately fibrillated, most commonly comprised of cotton lint or vegetable matter. In some eighteenth century Italian papers these flocs can be so substantial that they can be picked apart with a pin to create puff balls on the sheet's surface. Paper formation is akin to a paper mill fingerprint, as is the location of the watermark and countermark on the mould, the distance between chains lines, how many laid lines lay within a certain measurement, the bulk or thickness of the sheet and the fibers used in the sheet. All these factors provide context for watermark analysis.



Fig. 7: A cloudy sheet, uneven in its formation, with a grass stem inclusion. (Private collection).

In the eighteenth century, as the demand for paper grew and rags became increasingly scarce, papermaking was transformed. There were experiments with replacement for rags or bulking additives including hemp, spinning mill waste such as cotton lint, straw, sugar cane waste — bagasse, agricultural plant matter, esparto grass — *halfah* or *hilfah*, wood — spruce, balsam, fir, pine, poplar — and minerals such as calcium carbonate and gypsum. There were experiments with short-cuts in washing felts or not washing felts. Bleaching agents were developed that enabled papermakers to bleach dirty or dark rags, as well as to bleach printed and written paper for recycling into white paper. Sizing experiments led to a change from using animal or fish glues and gelatin combinations to alum-rosin. The development of practical papermaking machines — there are two types: continuous (Fourdrinier) and cylinder (the Italian *al tamburo*, *al tondo* or *cilindro*) — took decades but meant that large quantities of paper could be made easily and quickly by fewer people.

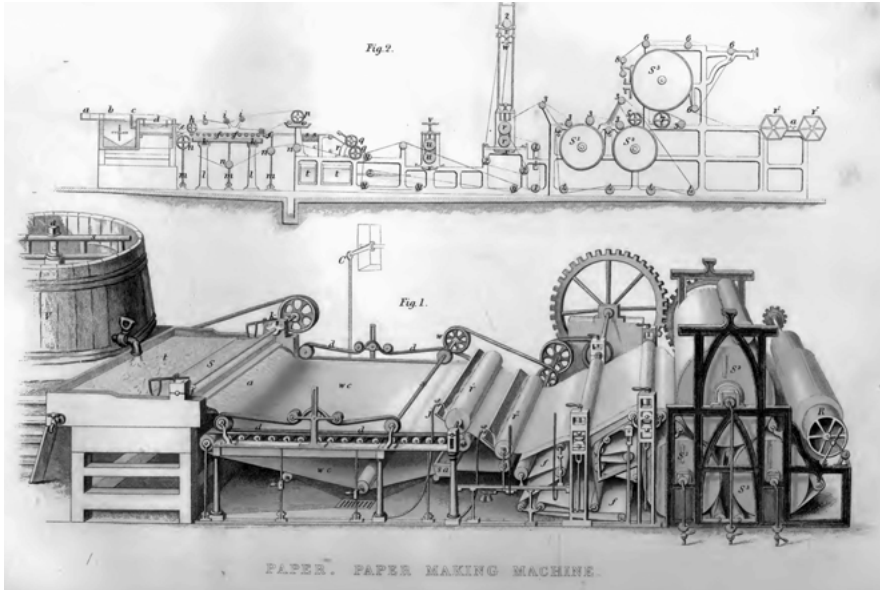


Fig. 8: A mid-nineteenth century continuous Fourdrinier machine. (Tomlinson 1855, plate between 364 and 365).

However, these papermaking machines, and attendant industrial processes, required large upfront investment of capital and space. Continuous machines are complex and very large. Continuous and cylinder machines can and do produce both laid and wove sheets. We find all types of paper in northern Nigerian manuscripts — hand-made laid and wove, continuous laid and wove, cylinder laid and wove.

There was considerable regional variation in the adoption of these new technologies. In 1883 it was reported that there were 227 mills making paper by machine and twenty-two mills by hand in England — a ratio of ten machine mills to one hand mill — whilst in the same year, just in the area north of Venice, there was only one mill making paper by machine and thirty-nine by hand — a ratio of one to thirty-nine.²³ There is no doubt that the mid-nineteenth century decades-long unification process in Italy followed by the Long Depression of 1873–1896 impacted papermakers' industrial modernization efforts, but the details of when a mill adopted a cylinder or continuous machine or started to add ground wood to their paper can help us in dating their watermarks in the paper exported to

²³ Bryan 1883.

sub-Saharan Africa. Contemporary trade publications reveal that Italian mills initially favored cylinder machines, undoubtedly due to their smaller size and lower complexity.²⁴ Most Italian paper mills were family owned and only a relative few went on to adopt continuous machines. Some became joint stock companies like Cartiera Bernardo Nodari e Cie in Lugo or Cartiera Rossi of Arsiero, both of which exported extensively to the — to use an old catchall term designating the *Dar as-Salam* — the ‘Oriente’ market.²⁵



Fig. 9: Dandy rolls (with detail) produce watermarks and countermarks and can easily be changed on both cylinder and continuous machines. These machines can also produce large quantities of paper from the same dandy roll and the same roll can be used for decades. (Musée Canson-Montgolfier, Annonay, France, 2013).

To add to the complexity, watermarks can be made not only with hand moulds but on either a cylinder or a continuous machine with a dandy roll. In the mid-1820s John Marshall of T.J. Marshall of London developed a cylindrical roller that could be attached to either a continuous or a cylinder machine. This dandy roll could make an impression of laid and chain lines upon the sheet of paper or pulp as it exited the machine. These rolls were added because they speeded-up the draining of water from the paper sheet. In 1830 Thomas Barrett of St. Mary Cray,

²⁴ *Annuario* 1884, 358–378.

²⁵ Fontana/Sandal 2001, 89–98.

London, obtained a patent for inserting the watermark and maker's name on continuous paper.²⁶ Dandy rolls were not in wide spread use until the 1840s but by 1860 even complex light-and-shade marks were being produced. Initially watermarks were hand-tied to the dandy roll, just as on a hand mould, but by the 1870s solder was usually used to attach the watermark to the wire cover of the roller.²⁷ In the machine-made era papermakers use dandy rolls not only to watermark paper for the mill that produced the paper but also produce and watermark paper for merchants, as is the case with the Beniamino Arbib and Ydlibi marks²⁸ (Fig. 10), and for organizations, such as the CMS crest for the Church Mission (Missionary) Society. All three of these watermarks — Arbib, Ydlibi and CMS — and others of this type appear in northern Nigerian manuscripts.



Fig. 10: The YDLIBI watermark/countermark combination made by a dandy roll on machine-made paper. (Falke 14).

²⁶ Tomlinson 1855, 367.

²⁷ Herring 1860, 29; Hunter 1947, 400–408.

²⁸ Biddle forthcoming a.

Another complicating factor with sub-Saharan manuscripts is their unsewn structure. Many larger northern Nigerian manuscripts contain combinations from various mills and sheets are found shuffled with watermarked sheets from one mill immediately followed by countermarked sheets from another mill. This makes sheet analysis all the more important if one is to determine which countermark belongs to which watermark but it also hints at the layers of complexity in the codicology of these manuscripts.²⁹

3 Distinguishing hand-made from machine-made paper

The side of a sheet marked by the hand mould is called the ‘wire’ side. The other side, which is usually smoother, is the ‘felt’ side. In hand-made paper the laid structure is part of the mould so that the laid and chain lines, and the watermark/countermark, are transferred to the wire side of the paper. This is important in reading countermarks in sub-Saharan manuscripts as sheets were cut into four, slicing through the most common placement of the countermark in northern Italian papers. VG can easily be read as AC if sliced in half and read from the wire side (Fig. 11).

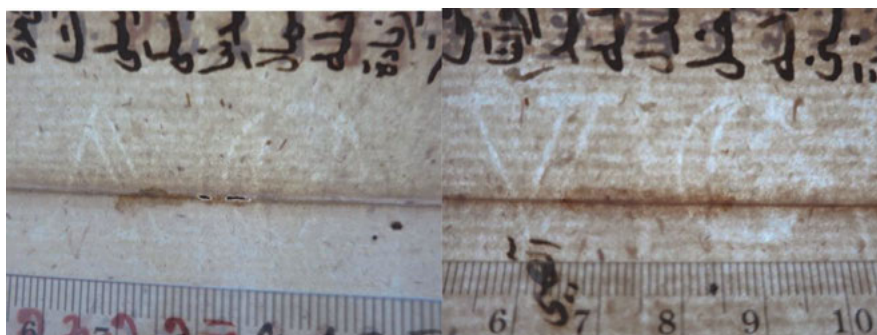


Fig. 11: The same countermark viewed from the wire side (left) and the felt side (right). (B/AR4/3).

²⁹ Biddle forthcoming b.

In contrast the laid structure of continuous machine-made paper is transferred to the felt side, the smoother side. Early cylinder machine-made paper resembles hand-made in that the laid lines and watermark appear on the wire side of the paper. The wire side of most hand-made papers should be easy to perceive in raking light and one might think that this is an easy way to distinguish hand-made from machine-made paper. In fact it is often difficult to determine because by the mid-nineteenth century heated drying rolls were added to continuous machines, pressing both sides of the paper sheet, and in northern Nigerian manuscripts sheets are additionally pressed by cyclical high humidity and traditional storage methods that tightly compress and smooth the sheets. Paper makers sometimes created their marks on dandy rolls in a mirror image (Fig. 9).

Continuous machines typically create two deckles but c.1905 cylinder machines could create four³⁰ as in hand-made paper. In continuous laid paper the pulp tends to consistently hug one side of the laid lines but in cylinder laid paper the pulp can mimic that of hand-made paper and often lie somewhat evenly between the laid lines. But in hand-made paper there are imperfections; it lacks the machine-made consistency of pulp distribution found in continuous and cylinder paper. In both continuous and cylinder machine-made paper the grain of the paper, the direction in which the fibers line up, is stronger in the machine direction whilst in hand-made paper it is practically equal in both directions. This latter fact is the most easily applied in efforts to determine whether paper is made by hand or by machine. Taking advantage of the fact that sub-Saharan manuscripts are unbound, laying a sheet of paper over the edge of a table and comparing the deflection provides a clue as parallel to the grain the resistance is far less than against the grain. If a grain can be detected, but it looks like hand-made paper, then it was probably made on a cylinder machine.

4 Date of production vs. date of use

The date of production of paper sheets and their date of use can be decades apart. Heawood states that Denham used paper that was six to seven years old.³¹ Gacek believes that a gap of 10–15 years is possible.³² While some remnant sheets might survive unused for a lengthy period of time in Ottoman chanceries or scriptoria

30 Hunter 1947, 368.

31 Heawood 1950, 31.

32 Gacek 2009, 292.

in monasteries, this does not appear to be the case with pre-twentieth century writers in northern Nigeria. Paper, good for writing with soft African reed (*qalam*), could be scarce and from travelers' and ethnographic accounts — Denham, Clapperton, Barth, Nachtigal, Alhaji Koki and others — we know that scraps were washed and reused and that gifts of paper were prized.³³ But even so, the interval between the year a sheet of paper was produced and the year it was used could vary enormously. It also appears to be the case that the papermakers engaged in export used the same mould design for many decades as this would have minimized their costs.

Northern Nigerian manuscript copyists rarely added the date of the copy but instead copied the original, including the original date if there was one, but analysis of watermarks, countermarks and paper characteristics can help in determining if a document was actually written by Uthman dan Fodio or is a fair copy. It can provide more precise means for dating a document than that recorded in a colophon but analysis can be more complex in the frequent occurrence of a single manuscript containing paper that was produced over several centuries.³⁴

5 Watermark studies

Several collections of watermark tracings and photographs have been published that traditionally have been used in the study of watermarks in sub-Saharan manuscripts. The major ones are: Nikolaev 1954: *Watermarks of the medieval Ottoman documents in Bulgarian libraries*; Eineder 1960: *Ancient Paper-Mills of the Former Austro-Hungarian Empire*; Heawood 1960: *Watermarks mainly of the 17th and 18th centuries*; Ersoy 1963: *XVIII. Ve XIX. Yuzyillarda Turkiye'de Kagit*; Fedrigoni 1966: *L'industria Veneta della carta*; Velkov/Andreev 1983: *Trois croissants*; Velkov 2005: *Divers types d'images*; Andreev 2007: *Les Filigranes dans les Documents Ottomans: Couronne*; Regourd 2008: *Manuscrits de Zabid*.

Others are listed in the bibliography of this paper. Eineder, Heawood, Fedrigoni and Nikolaev ignore paper characteristics and all of these authors use the tracing methods of recording watermarks with attendant omissions and inaccuracies. Much of Eineder's text regarding the Galvani has been contradicted by recent archival research.³⁵ Eineder and Heawood rely exclusively on European

³³ Denham/Clapperton/Oudney 1826; Denham's narrative 208,329, Clapperton's narrative 53; Barth 1857 I, 519, II, 155; Nachtigal 1881 II, 227, 230, 232, 382–383; Skinner 1977, 33–34

³⁴ Biddle forthcoming b.

³⁵ Mattozzi 1994, 1996, 2001; Ganzer 1994; Crippa/Mattozzi 1999.

sources – printed books, governmental and commercial transactions – but the paper we find in sub-Saharan manuscripts was primarily produced for the ‘Oriente’ export market and therefore is rarely included. Fedrigoni records only thirty-eight watermarks and, along with Nikolaev, does not record laid or chain line placement; however, Fedrigoni’s text is a dense mine of information with the exception of the Ceneda/Serravalle papermakers. This is understandable as Ceneda/Serravalle was at the heart of the decisive 1918 Battle of Vittorio Veneto. The bombing was intense and much of the archival and archaeological record was obliterated, a great loss, given the fact that Briquet (1968) recorded Serravalle paper makers as responsible for the earliest proto *tre lune* – Briquet 3256 dated 1543.

Ersoy’s tracings are wildly imprecise and laid lines are only occasionally included. The Velkov/Andreev volumes are useful, using photographs rather than tracings. The photographs are small but usually one is able to ascertain laid and chain line placement as well as some paper characteristics but the volumes terminate with documents dated earlier than 1799. The Ersoy and Velkov/Andreev volumes rely on documents from chanceries where the paper was of a mandated high quality, unlike much of the paper sent across the Sahara. Regourd’s work is well done and has proven to be useful. In addition to these sources we can also find out much from a proper examination of the components present in the paper and the proportion of those components. For instance nineteenth to early twentieth century papers from the north of Venice, which includes those marked ‘Andrea Galvani Pordenone’, have a far greater proportion of cotton than linen and sometimes include traces of silk, not surprising when we find that the main activity that characterized nineteenth and early twentieth century industrial production in Pordenone was the cotton, and to a lesser extent, the silk industry.³⁶ We find little use of wood pulp in Italy until papermakers began to use machines, which due to their increased capacity required massive amounts of material that could not be met by the already insufficient rag supply.³⁷

6 Galvani watermarks

The Galvani paper mills provide a useful case study as to how we can deduce date ranges for their watermarks by using a holistic approach – combining paper

³⁶ Populin 2009.

³⁷ Morpurgo 1874; Sartori 1897; *Ministero di Agricoltura* 1898; Mattozzi 2001,104.

sheet analysis with the information to be found in watermark directories, regional, town, family, mill or paper-sector economic history and archaeology, works that flesh out the activities of Italian papermakers.

The Galvani family is documented as being in the papermaking business from the 1730s. They had paper depots in Udine, north of Venice, and later in Trieste. They also opened a ceramics factory in 1811 that lasted until 1969 and they also operated cotton and silk mills. Their ceramics were widely exported. A close relative of mine, born in the 1890s on a cattle ranch in Roswell, New Mexico, owned a Galvani plate she inherited from her mother. One of the Galvani, Andrea IV (1797–1855) who first used the ‘Andrea Galvani Pordenone’ script countermark, was a formidable scientist and inventor as well as an entrepreneur, running the family paper, ceramic, cotton and silk mills. For more than two centuries Galvani was a small family-owned company that generated the bulk of its sales abroad to the ‘Oriente’, North and South America and even Malaysia. They dominated a narrow but lucrative market in Italian exports.

The Galvani had five paper mills: Viazzol in Cordenons — rented c.1730, purchased prior to 1796, sold 1984; San Valentino in Pordenone — 1770–1860; Belasio in Cordenons — c.1803–1897; Porcia nella Villa di Rorai Piccolo, adjacent to Pordenone — 1804–1929; Rizzardì in Ceneda (now Vittorio Veneto) — c.1838–1895. Whilst Eineder stated there was a Galvani mill in Codroipo³⁸ it was not a paper mill. Porcia Rorai is separated from Pordenone by a ditch and Pordenone melds into Cordenons. Ceneda melds into Serravalle (both now called Vittorio Veneto) and by road is about 43 km (26 miles) to the northwest of Pordenone. The only Galvani mills that produced machine-made paper were Viazzol and Porcia Rorai.

Andrea II (1668–1758) operated Viazzol 1734–1758. He exported to the Levant and there are reports of Arabs and Turks frequently coming to Pordenone to demand his products.³⁹ His grandsons, Valentino III (1723–1797) and Andrea III (1722–1809), inherited directly from him but they divided the property in 1764 when the paper making operations were turned over to Valentino III, while activities relating to land became the purview of Andrea III. Valentino III continued to rent Viazzol and purchased San Valentino in 1770. In 1796 Valentino III’s sons, Antonio, Giuseppe and Carlo, officially took over the paper mills and the company became ‘fratelli Galvani’ or ‘Antonio e fratelli’. They acquired Porcia Rorai after a lengthy legal battle in 1804.

³⁸ Eineder 1960, 169.

³⁹ Benedetti 1964, 370–371.

In 1803 Andrea III purchased Bellasio on his own and restored it. Andrea III ceded his interest in this paper mill to Antonio (1767–1823?) and Carlo (1775–1837) before he died in 1809. In 1818 the four mills (Viazzol, San Valentino, Porcia Rorai and Bellasio) were registered as ‘Galvani e fratelli fu Valentino’. When Antonio went blind he sold out to Carlo and in 1823 the company became ‘Carlo Galvani già Valentino’. In 1826 when Andrea IV, Andrea III’s grandson, married Carlo’s only child, Catterina, the two branches of the family were reunited. The mark ‘Andrea Galvani’ was also registered the same year. By 1836 the scientist and inventor Andrea IV had assumed directorship of the firm and began to institute modern manufacturing methods. Antonio and Giuseppe predeceased Carlo, who died in 1837. Andrea IV was the sole heir and now had the four paper mills, in addition to other factories — ceramics, silk, etc. — that he inherited from other family members. Around 1838 he acquired the fifth paper mill, Rizzardi in Ceneda.

Until Andrea IV’s death in 1855 the Galvani regularly won medals for the quality of their paper and for numerous paper-making innovations. But by 1868 it was sadly noted that they were faithful to the ‘ancient methods, perhaps because of the strong marketing in the Levant where even the poorest and bad paper manufactured has advantageous outlet’.⁴⁰ The succeeding generations of the Galvani family continued to use the name ‘Andrea Galvani’ as the name of the paper making firm from the time it was first registered in 1826 until the 1960’s. They sold out in 1984 to the Gilberti family, who continue to operate the Viazzol mill as Gruppo Cordenons. The Gilberti also continued to use the ‘Andrea Galvani’ mark until 2008 when one could still buy filter paper with a *carta da filtra* watermark first introduced in 1881.⁴¹ From northern Nigerian examples we find that by the nineteenth century Galvani paper is characterized by a rigid layout initially with countermarks, and then watermarks, centred between the chain lines. For more than a century their *tre lune* watermark was made-up of three small crescents, gradually diminishing in size and centred between the chain lines. Watermarks are centred on the left of the mould and the open crescents face right. The countermark is centred on the right half of the mould. Watermarks and countermarks are at the central horizontal line. This means that in northern Nigerian manuscripts the watermark and the countermark are found cut in half since single sheets, 480 × 340 mm, were cut into four pieces. This results in the common 240 × 170 mm sheet size found in northern Nigerian collections. The Galvani used hollow Roman capital letters for the two-letter countermark from 1773

⁴⁰ Ganzer 1994, 37 my translation.

⁴¹ *Bibliografia Italiana* 1881, 37.

to the late 1880s. Their mould makers used wooden molds to shape the single wires used to make up watermarks and countermarks resulting in little variation.

Valentino III installed the first Holland beater in the Veneto c.1770, a century after its invention, a contributing factor in the good formation of their hand-made papers, even those not of the first quality. Their paper sheets become cloudy when they began using the cylinder/*tamburo* machines in the late 1880s. Using this information, found in Italian and paper-sector sources⁴², coupled with published watermark studies and field discoveries, we can deduce the following:

7 VG countermark

The VG countermark was used by the Galvani mills c.1760s–c.1839. The Galvani VG is listed as terminated in the first catalogue of countermarks issued by the *fabbricanti della carta* published in 1768.⁴³ This implies that it had been used previously but all recorded examples are later than 1768. The VG countermark is documented in Eineder, the earliest, VG 319 dated 1769, the latest 368 dated 1837; Nikolaev earliest VG 577 dated 1773, latest 1075 dated 1839; Ersoy earliest VG 209 dated 1774–5, latest 155 dated 1836–7.

7.1 VG plus watermark of an ornate crowned crest with moon face facing right and *TRE LUNE* spelled out in hollow capital letters

This watermark is found in Nikolaev 598, dated 1779. Velkov⁴⁴ uses the same source. This is an early occurrence of the hollow Roman VG. Velkov illustrates several examples of this watermark (184–199), all with slight mould variations, with the latest dated 1799. Eineder 424 dated 1793 shows the ornate crowned crest with moon face and VG. The Velkov and Eineder examples do not have the *TRE LUNE* spelled out. Paden 9 is a complete example in a Nigerian collection, purchased in the 1960s by John Paden in the Kano market.

⁴² *Annuario della Libreria* 1884, 376; *Ministero di Agricoltura* 1898, 53; Fedrigoni 1966, 241; Tranchini 1991, 36–37; Ganzer 1994, Mattozzi 1994, 1996 and 2001; Crippa/Mattozzi 1999, 80–82, 101–105; Rosa 2004; Antonioli et al 2006, 4; Carniel et al 2008, 30, 59–60; Zakaria/DeGuise/Abdul Latif 2008; Populin 2009.

⁴³ Mattozzi 1996, 338.

⁴⁴ Velkov 2005, 178–179.



Fig. 12: VG plus watermark of ornate crowned crest with moon face facing right and *tre lune* spelled out. This paper is very white and smooth. (Paden 9).

VG plus ornate crowned crest and *tre lune* (Fig. 12)

Date:	c.1779–1799
Type:	Laid hand-made
Watermark dimension:	50 × 135 mm
Fiber:	Cotton and linen
Laid lines:	6 per cm
Chains lines:	29 mm
Bulk/thickness:	.18–.2 mm

7.2 VG with watermark of *tre lune* (three moons)

Eineder records no VG *tre lune* (three moons) watermarks. Nikolaev 616 is dated 1779 and has *Tre Lune* spelled out under the three moons (as in Andreev and Velkov 812 dated 1779). Ersoy 164 dated 1779 also records this watermark with *Tre Lune* spelled out. In addition, Ersoy 209 records a crowned VG with *tre lune* dated 1774–5. This watermark, but without *Tre Lune* under the crescents or a crown above the VG, was used by Major Dixon Denham in his 1822–1824 expedition journals (recorded as Heawood 880), currently held by the National Archives (Public Record Office) in London. During the same expedition Captain Hugh Clapperton also used paper that was similarly marked (from two different moulds) for two maps of the area around ‘Lake Tchad’. The paper in these maps is extremely floccular, heavily sized, with shadow lines along the chain lines and is .18–.21mm

thick.⁴⁵ This simple Denham-Clapperton type was also found in a northern Nigerian manuscript, NAK B/AR4–3 dated 1839, with the same watermark and countermark but on a very different paper that used by Clapperton.



Fig. 13: VG with plain *tre lune* watermark. There are no shadows along the chain lines (NAK B/AR4-3 dated 1839).

VG with plain *tre lune* watermark (Fig. 13)

Date:	c.1823–1839
Type:	Laid hand-made
Watermark dimension:	75 × 25 mm
Fiber:	Cotton and linen
Laid lines:	6 per cm
Chains lines:	29–31 mm
Bulk/thickness:	.13–.15 mm

7.3 VG with watermark of moon face in simple crest – *carta reale*

In Nikolaev 959 dated 1810 and without the VG countermark Nikolaev 1005 (1821), 1038 (1829) and 1075 (1839). This paper was found in an undated northern Nigerian manuscript, Falke 1326 and in NAK B/AR4–2 dated 1834, both of which had extremely good sheet formation and were thick (.19–.21 mm and .20–.23 mm respectively).

⁴⁵ Clapperton Papers MS 171/5/3–4. The Brenthurst Library, Johannesburg, South Africa.



Fig.14: VG with watermark of moon face in simple crest. (Falke 1326).

VG with moon face in simple crest (Fig. 14)

Date:	1810–1839
Type:	Laid hand-made
Watermark dimension:	52 × 77 mm
Fiber:	Cotton and linen
Laid lines:	7 per cm
Chain lines:	31 mm
Bulk/thickness:	.19–.21 mm-VG with three curly moon faces

7.4 VG with three curly moon faces

This watermark is found in Wiesmüller — Refaiya Vollers 622 dated 1836⁴⁶; in Ersoy 155 dated 1836–37 and in northern Nigerian manuscripts NAK B/AR4/3 dated 1839 and undated Falke 1304, 1326.

⁴⁶ Wiesmüller n.d.



Fig. 15: VG with three curly moon faces. (NAK B/AR4/3 dated 1839 — two moulds).

VG with three curly moon faces (Fig. 15)

Date:	1834–1839
Type:	laid hand-made
Watermark dimension:	60 × 30mm
Fiber:	Cotton and linen
Laid lines:	6 per cm
Chain lines:	29–31 mm
Bulk/thickness:	.13–.15 mm

8 AG countermark

Whilst it is possible that the AG countermark was used by Andrea III during the two periods he was involved in papermaking, 1756–64 and 1803–8, there is no archival record to support this. ‘Andrea Galvani’ was registered as a mark in

1826.⁴⁷ Andrea IV assumed direction of the family business in 1836⁴⁸ and archival evidence strongly suggests he adopted the AG countermark the same year. It was during his tenure that modern industrial practices come to the fore with, amongst other innovations, mould standardization. AG is used until the late nineteenth century when the remaining two mills – Viazzol and Porcia Rorai – added *al tamburo* machines.

8.1 AG with *tre lune*

Amongst the examples found in northern Nigerian collections: MAF 1, 128, and 183 with no dates; Jos 345 dated 1872; and CTSS 86/0006 dated 1796 and CTSS 86/0029 dated 1795. Archival evidence suggests that neither of these CTSS dates are valid.⁴⁹ Other examples are Regourd 2008 76–77 dated 1866; 78–80 dated 1822 – another improbable date; and 159–162 dated 1866 (with a somewhat script-like AG). In all Nigerian sheets the A and G are centered between the chain lines, the points of the crescents touch the chain lines, and the sheets are speckled with short dark fibers and flocs.

AG with *tre lune* (Fig. 16)

Date:	1836–late 1880's
Type:	Laid hand-made
Watermark dimensions:	95 × 32 mm
Fiber:	Unknown, many dark inclusions and flocs
Laid lines:	7 per cm
Chain lines:	32 mm
Bulk/thickness:	.11–.13

⁴⁷ Mattozi 1994, 20.

⁴⁸ Rosa 2004, 9.

⁴⁹ Mattozzi 1996, 323-4; 2001, 162.



Fig. 16: AG with *tre lune*. (MAF 1 undated).

8.2 AG with *tre lune* and ‘Andrea Galvani Pordenone’ in script

Examples found in Nigerian collections include undated MAF 21, B/AR2-2 dated 1847 and B/AR6-5 dated 1882. This is the first appearance of ‘Andrea Galvani Pordenone’ spelled out in script, as a countermark, coupled with the AG and *tre lune* watermark. During the early 1840s Andrea IV had developed numerous improvements speeding up paper-making production. In 1846 he was awarded a 5-year patent, or *privilegio*, for three of these inventions, one of which was for substituting plant matter for rags. MAF 21 was found with intact *bifolium* allowing a confident reconstruction of the mould layout. The three crescents were centred on the right and the AG centred on the left of the mould. The placement of the script countermark, hugging the lower right edge of the mould under the AG, suggests that he added his name in script to existing moulds, perhaps in celebration of his numerous awards and achievements coupled with ten years of directing the mills’ activities and twenty years since ‘Andrea Galvani’ was registered as a mark.

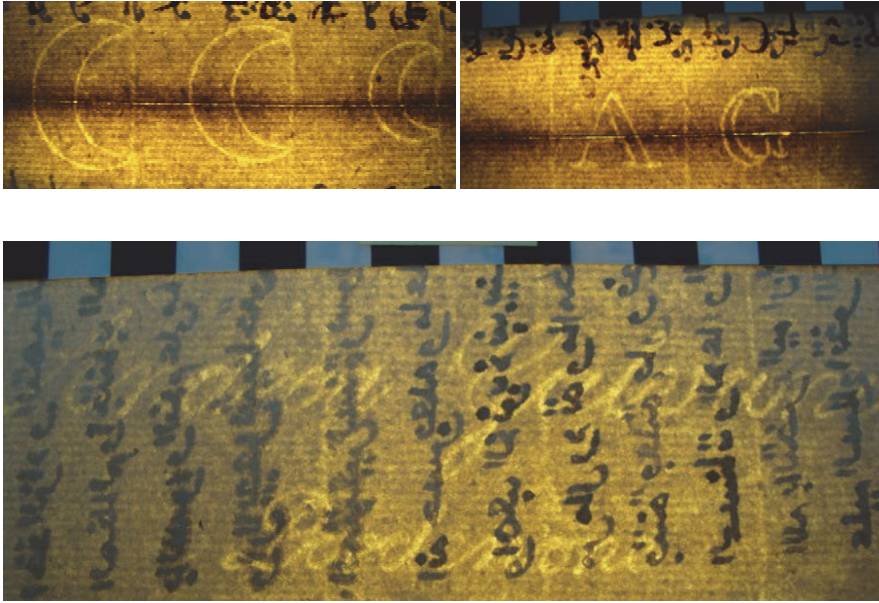


Fig. 17: AG with *tre lune* and ‘Andrea Galvani Pordenone’ in script under the AG. (MAF 21).

AG with *tre lune* and ‘Andrea Galvani Pordenone’ in script (Fig. 17)

Date:	1846–late 1880’s
Type:	Laid hand-made
Watermark dimensions:	95 × 32 mm
Fiber:	Cotton, linen, silica
Laid:	7 per cm
Chains:	32 mm
Bulk/thickness:	.11–.12 mm

After examining scores of sheets with three graduated crescents and the points of the crescents touching the chain lines, 7 laid lines per cm, and chain lines 32 mm apart, even without finding the AG countermark, I am confident that all these sheets are from the Galvani mills.

8.3 AG with moon face in simple crest and ‘Andrea Galvani Pordenone’ in script

The James McBey Collection of watermarked paper⁵⁰ was created by McBey as a by-product of his work as an engraver and etcher during the late nineteenth and early twentieth century. It was issued in a limited collection by Harvard University and is comprised of fifty-seven fully catalogued unprinted sheets. The Galvani sheet, #37, was purchased by McBey in Cairo in 1917. It is of high quality, fairly thick, white, well, though not superbly, made paper that does not appear to have been used. In quality it looks as if it were earlier made than 1917 but even today, in 2014, many mills continue to make hand-made paper for special projects and they admit to using old moulds. The sheet size is 480 × 340 mm. When overlaying the AG and ‘Andrea Galvani Pordenone’ layout in this sheet and the one from MAF 21, there was no difference between this mould and the one used in 1847, an example of Galvani standardization. Nigerian manuscripts CTSS 86/0029 and Falke 1028 are other examples. Regourd 2008 records 36–41 undated and 73–75 dated 1875.



Fig. 18: McBey #37 c. 1917. The crest and the AG are at the horizontal centre line of the sheet.

⁵⁰ Barker 1981.

AG with moon face in simple crest and ‘Andrea Galvani Pordenone’ – *carta reale* (Fig. 18)

Date:	1846 – early twentieth century
Type:	Laid hand-made
Watermark dimensions:	52 × 77 mm
Fiber:	Cotton and linen
Laid lines:	7 per cm
Chain lines:	31 mm
Bulk/thickness:	.18 mm
Sheet size:	480 × 340 mm

9 Galvani countermarks and watermarks in the machine era

In 1889 the Porcia Rorai mill was modernized with the installation of a hydraulic turbine generating electricity. In 1895 the Rizzardi Ceneda mill closed and the building remained unused for a century. In 1898 *Annali di Statistica Industriale* reported that a cylinder or al tamburo machine was operating in Pordenone and Cardenons. The Cordenons mill would have been the Galvani Viazoll mill. The Pordenone mill would have belonged to Carlo Lustig of Trieste who took over the ancient Trevisan mill, Cartiera Noncello, in 1890.⁵¹

Phillips’ Paper Trade Directory of the World resumed publication in 1906/7 after a thirteen-year gap. They record that in 1906/07 Galvani reported twelve vats but ‘two machines 135 cm’. By 1913/14 they record that their annual output had decreased by a third from 624 tons to 400, from twelve vats to two but still had ‘two machines 135 cm’. Circa 1912 they acquired an English agent, Slade-Jones of London, and advertised as a source of ‘Antique papers and papers for export to the Levant’.⁵² Between 1906/07 and 1946/7, with every issue of Phillips’ Paper Trade published, Galvani continued to report ‘two machines 135 cm’ and an annual production of 400 tons even though they closed the Porcia Rorai mill in 1929 and sold it in 1932.⁵³

⁵¹ *Ministero di Agricoltura* 1898, 53; Mattozzi 2001, 103; Populin 2009, 26.

⁵² Phillips 1907, 486; 1914, 536.

⁵³ In *Phillips’ Paper Trade Directory of the World* (1884, 1905-1946), Galvani is listed in each volume under the entry for Italy.

Because there were two Galvani mills until 1929 and each mill could have had its own set of dandy rolls producing hundreds of thousands of marked sheets, it is difficult to date these machine-made marks. However, close examination of the sheets allows an archaeological typological sequence – types I have tagged for ease of reference as AGmm1 to AGmm7 – with the caveat that each type could have been produced concurrently with another type and in particular AGmm4–7. There is the slight possibility that the last four types were made on continuous machines or, more probably, with cylinder *al tamburo* machines operating at high speeds, resulting in pulp hugging one side of the laid lines.

9.1 AGmm1

Amongst Nigerian examples are Jos 50 and Falke 34, both undated. Initially the Galvani ran their cylinder *al tamburo* machines at a low speed, resulting in a paper with no discernible grain, and continued to use their usual pulp mixture of cotton and other rags. Their first machine-made paper c. 1890s is watermarked A. Galvani Pordenone in hollow sans-serif letters with all letters connected by wire. The letter attachment to the dandy roll is uneven and one can see tie-downs. Some of the wires cut through the paper sheet. Paper fibers are cotton and linen; formation is very cloudy. No watermark found.

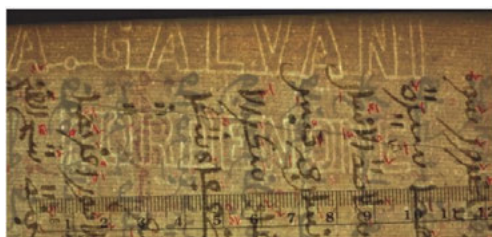


Fig. 19: AGmm1 c. 1890. (Falke 34 undated).

9.2 AGmm2

A. Galvani Pordenone in hollow sans-serif letters, each letter separate, c.1890s. In a second phase of machine-made production they are still using the same watermark but with letters individually soldered to the dandy roll's wire cylinder. Again some of the wires cut through the paper sheet. Paper fibers are cotton and linen and formation is still very cloudy. No watermark found.

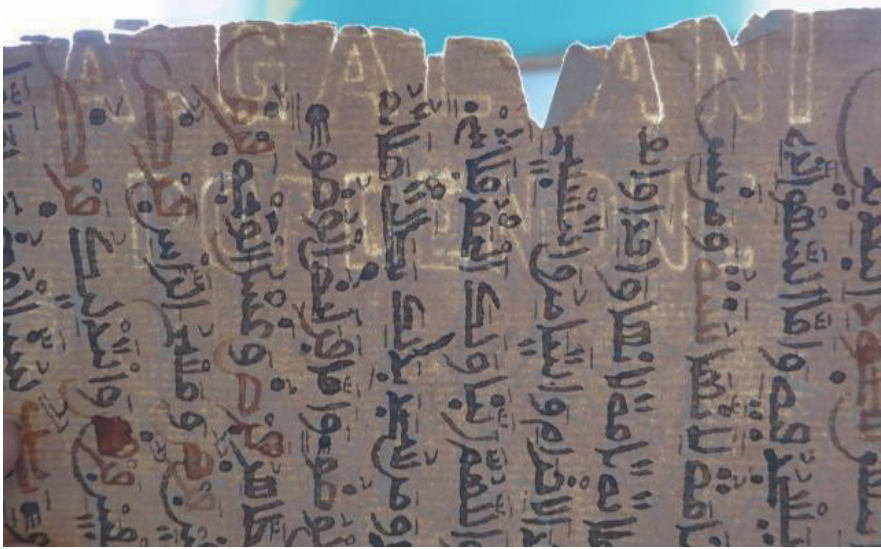


Fig. 20: AGmm2. (NAK B/AR5/6 dated 1913).

9.3 AGmm3

In a third iteration Andrea is spelled out but with no space between the names – Andreagalvani – with Pordenone underneath – in hollow sans-serif letters solidly soldered to the roll face plus fat *tre lune*. Amongst many examples in Nigerian manuscripts are Falke 2108 and MAF 19, both undated. Nikolaev 1195 is dated 1903. MAF 19 has sheets showing that this version was used until the dandy roll began to shred. The last image shows the impression where the wire is stitched together around the cylinder. Fibers cotton, linen and miniscule traces of silk. Paper formation is sometimes cloudy, the *tre lune* are often blurry. The machine was running at a very low speed as the fibers do not consistently hug one side of the laid lines. The sheets exhibit little grain.



Fig. 21: AGmm3 c.1903. (MAF 19 undated).

9.4 AGmm4

Andrea Galvani Pordenone in curly script with fat *tre lune*. This is a very common paper in Nigerian manuscripts with every northern Nigerian collection examined having examples – MAF 20, Falke 27, CTSS 86/0039, etc. Fibers are cotton, linen and mechanical ground wood. The ‘A’ in Andrea is pointy at the top and whilst there is space between Andrea and the Galvani a single wire usually connects the lower-case ‘a’ and the upper-case ‘G’ but its *tre lune* are a distinguishing characteristic. The points of the *tre lune* touch the chain lines just as they did in the hand-made era and these marks are oftentimes blurry and the paper cloudy. The mills appear to have been struggling with the new technology or with a new pulp combination that contains ground wood. With the continuous machine the pulp was sprayed onto the wire mesh, a very different and a very challenging pulp application method when compared to centuries of experience with dipping a mould into a vat.

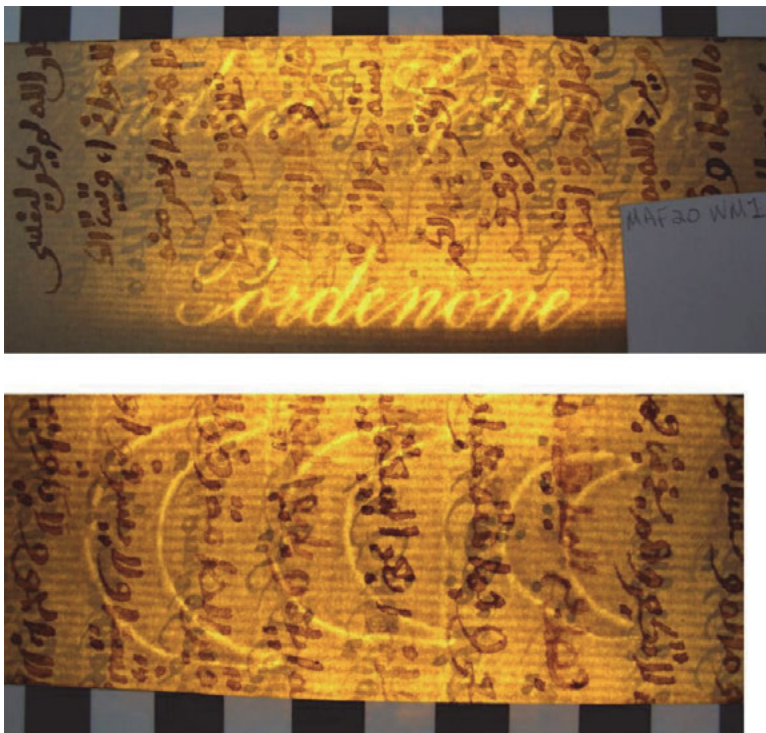


Fig. 22: AGmm4 c. 1905. (MAF 20 undated).

9.5 AGmm5

Andrea Galvani Pordenone in curly script and very slender *tre lune*. Dated examples include NAK B/AR5/5 dated 1913 and Jos 568 dated 1928. Usually the sheets have a closed, even formation. Fibers cotton, mechanical ground wood and assorted vegetable. AGmm5 is very common in northern Nigerian manuscripts and is frequently found together with ‘SSB’ *tre lune* paper from the Cartiera Italiana Serravalle-Sesia-Borgo mill.

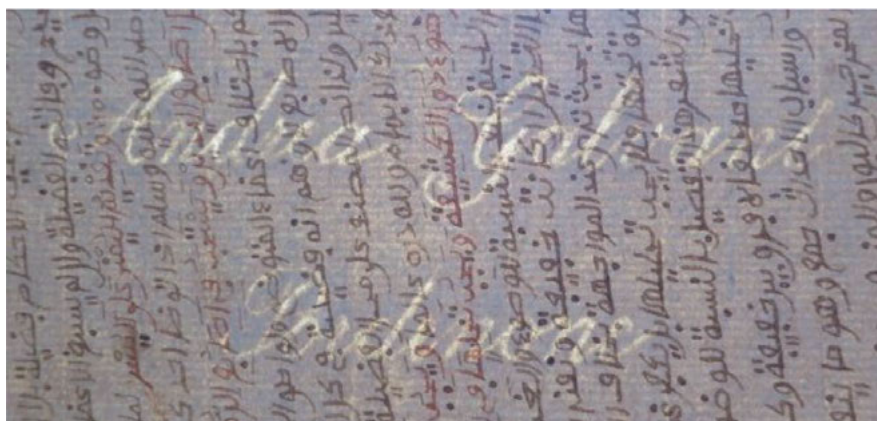


Fig. 23: AGmm5 c.1913–28. (NAK B/AR5-5 dated 1913).

As dandy rolls wore out they would be replaced. There are minor differences but the format is essentially the same. This example (Fig. 24) is from MAF 270 undated but the manuscript included paper from Cartiere Prealpine Intra (Italia), active 1929–1983.



Fig. 24: AGmm5 (MAF 270 undated).

9.6 AGmm6

Andrea Galvani Pordenone in curly script with moon face in simple crest. The Galvani continued to produce the two varieties – *tre lune* and *carta reale*. This Nigerian example dated 1924 is in a private collection, its formation is variable and the fibers are cotton, wood and miniscule coloured fibres. Another example is Regourd 2008 13–14 dated 1918.

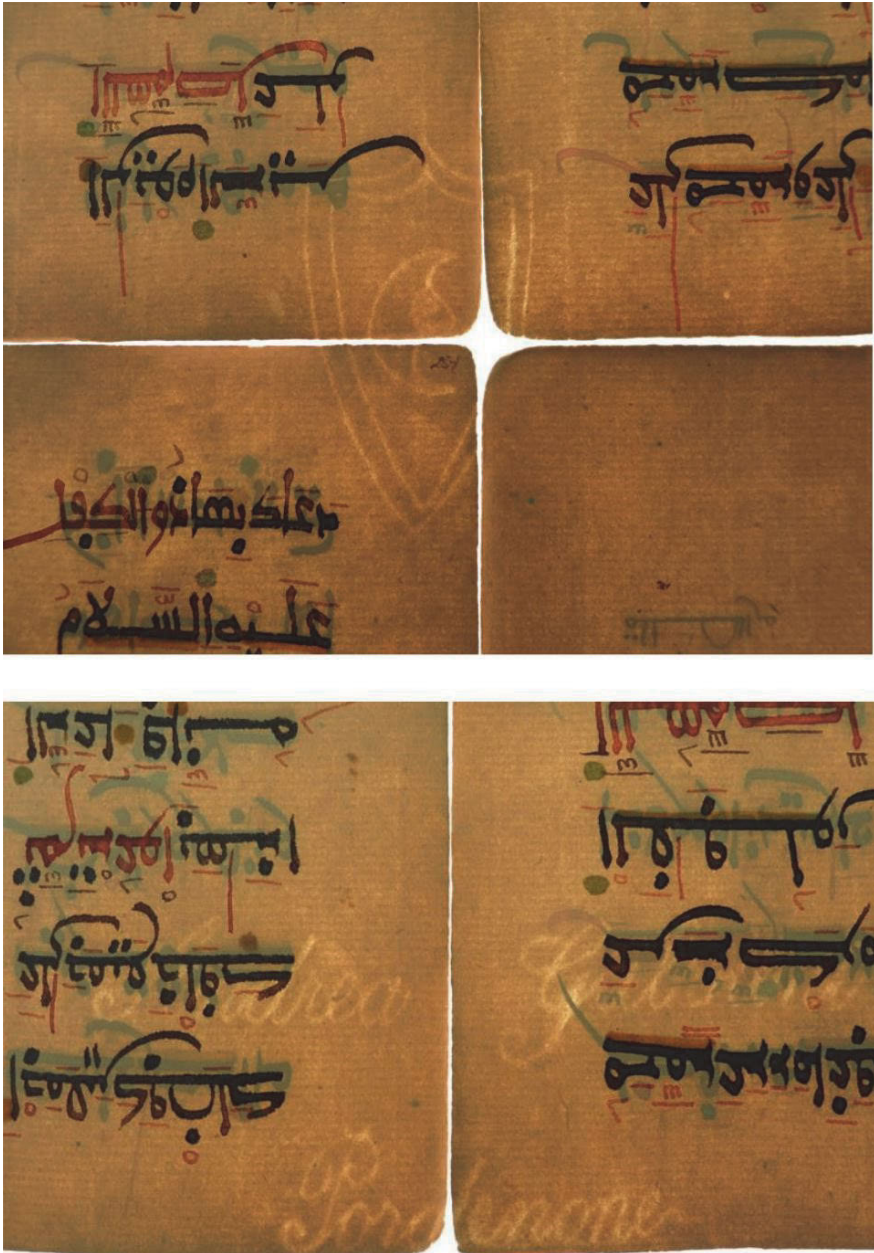


Fig. 25: AGmm6 in a *Dalā'il al-Khayrāt* dated 1924. (Private collection).

9.7 AGmm7

Regourd recently published a previously unknown machine-made variant.⁵⁴ It is atypical in that the crest with moon face facing right has only one rim but the script signature of ‘Andrea Galvani Pordenone’ is similar to AGmm4 in that a single wire appears to connect the lower-case ‘a’ and the upper-case ‘G’. These Galvani machine-made papers were watermarked with dandy rolls so there is no reason why differently marked papers could not have been produced concurrently as there were two mills — Porcia Rorai in Pordenone and Viazzol in Cardenons — both in production between the late 1880’s and up to 1929. And by 1906/07 each mill could have had its own machine and each would have had its own set of dandy rolls. This is another example of why we should routinely expect date ranges for the same watermarks in machine-made paper rather than precise dates.

10 Conclusion

As we can see, watermarks together with their countermarks, whether in hand-made or machine-made paper, can be useful for dating and authenticating but all the more so when studied holistically, that is within the context of what the sheets themselves tell, and with reference to the historical and archaeological record. We should record not only watermarks and countermarks, but also their precise placement, the details of the sheets in which they appear, and whenever possible obtain paper samples in order to conduct microscopic and chemical analysis. It takes a great deal of paper data to create reliable information sources and we are now only in the early stages of that collection process. When combined with mill and paper economic and with technological history and archaeology, this knowledge will allow us to make a more accurate use of the marks we find in paper.

As there will only ever be a few cases in which ‘identical’ watermarks can be compared to those in securely dated manuscripts, we should be prepared to say we have fuzzy dates or a date range when using watermarks to date sub-Saharan manuscripts in Arabic script.

⁵⁴ Regourd 2015.

Abbreviations

- CTSS – Center for Trans-Saharan Studies, University of Maiduguri, Nigeria
 Falke — Umar Falke Collection, Melville J. Herskovits Library of African Studies, Northwestern University, Evanston, Illinois, USA
 Jos — Arabic Manuscript Collection, Jos Museum, National Commission of Museums and Monuments, Jos, Nigeria
 MAF — Modibbo Ahmadu Fufore Collection, Arewa House, Ahmadu Bello University, Kaduna, Nigeria
 NAK — National Archives Kaduna, Nigeria
 Paden — John Paden Collection, Melville J. Herskovits Library of African Studies, Northwestern University, Evanston, Illinois, USA
 PLM — Polarized light microscopy was carried out by the author under the tutelage of Dr. Gary Laughlin of McCrone Research Associates.

Acknowledgement:

This work would not have been possible without the cooperation and support of: Dr Mahmoud Hamman, Dr Kabiru Chafe, Malam Musa Salih Muhammad and Dr Salisu Bala, Arewa House, Ahmadu Bello University, Kaduna; Director A.O. Umar and Ibrahim Abdu, National Archives Kaduna; Dr Abubakar Garba and Malam Ahmadu Girei, Centre for Trans-Saharan Study, University of Maiduguri; Director Idris Musa Hausawa, Kano State History and Culture Bureau, Kano; The Late Lamido Zubairu, Alhaji Murtala Aminu, Chairman of Fombina Palace Museum Council, Alhaji Sa'adu Ahmed and the Fufore Family, Staff of the Fombina Palace Museum, Yola, Adamawa; Director General Yusuf Abdullah, National Commission for Museums and Monuments, Abuja; Dr Hamid Bobboyi, Centre for Regional Integration and Development, Abuja; Prince Adetokunbo Kayode, Minister of Culture, Abuja; Dr A.A. Balarabe and Dr Sahabi Maidamma Jabo, University Library, Usmanu Danfodiyo University, Sokoto; Director Muhammad Bello Idris and staff, Waziri Junaidu History and Culture Bureau, Sokoto; Malam Muhammad al-Amin, Salame; Staff of Katsina History and Culture Bureau, Katsina; Staff of Northern History Research Scheme, Ahmadu Bello University, Zaire; Colin Baker and John Mumford, British Library, London; Dr David Easterbrook and Scott Devine, Herskovits Library of African Studies, Northwestern University, Evanston, Illinois; Dr Gary Laughlin, McCrone Research Associates, Chicago, Illinois; Dr Laura Weinstein, Ananda Coomaraswamy Curator of South Asian and Islamic Art, Boston Museum of Fine Arts, Boston, Massachusetts; Wesleyan University Fund for Professional Development; Robert McKelvey and the Adelpic Education Fund; The Islamic Manuscript Association; Wesleyan University, Middletown, Connecticut - Head Librarian Pat Tully, Director Special Collections and Archives Suzy Taraba, Interlibrary Loan Unit Kate Wolfe and Lisa Pinette.

References

- Andreev, Stephane (2007), *Les Filigranes dans les Documents Ottomans*, Couronne: Stoyan Shivarov.
- Annuario della libreria e tipografia e delle arti affini in Italia* (1884), Anno I, Milano, Associazione Tipografico-Libraria Italiana.
- Antonoli, F./ Montagnini, M. / Tricoli, A. (2006), *Una Proposta di recupero per l'ex Cartiera Galvani di Vittorio Veneto*, TICCIH: The International Committee for the Conservation of the Industrial Heritage, www.ticcihcongress2006.net/paper/Paper%205/Antonio%20et%20a.pdf (seen 1.1.2010).
- Babinger, Franz (1931), 'Appunti sulle cartiere e sull'importazione di carta nell'impero ottomano specialmente da Venezia', in *Oriente Moderno*, 11(8): 406–415.
- Barker, Nicholas (1981), *The James McBey Collection of Watermarked Paper*, Cambridge: President and Fellows of Harvard College.
- Barth, Heinrich (1857), *Travels and Discoveries in North and Central Africa in the Years 1849–1855*, New York: Harper and Brothers.
- Benedetti, Andrea (1964), *Storia di Pordenone*, Pordenone: Edizioni de "Il Noncello", Antonini, Pordenone, 76–80.
- Bibliografia Italiana: Giornale dell'Associazione Tipografico-Libraria Italiana* (1881), Anno XIV, Milano, Associazione Tipografico-Libraria Italiana.
- Biddle, Michaele (2008), *Saving Nigeria's Islamic Manuscript Heritage*, (<http://works.bepress.com/mbiddle/1>)
- Biddle, Michaele (2011), 'Inks in the Islamic Manuscripts of Northern Nigeria: Old Recipes, Modern Analysis and Medicine', in *Journal of Islamic Manuscripts*, 2(1): 1–35.
- Biddle, Michaele (forthcoming a), 'Arbib, Ydlibi and Suru (Hakuri): Three Arabic Script Watermarks in Northern Nigerian Manuscripts', in Anne Regourd (ed.), *Les Papiers a Marques Caractere non-latin /Papers Bearing Marks in non-Latin Characters*, Leiden: Brill.
- Biddle, Michaele (forthcoming b), 'Imbedded in Paper – Baraka in the Islamic Manuscripts of Northern Nigeria'.
- Bidwell, John (1992), 'The Study of Paper as Evidence, Artefact, and Commodity', in Peter Davison (ed.), *The Book Encompassed: Studies in Twentieth-Century Bibliography*, Cambridge: Cambridge University Press, 69–82.
- Bivar, Adrian David Hugh (1960), 'A Dated Kuran from Borno', in *Nigeria Magazine*, 65: 199–205.
- Bivar, Adrian David Hugh (1968), 'The Arabic Calligraphy of West Africa', in *African Language Review*, 7 (1968): 3–15.
- Bower, Peter (1999), 'The White Art: The Importance of Interpretation in the Analysis of Paper', in John Slavin et al (eds), *Looking at Paper Evidence and Interpretation, Symposium Proceedings*, Toronto 1999, 5–16.
- Brockett, Adrien (1987), 'Aspects of the Physical Transmission of the Qur'an in 19th century Sudan: Script, Decoration, Binding and Paper', in *Manuscripts of the Middle East*, 2: 45–67.
- Bryan, Clark W. (1883), *The Paper Mill Directory of the World*, Holyoke, Massachusetts, Clark W. Bryan & Co.
- Carniel, Alberto et al. (2008), *Lagheti di citta' e di pianura : indagine nel territorio Pordenonese*, Pordenone: Il Popolo.
- Clapperton Papers MS 171/5/3–4*. The Brenthurst Library, Johannesburg, South Africa.

- Crippa, Flavio, and Ivo Mattozzi, (1999), *Archeologia industriale a Pordenone acque e Fabbriche dal XV al XX Secolo*, Pordenone: Del Bianco Editore.
- Denham, Dixon, Hugh Clapperton, and Walter Oudney (1826), *Narrative of Travels and Discoveries in Central Africa in the Years 1822, 1823 and 1824*, London: John Murray.
- Eineder, Georg (1960), *The Ancient Paper-Mills of the Former Austro-Hungarian Empire and their Watermarks*, Hilversum: Paper Publications Society.
- Ersoy, Osman (1963), *XVIII. ve XIX. Yüzyillarda Türkiye’de Kâğıt*, Ankara: Basimevi University.
- Fahy, Conor (2004), ‘Paper Making in Seventeenth-Century Genoa: The Account of Giovanni Domenico Peri (1651)’, in *Studies in Bibliography*, 56: 243–259.
- Fedrigoni, Antonio (1966), *L’industria Veneta della carta dalla Seconda Dominazione Austriaca all’unità d’Italia*, Torino, ILTE – Industria Libreria Tipografica Editrice.
- Fontana, Giovanni Luigi, and Ennio Sandal, (eds) (2001), *Cartai e Stampatori in Veneto*, Brescia: Grafo Edizioni.
- Gacek, Adam (2009), *Arabic Manuscripts: A Vademecum for Readers*, Leiden: Brill.
- Ganzer, Gilberto (1994), ‘La famiglia Galvani: appunti genealogici’, in Gilberto Ganzer (ed.), *Andrea Galvani 1797–1855: Cultura e industria nell’ottocento a Pordenone*, Pordenone: Studio Tesi, 7–15.
- Heawood, Edward (1950), *Watermarks Mainly of the 17th and 18th Centuries*, Hilversum, Paper Publications Society.
- Herring, Richard (1860), *A Practical Guide to the Varieties and Relative Values of Paper*, London: Longman, Green, Longman and Roberts.
- Hunter, Dard (1947), *Papermaking: The History and Technique of an Ancient Craft*, New York: Alfred A. Knopf.
- Levey, Martin (1962), ‘Medieval Arabic Bookmaking and its Relation to Early Chemistry and Pharmacology’, in *Transactions of the American Philosophical Society*, New Series, 52(4): 1–50.
- Loeber, Edo G. (1982), *Paper Mould and Mouldmaker*, Amsterdam: Paper Publications Society.
- Mattozzi, Ivo (1994), ‘I Galvani, fabbricanti di carta’, in Gilberto Ganzer (ed.), *Andrea Galvani, 1797–1855: Cultura e industria nell’ottocento a Pordenone*, Pordenone: Studio Tesi, 16–41.
- Mattozzi, Ivo (1996), ‘Le filigrane e la questione della qualità della carta nella Repubblica Veneta della fine ’700. Con un catalogo di marchi di filigrane dal 1767 al 1797,’ in Giancarlo Castagnari (ed.), *Produzione e uso delle carte Filigranate in Europa (secoli XII–XX)*, Fabriano: Pia Università dei Cartai, 309–339.
- Mattozzi, Ivo (2001), ‘Le cartiere nello stato Veneziano: una storia tra strutture e congiunture (1450–1797)’, in Mauro Grazioli, Ivo Mattozzi and Ennio Sandal (eds), *Mulini da carta. Le cartiere dell’Alto Garda. Tini e torchi fra Trento e Venezia*, Verona: Cartiere Fedrigoni, 97–162.
- Ministero di Agricoltura, Industria e Commercio* (1898), *Annali di Statistica, Statistica Industriale, Industria della carta*, Fascicolo 63, Roma: Tipografia Nazionale di G. Bertero.
- Morpurgo, Eugenio (1874), *La carta: Considerazioni sulla sua storia, la sua fabbricazione ed il suo Commercio*, Venezia: Tipografia del giornale “Il Tempo”.
- Nachtigal, Gustav (1881), *Sahara and Sudan II: Kawar, Bornu, Kanem, Borku and Ennedi*, translated by A. G. B Fisher and Humphrey J. Fisher (London: Hurst, 1980).
- Nikolaev, Vsevolod (1954), *Watermarks of the Mediaeval Ottoman Documents in Bulgarian Libraries: Watermarks of the Ottoman Empire, Volume 1*, Sofia: Bulgarian Academy of Sciences.
- Phillips’ Paper Trade Directory of the World* (1884, 1905–1946), London: S.C. Phillips & Co.

- Populin, Elisabetta (2009), *Pordenone ed il suo Fiume*, Pordenone: EFASCE.
- Regourd, Anne (2015), 'Le ms. Or. 6980 de la Bibliothèque universitaire de Leyde. I. Premiers éléments de datation et de localisation du manuscrit: apport d'un papier Andrea Galvani inédit', in *Chroniques du Manuscrit au Yémen* 20: 65–81.
- Regourd, Anne (ed.) (2008), *Catalogue cumulé des bibliothèques de manuscrits de Zabid: Fascicule 1, Les papiers filigranés*, Sanaa: Centre français d'archéologie et de sciences sociales de Sanaa.
- Rosa, Alessandro (ed.) (2004), *La ceramica Galvani di Pordenone: Storia e Sviluppo di una Manifattura*, Pordenone: Fiere.
- Ruckert, Peter, Sandra Hodecek, and Emanuel Wenger (2009), *Bull's Head and Mermaid: The History of Paper and Watermarks from the Middle Ages to the Modern Period, Booklet and catalogue of the exhibition presented by the Landesarchiv Baden-Württemberg, Hauptstaatsarchiv Stuttgart and the Austrian Academy of Sciences, Kommission für Schrift- und Buchwesen des Mittelalters*, Vienna. Stuttgart and Vienna: Landesarchiv Baden-Württemberg and Vienna.
- Sartori, Leonzio (1897), *L'Industria della carta*, Milano: Hoepli.
- Skinner, Neil (ed.) (1977), *Alhaji Mahmudu Koki: Kano Malam*, Zaria: Ahmadu Bello University Press.
- Tapiero, Norbert (1968), 'A propos d'un manuscrit arabe d'origine soudanaise déposé à la Bibliothèque Nationale de Paris', in *Research Bulletin* (University of Ibadan, Nigeria) 4: 26–40.
- Tomasi, Giovanni, and Silvia Tomasi, (2012), *Ebrei nel Veneto Orientale: Conegliano Ceneda e insediamenti minori*, Firenze: Giuntina.
- Tomlinson, Charles (ed.) (1855), 'Paper', in *Cyclopaedia of Useful Arts and Manufactures*, London: James S. Virtue, 357–374.
- Tranchini, Eugenio (1991), *Le cartiere Vittoriesi tra il XVII e il XIX secolo. Appunti di storia economico-sociale*, Vittorio Veneto: La Vittoriese.
- Van der Horst, Koert (1989), 'The Reliability of Watermarks', in *Gazette du livre Medieval*, 15: 15–19.
- Velkov, Asparoukh, and Andreev, Stephane (1983), *Filigranes dans les Documents Ottomans, I. Trois Croissants* [= Водни знаци в Османотурските документи. I Три луни], Sofia: Narodna Biblioteka Kiril i Metodii.
- Velkov, Asparouh T. (2005), *Les filigranes dans les Documents Ottomans: Divers Types d'images*, Sofia: Editions 'Texte – A. Trayanov'.
- Walz, Terence (1985), 'The Paper Trade of Egypt and the Sudan in the Eighteenth and Nineteenth Centuries', in Martin W. Daley (ed.), *Modernization in the Sudan: Essays in Honor of Richard Hill*, New York, Lilian Barber Press, 29–48.
- Wiesmüller, Beate (n.d.), 'The Watermarks from the Refaiya-Library' (translated by Steven Black), http://www.refaiya.uni-leipzig.de/texts/Watermarks_Refaiya.pdf. (seen 1.1.2016)
- Zakaria, Ros Mahwat Ahmad, Lucien De Guise, and Latifah Abdul Latif (2008), *Malay Manuscripts: An Introduction*, Kuala Lumpur: Islamic Arts Museum Malaysia.