and Persian moulds differed sufficiently from Western examples, that sheets were freed with greater ease from the former, and felts were not needed to provide a means of attraction for the paper.

17. It is probable that this technique was used in preference to the practice of pouring the fibre solution on to the mould, although it is not known to what extent, and from which period, it was favoured. Nevertheless, when papermaking was introduced into Muslim Spain in the 11th century AD, the technique of dipping was employed exclusively, as it would be later throughout Western Europe.
19. To couch, from the French verb coucheur ("to lay down"); Old French calcheur, from calcher; from the Latin colloocare ("to place").
23. It is equally possible that Middle Eastern

CHAPTER FOUR
Qualitative Characteristics of Islamic Paper

The techniques and materials employed by the papermaker constituted the essence of his craft. But if the fundamental principles of papermaking differed little from East to West, the manner in which techniques were practised varied greatly, ensuring that a sheet of paper was unique to the person or mill who produced it. Not only was there a marked variation in paper characteristics from sheets produced in different regions, towns and mills, but often a noticeable difference in quality of paper produced by the same hand.

**Determination of Quality**

To a large extent, paper quality is determined by fibre type. On the basis of their location in the plant, fibres are classified roughly as follows: seed hair (cotton and linen); bast fibres (flax, hemp, jute, ramie); wood fibres (coniferous and deciduous woods); leaf fibres (esparto, manila, sisal); and grass (straw, bamboo, bagasse, maize stalks). Traditionally, Islamic papers were made from a combination of linen and hemp, imparting softness, strength, bulk, opacity, purity, durability and absorbency to the sheet. As with the earliest European papers, they were typically of high quality and tended to deteriorate little over time.

Quality of paper is determined equally by the manner in which the raw materials are beaten. Absorbency and strength are directly related to the extent to which fibres are separated and fractured: through the partial removal of the outer cellulosic wall, fibres increase in surface area and flexibility, and bond more readily with neighbouring matter. The greater the area of contact between the fibres, the greater the degree of bonding; the greater the degree of bonding, the stronger and less absorbent the sheet. In the Islamic world, satu-
rated pulp was not beaten extensively and, consequently, the papermaking fibres remained little modified: some were split, but extensive fibrillation was rare, and clumping of fibres was common. Thus Islamic paper will readily absorb moisture, and is prone to water staining. Cellulose fibres are affected by changes in moisture content, as reflected in the dimensional instability of paper, and if a sheet of paper becomes wet and is then dried, its strength is affected permanently.

Paper durability is dependent upon the composition of the sheet, the manner in which it is made, and the environment in which it is produced and housed. Islamic papers were typically long fibred due to the nature and characteristics of linen and hemp, and the restrained beating of the paper stock. Thus, although Islamic paper has a good tensile strength, and is not easily torn, it is easily abraded, and can be split in the plane of the sheet (figure 7). However, the addition of size to the sheet helped to enhance the bonds between the fibres, ensuring that its internal structure relaxed little over time, and was hardly affected by folding or excessive handling. Mineral fillers were not added to the pulp, and lignin, the complex organic polymer that is largely responsible for the acidic breakdown of wood-based papers, was absent from the sheet. Essentially, there was nothing inherent in the paper to promote or accelerate its deterioration, and through the addition of lime during the manufacture process, the paper was further protected from acid degradation. Pollutants which are contributory to the acidity and breakdown of paper, such as sulphur dioxide, oxides of nitrogen, hydrogen sulphides and ozone, were barely present in Persia and the Middle East prior to industrialisation. Daily cycling of temperature and relative humidity, known to be detrimental to the physical properties of paper, was equally untypical.

Grade

Papers were categorised in terms of grade and usage, and labelled accordingly. With regard to quality, we find Persian terms such as kāghbaz-i dafāri (‘common paper’); kāghbaz-i kham (‘raw or unrefined paper’); and kāghbaz-i kabī (‘straw paper’, meaning poor quality sheets). With regard to the method of production and intended use, there are terms such as kāghbaz-i ābār mubārah (‘glazed paper’); kāghbaz-i barqī (‘glossy paper’); kāghbaz-i tabīrī (‘writing paper’); kāghbaz-i charbī (‘smooth paper’); and kāghbaz-i masbī (‘exercise or calligraphy paper’). Terminology also referred to the place of manufacture – for example Isfahāni, Baghdādi, Dawlatabadī, Samarqandi, Shāhi, and Hindī. Of these, Samarqandi was the most famous, with reference to it from the 10th century AD onwards, and to quote a poet by the calligrapher Mawlama

Sultan ‘Ali, written circa AH 1015 (AD 1606–7),

On Paper

There is no paper better than Chinese (khīṭa’ī),

However much you may try.

Saffron, honey, and a few drops

Of ink are (the means of the test?),

Until then, do not approve!

How good is Samarqand paper?

Do not reject it, if you are wise.

Writing upon it comes clearly and well,

But the paper should by clean and white.

Paper could equally be named after the rulers or high officials governing the province where it was produced. Al-sabā‘īnī paper was probably named after Harun al-Rashid’s controller of finance in Khurasan, al-jāfārī, after Ja‘far ibn Yahya, vizier of Harun al-Rashid; al-jālī, after Tālib ibn Tahir, governor of Khurasan in AD 822–828; al-jāhārī, after Tahir ibn ‘Abdallah, governor of the same place in AD 844–862; and al-nāḥī, after the Samarqand Nūh ibn Nāsir, who ruled over Transoxania in AD 942–954.

Colour

Paper is naturally off-white in tone. Through the addition of a colour, either by brushing or dipping the sheet, the Islamic papermaker could alter the appearance of his product dramatically. His delight in colour, and that of contemporary calligraphers and readers, is identified in the many and varied decorated pages of manuscripts produced across the centuries. There is no record of colour being added to the pulp in the initial stages of papermaking, and cross sections taken from coloured sheets show that the interior fibres are whiter in tone than those on the surface, indicating a preference for applying colour after the formation of the sheet. A range of colours was available to the papermaker, these being either simple or compound in composition. Blue was generally produced from indigo or aloe; yellow from saffron and lemon; red from the dissolved bodies of the mealy bug; olive green from blue with saffron added; green from saffron with verdigris; and violet from blue and red. Popular colours included al (reddish-yellow), bīnā’t (reddish orange), limānī (lemon green), ûstuqī (pistachio green) and nukhā (buff). According to Ibn Badis,

The red in dyeing is of many types. In one, the best possible sapanwood is taken. There are two types: one is the “little” and the other is the “princely”. An ounce is taken of the powder. It is immersed in water a night or a day. It is then put into a copper pot, a clean utensil.

On it is poured ten raths of the best powdered, sieved wild galls. It is then boiled on a good
fire until half the water is lost. The essential of the process is that a rod is left in it. Drip it on your thumb. If it remains and does not drip, then it is successful. It is taken down and purified. If desired, this may be repeated on that type which is sold. The first is the better of the two. It is left until it cools. Then dye with it. For dyeing, paper is put in the solution with care and then spread in the shade.7

Colouring of paper was carried out for a number of reasons: for aesthetic effect; for symbolic significance; or for the comfort of the reader. Blue was equated with mourning, such that orders for the death sentence were issued to criminals on blue paper in Syria and Egypt. Red could symbolise humanity, and was used frequently when presenting petitions for justice; it equally symbolised festivity and joy, and for this reason light red and rose-tinted papers were particularly popular. A full red colour was considered a prerogative in official correspondence of individuals of high rank, or on whom special favours had been bestowed.4 Pure white was believed by some to be harmful to the naked eye, and colour was required to reduce the glare of paper in bright light. On the merits of coloured paper, Mawla Sultan ‘Ali writes,

The color of paper best for writing
There is no better color than that of Chinese (khita’i) paper.
There is no need for you to test:
Writing on it is good, it is also good for gold,
It is excellent and it embellishes good writing.
For writing slightly tinted (sain-rang) paper is suitable,
That it should be restful to the eye.
The red, green, and white colors
Strike the eye, like looking at the sun.
Darkish colors suit colored writing.9

Size of sheet
From the advent of papermaking, a degree of standardisation of terminology existed with regard to the size of paper produced. Usually a single sheet was known as darj, plural durrajj, and a page was qartas (the European charta), plural qarätts.10 Al-Qalqashandi mentions nine different types and sizes of papers. Of these, the best quality was the full-size baghdadi (1099 × 733 mm), used for writing the caliph’s documents and treaties; the shami (‘Syrian’) was of various grades and sizes, one of which – the hamawi – was used in governmental departments. Among the remaining grades was the lightweight waraq al-tayr (‘Bird’s Paper’, measuring 91 × 61 mm), so-called because it was thin enough to be sent by carrier pigeon.9

Nine theoretical sizes of paper have been suggested by Joseph von Karabacek, the three most popular measuring 290 × 420 mm, 420 × 580 mm and 580 × 840 mm.12 On the basis of these measurements, Jean Irigoin has noted the following: first, paper sizes were the same in Egypt and Syria; second, the width of the finished sheet is two thirds its length; and third, the width of the sheet is the same as the length of the size of sheet immediately below it, as the measurements above show.9 This standardisation of size was ingenious as it permitted the use of different formats by appropriate folding of the sheets.14

Echoing the sale of papyrus, sheets of paper were occasionally pasted together and sold in large rolls from which the user cut suitable pieces. It was more usual, however, for the buyer to receive sheets in the format in which they emerged from the frame, and this could vary widely. The sheet was folded to size, and 20 such standard sheets were called dast (‘hand’) in Persian, translated into Arabic as kaff, and heard in the French expression, main de papier. Five ‘hands’ were called a rizmah or ‘bundle’, a term which is used extensively in the West: in English, ream; French, rame; German, Ries; and Danish, Ris.11

Watermarks
The practice of transferring insignia into a sheet of paper through incorporating a twisted wire or cord motif in the construction of the mould, was unknown in the Islamic world. This may be due to the fact that the moulds were flexible, and the flexing action of the screen would have inhibited the durable attachment of such a device.15 It is equally possible that this method of marking paper was not known. However, the distribution and grouping of laid and chain lines present in a sheet can be measured and categorised to some extent. Patterns in chain-line groupings in Syro-Egyptian papers are distinct and often highly individual. In Persian papers they are rarely seen, although it is unlikely that chain lines were altogether absent from the mould’s construction: only through the inclusion of silk or animal hair stitching could grass moulds be given support. If it was the case that in Persia any additional stitching was not intended to be seen, we can assume the opposite in Syria and Egypt. It can be argued that although we do not know the extent to which these markings were intended as a means of classification and identification, design was intentional and evidently served a purpose.

It was only in Spain that anything approaching a Western watermark was found. However this was still not a true watermark, but a zig-zag indentation running from the head to the tail of the sheet, or a series of overlapping diagonal crosses, drawn with a brush or a pointed implement while the newly made
paper was still moist. Markings such as these are found in papers produced in the regions of Valencia and Catalonia in the 12th to mid-14th centuries AD, and are also included in papers used in Fez, Tunis, Tetouan and Ceuta. The latter indicates the close trade connections between the Valencia/Catalonia regions and the Maghrib. The practice of marking sheets of parchment with pricks and knife marks in order to identify the parchment maker or tanner was common in the Middle Ages, and the continuing use of this device in modern-day Morocco may shed some light on the significance of the marks. It is interesting to note that the oldest example of the zig-zag pattern is found in the aforementioned codex of Silwai’s Gramatica. Pages of paper alternate with those of parchment, and both are marked with the same pattern. But other than what we can interpret from this, very little is known about this very particular Spanish practice.

1. In China, there is a tradition of producing laminated paper composed of anything up to four fine sheets, but in the Islamic world this is unusual. Papers manufactured in the Middle East and Persia have a tendency to delaminate due to the creation of two distinct sides of a sheet of paper, resulting from sizing and burning practices. If a sheet is sized and burnished on both sides, it is possible to divide the sheet because the bonds between the fibres will break more readily than the bonds created between the fibres and the size. Delamination of Islamic papers should not therefore be regarded as evidence for the laminating of separate sheets of paper during the papermaking process.  
18. For further information, see Valls I Subira 1970, pp. 3–18.

As mentioned above, the aim of this research is to identify the characteristics of a sheet of paper that are significant for its classification according to its origin and date of manufacture, and to plot a chronology of these characteristics in order to evaluate trends, patterns and changes in the craft of papermaking in Syria, Egypt and Persia from the 12th century AD until the beginning of the 19th century. The intention is to corroborate and add to existing research into paper typology carried out by scholars such as C.M. Briquet, J. von Karabacek, and M. Beit-Arié.

This study has involved the analysis of the paper of 1237 dated manuscripts according to the criteria detailed below, and the subsequent collation of all information gathered. Manuscripts have been selected at random from public and private collections and libraries, and in terms of subject matter, they include Qur’ans, prayer books and religious works; scientific manuscripts and cosmographies; and a range of literary and illustrated works such as Shabnamahs and divans (anthologies). Of the above, Qur’ans form the largest single category, totalling 18% of all manuscripts examined. There is some disparity in the percentage number of manuscripts examined from Persia (39%), compared to those produced in Syria and Egypt (41%). Greater emphasis has been placed on the former due to the difficulty in the classification of Persian papers according to chain- and kil-liner distribution. A lack of distinct mould markings may have contributed to the fact that, compared to Syro-Egyptian paper, relatively little is known about the manufacture of paper in Persia.

Protocol for Paper Classification

The validity and success of any systematic analysis of paper is dependent on the quantity of dated examples examined, and the existence of a standard,
objective means of describing each item. The greater the number of manuscripts examined, the more accurate and refined the final classification, providing that all have been examined in an identical fashion. Outlined below are details of the specific properties and characteristics of a sheet of paper that are significant for its classification, against which all subsequent sheets should be measured. Other relevant information should also be noted: the title, date and place of origin of each work, and the size and folio reference of each sheet of paper examined.

(i) Quality
The quality of a paper can be described as good, medium or poor. Of all the standards, this is the most subjective — an immediate impression of the degree of refinement that has gone into making the sheet, and the manner in which its surface has been subsequently treated. A record of the crispness of the finished sheet is taken.

(ii) Thickness
Thickness is measured in millimetres with a micrometer (1 Division = 0.01mm). Measurements are taken across the sheet and from ten pages selected at random from the manuscript, in order to account for variation in paper thickness throughout the manuscript.

(iii) Surface characteristics
These include the natural colour of the sheet and the manner in which its surface has been treated.
- **Natural colour:** ranges from white to cream to dark cream to biscuit to brown. Papers are matched against a colour chart, making judgements about hue more objective than if left to the memory and opinion of the examiner.
- **Treatment of surface:** sized (lightly or heavily) and/or burnished. Papers show considerable surface modification, particularly in respect of how much rice or wheat starch was employed for sizing purposes, and how evenly their surface was burnished to produce a gloss. As one paper will be noticeably soft, lightly sized, and with little evidence of burnishing, so the next may be heavily sized, extremely glossy, and with distinct grooves across its surface from the use of a burnishing tool.

(iv) Quality of pulp
This covers the distribution of the fibres and any inclusions within the sheet, together with its degree of opacity.
- **Distribution of fibres:** from uniform to floccular, examined through transmitted light. The distribution of fibres in some papers is even, with little clumping and minimal variation in density. Other papers show distinct clouding and/or swirling of fibres, with marked clumping and great variation in density across the sheet.
- **Inclusions:** the uncharacterizable bits, specks and flecks that can be seen in a sheet of paper. A note is made of whether a paper has few or many inclusions, and whether it is noticeably fibrous in its general appearance.
- **Translucency:** from opaque to translucent, with degrees in between — in effect, the 'see through' factor of the paper.

(v) Mould construction
Paper moulds are either laid or wove. If the former, chain- and laid-line characteristics must be noted (see vii, below).

(vi) Chain-line characteristics
These include a description of the individual chain lines, their alignment and the manner in which they are grouped.
- **Grouping and separation:** spaced at regular or random intervals, or grouped in twos, threes, alternating twos and threes, etc. Measurement of all intervals is taken in millimetres.
- **Direction:** horizontally or vertically aligned to the spine of the book. Chain lines run across the short dimension of the uncut sheet, their direction indicating the number of bifolia into which the sheet was divided.
- **Thickness:** from fine to approximately 2mm wide. Chain lines are matched against a series of lines of varying thickness drawn on to a sheet of Melinex, the latter placed on top of the sheet of paper and both examined through transmitted light. The finest line is the width of a fine line drawn with a pencil; the thickest is approximately 2mm wide. When it is possible to measure against a ruler, this is done.
- **Clarity:** from distinct to fuzzy to indistinct. Quite simply, how well the chain lines can be seen.
- **Character:** straight, wavy, or tending to deviate from their central axes. With regard to the latter, chain lines appear to be perfectly straight, but veer to the left or right at the head or tail of the sheet.

(vii) Laid-line characteristics
These include a number of diagnostic factors, such as the number of laid lines per centimetre, their alignment and their type.
- **Number of laid lines per centimetre:** although more accuracy is achieved through measuring the width of 20 laid lines, it is seldom possible to iden-
ify this number in one area; measurement of the number of laid lines in a smaller area would be unhelpful.
- **Direction:** horizontally or vertically aligned to the spine of the book, as above.
- **Thickness:** from fine to approximately 2mm wide, measured as above.
- **Clarity:** from distinct to fuzzy to indistinct, as above.
- **Character:** straight, 'sagging' or tending to curve at one end; at right angles to the chain lines, or out-of-square.
- **Type:** reed, grass or wire. In respect of their width and the regularity of spacing, a possible reconstruction of the papermaking mould can be proposed.

(viii) **Rib shadows**
The position of rib shadows (alternating or corresponding with chain lines) and their clarity are noted. Rib shadows — appearing as bands of greater density in a sheet of paper — are formed by the channelling of pulp in certain areas, defined by the ribs of the supporting frame of the mould. Their presence is of particular use for determining the way a piece of wove paper has been folded in the formation of a quire.

(ix) **Comments**
Any additional information about the paper which is not covered by the categories listed above; for example, greater degree of burningish on one side of the paper than the other; marked variation in the quality of paper used throughout a book; and marbling or decoration of the paper.

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1. See above, pp.7–8.
2. Brouzet 1886.
5. See above, pp.61 and 64.
6. Although relative to the experience and opinion of the examiner, this is an important consideration. The vast majority of papers are categorised as being of medium quality, however some are clearly of a higher or lower grade. It is important to be able to establish why a paper appears to be either refined or crude; it is not infrequently the case that the pulp used for what would appear to be a top-quality paper, is the least well preserved of all.
7. The extent to which papers have darkened over time is unknown, but if we consider the quality of raw materials used in the papermaking process, it is unlikely that papers have changed in tone to any great extent. Paper used for manuscript production is affected very little by heat or light, and is generally indicative of original colour.
8. A chemically inert, optically clear, polyester film.

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CHAPTER SIX

**Summary of Findings**

1. **Persian Paper**

   **Quality and thickness**

   Papers produced prior to the 15th century are typically sturdy. A marked density is produced from a high quantity and compactness of fibres within the web of the sheet. Papers vary in thickness, from 0.11–0.22mm, with no mean, and apparently no standardisation of weight or grade. Paper is not heavily sized, and consequently does not have a rigidity that one might associate with its robust character. The impression is one of a strong material, not dissimilar to blotting paper.

   From the 15th century onwards, paper becomes noticeably thinner, ranging from 0.04–0.15mm, with an average thickness of 0.09mm. Papers are heavily sized and, in respect of their crispness and distinct crinkle when handled, begin to take on characteristics that we might identify with brown paper.

   **Colour**

   From the 12th until the beginning of the 19th century, there is a gradual lightening in tone of most papers. At the beginning of the period, papers can range from dark cream to brown. However, from the 14th century onwards, the spectrum of colours begins to narrow, and by the 15th, papers are predominately cream, with little variation on this base colour. There is a marked shift in quality and intensity of tone at the beginning of the 19th century, with papers adopting a dull, greyish, off-white appearance. This shift in colour from cream to white is largely the result of a change in fibre stock, the quality and colour of which may have been affected by an increased use of bleaching.
agents within the textile industry. A noticeable dulling of the sheets is linked to the use of considerably more sizing within and on the surface of the paper.

**Surface characteristics**

Papers produced during the 13th century contain virtually no size within the web of the sheet, and there is little indication of starch on its surface. Between the 14th and the 15th centuries, very little sizing is applied to the newly formed sheet of paper; if the sized sheet is burnished at all, there is very little evidence of the use of the burnishing tool. To the touch, papers are textured and slightly rough.

From the 14th century onwards, sizing is applied in ever-increasing amounts, and a layer of starch is readily seen on the paper's surface. It is probable that a density of coating is achieved through brushing the size on to the sheet, rather than dipping the paper into a vat of solution. The sized sheet is burnished extensively, but it is rare that pressure applied to the burnishing tool creates indentations or grooves in the paper. The twin processes of sizing and burnishing give the sheet a distinct sheen, and the paper is almost sticky to the touch. By the beginning of the 16th century, paper is sized to such an extent that any glaze on its surface tends to crack and craze through flexing of the sheet.

**Quality of pulp**

The quality of pulp of the earliest dated examples of paper varies considerably. Although evidence of the use of a refined, well-macerated fibre solution is not unprecedented, the vast majority of papers are formed from fibre stock which has not been beaten extensively, and which contains clumps of raw material and an array of inclusions. The distribution of fibres within the sheet tends to be uneven and floccular. This quality of pulp characterises papers dating from the 13th century until the end of the 14th (figure 8).

From the 15th century onwards, improvement in the quality of pulp is marked. There is a greater uniformity of fibre distribution, and a reduction in the quantity of inclusions within the sheet. Whole individual fibres are visible with increasing regularity, both on the surface of the paper and in the web of the sheet, as seen through transmitted light. These fibres are distinct, and can measure up to 2 cm in length.

Papers from the 16th and 17th centuries are extremely fibrous — that is, the number of individual fibres that can be identified per square centimetre is higher than in previous centuries (figure 9). This is due to improved beating techniques, resulting in a reduction in the tendency of fibres to clump. A large number of papers dating to the 17th century contain fleck marks of very small par-

ticulate matter, giving the sheet a speckled appearance. This phenomenon is not seen in papers dating to any other century.

**Translucency**

The degree of paper translucency is dependent on three factors: the thickness of the sheet; the density of fibre distribution; and the quantity of sizing within the fibre structure. From the 14th century onwards, papers become more translucent, corresponding with a decrease in thickness of sheet, and an increase in surface sizing. Although early papers tend to be virtually opaque, some exhibit a high degree of translucency, due to an uneven distribution of fibres within their structure. It is important to note that a thinner paper can be more opaque than a thicker sheet if the quantity of sizing applied to the latter is greater.

**Mould construction**

Papers produced in Persia from the 14th century onwards are predominantly laid. Of the total number of dated examples examined, only 3% were made on a wove mould. Due to the highly dense and/or fibrous nature of many sheets, identification of mould markings is difficult, and it is easy to mistake a laid for a wove paper. But in the vast majority of cases, laid lines are identified on close examination of the sheet through transmitted light. Mould markings are often more pronounced in areas of degradation or discoloration.

From the 12th until the end of the 14th century, papermaking moulds were constructed of either reed or grass. Reed moulds typically contained between 5 and 7 lengths of reed per centimetre, measuring between 1–1.5 mm (occasionally 2mm) in width. Laid lines identified in the sheet of paper are straight, with very little curve. No chain lines or rib shadows are visible.

Papers formed on grass moulds from the 12th until the 15th century ordinarily contain 7 to 8 laid lines per centimetre, of up to 1 mm in width. Laid lines can waver, and there is often a noticeable curving of the line at its head or tail, corresponding to one edge of the sheet of paper (figure 10). From the 15th century onwards, the number of laid lines per centimetre increases to between 8 and 10, and there is a corresponding decrease in width of line of approximately 0.5 mm. Papers produced towards the end of the 18th century characteristically contain up to 16 laid lines per centimetre. These lines are distinct, fine and very straight, and point to the use of wire moulds for the manufacture of the sheets.

Persian paper is not generally associated with the inclusion of chain lines within the sheet. But although these supporting lines are not readily visible, their absence should not be assumed. From the 13th century until the end of
Figure 8  
Detail of a manuscript leaf, Persia, late 14th century AD, showing uneven distribution of fibres within the sheet; clumping of fibres; some inclusions.  
*Photo: Helen Loveday*

Figure 9  
Detail of a manuscript leaf, Persia, late 16th century. The well beaten pulp has resulted in a fibrous paper of even fibre distribution.  
*Photo: Helen Loveday*
the 17th, chain lines can be identified, although their appearance is sporadic, and whole lengths are rarely seen. When visible, chain lines are spaced at regular intervals of 15, 25 and 30 mm across the sheet (figure 11), or arranged in pairs. With regard to the latter, the distance between the chain lines is approximately 15 mm, and the interval between the pairs approximately 45 mm. A surprising 20% of papers examined contained an impression of one of the above arrangements. None of the papers examined contained rib shadows.

II. Syro-Egyptian Paper

Quality and thickness
Papers originating from Syria and Egypt are characterised by their sturdy and durable nature. As with Persian paper, density is produced from a high quantity and compactness of fibres within the web of the sheet. From the 12th until the 18th century, papers are consistently strong. Although there is some lessening of density from the 15th century onwards, papers never achieve the crispness associated with their Persian counterparts. There is a marked variation in thickness of sheet, with papers ranging from 0.04 mm – 0.30 mm over the 700 years covered by this survey. An average thickness of between 0.15 – 0.20 mm can be tentatively ascribed to all centuries.

Colour
The variation in colour of Syro-Egyptian paper mirrors that of Persian paper. From the 12th century until the end of the 18th, there is a gradual lightening in tone of most papers. At the beginning of the period, papers can range from dark cream to a brown hue. From the 14th century onwards, the spectrum of colours begins to narrow, and by the 15th, papers are predominately cream, with little variation on this base colour. There is no change in quality and intensity of tone of papers manufactured at the end of the 18th century and beyond.

Surface characteristics
Through the introduction of slightly more sizing at an early date, papers are initially smoother than those originating from Persia. However, from the 13th century onwards, there is no marked increase in quantity of sizing applied to the sheet, and papers retain a degree of softness as a result. Papers are burnished, but again to a lesser degree than Persian papers. The marks of the burnisher’s tool are virtually never seen, and papers are rarely glossy.

Quality of pulp
At the beginning of the 12th century, papers are generally formed from relatively poor fibre stock: fibres are not beaten extensively, and the pulp contains

Figure 10
Detail of a manuscript leaf, Persia, 16th century, showing the curving of laid lines away from the central axis at folio edge.
Photo: Helen Loveday
clumps of raw materials and an array of inclusions. As with Persian paper, the
distribution of fibres within the sheet tends to be uneven and floccular, and
paper has a distinct mottled and patchy appearance. By the middle of the cen-
tury, there is a noticeable improvement in the quality of pulp: though fibrous,
with whole individual fibres seen within the sheet and on its surface, it
becomes more uniform, and contains fewer inclusions. However, there
appears to have been little refinement of the process of maceration from the
end of 12th century onwards, and papers never achieve the uniformity of fibre
distribution characteristic of Persian paper from the 15th century onwards.

Translucency
From the 12th century until the end of the 18th, Syro-Egyptian paper
becomes increasingly translucent, but not to the same degree as Persian paper
form the 15th century onwards. This is due to the fact that papers are some-
what thicker, and not as heavily sized.

Mould construction
As with Persian paper, paper produced in Syria and Egypt from the 12th cen-
tury onwards is predominantly laid. There appears to be little tradition of the
manufacture of paper on wove moulds, with only 0.5% of the total number of
dated Syro-Egyptian manuscripts examined showing no laid-line markings.

In the 12th century, paper was formed on moulds constructed of either
reed or grass. The reed mould used by the Syrian and Egyptian papermakers
was identical to the reed mould of the Persian craftsmen. Papers therefore
generally contain 5 to 7 straight laid lines per centimetre, of between 1–
1.5 mm in width. There are no chain lines or rib shadows. From the beginning
of the 13th century onwards, grass moulds were used with greater frequency;
as a result, papers made on reed moulds from the 14th century onwards are
rarely found, if at all. This is in contrast to Persian papermaking, where the use
of reed moulds ran side by side with that of grass until the beginning of the
15th century.

With regard to the quantity and quality of laid lines visible in the sheet,
grass moulds used in Syria and Egypt from the 12th century onwards were
very similar to Persian moulds of the 15th and 16th centuries. Papers therefore
contain an average of 7 to 10 laid lines per centimetre, of between 0.5–1 mm
in width. Lines are distinct and fairly straight, although there is some curving
at the head or tail. From the 16th century onwards, there is a slight increase in the
number of laid lines per centimetre, with a highest number of 12. These lines
wave and sag considerably more than in previous centuries, and become
noticeably less distinct.
Figure 12
Detail of a manuscript leaf, Syria or Egypt, early 13th century AD, showing chain lines arranged in groups of three.
Photo: Helen Loveday

Figure 12a
Detail of Figure 12.
Photo: Helen Loveday
Syro-Egyptian paper is characterised by the inclusion and arrangement of chain lines within the sheet; examination of the manner in which chain lines are grouped largely corroborates Malachi Beit-Arié’s classification of papers. Until the 13th century, the pattern and distribution of chain lines is largely irregular and unclear. From then onwards, chain lines are arranged predominantly in groups of three (figures 12, 12a); groups of two and four – and alternating groups of two and three, or three and four – are noticeably less popular but not unknown (figure 13). The majority of chain lines grouped in threes occur in papers dating from the 14th and 15th centuries; between the individual chain lines are intervals of 10–15 mm, and between the groups are intervals of approximately 40–45 mm.

The grouping of chain lines in pairs is regarded as the oldest configuration, and is generally not found in papers manufactured after the beginning of the 13th century. However, pairs of chain lines have been identified in a manuscript which is dated AH 1047 (AD 1637–8). Chain lines grouped in fours are seen in the paper used in a Mamluk manuscript dated to AH 762–82 (AD 1360–80). Alternating groups of two and three appear to have been common only in the 14th century; the earliest manuscript in which this arrangement is found is dated AH 773 (AD 1371–2). Alternating groups of three and four have been identified in one manuscript dated AH 971 (AD 1563–4). Chain lines spaced at regular intervals are very unusual; papers in which this arrangement has been found were all dated to between the 13th and 15th centuries.

Rib shadows are seen in papers made on grass moulds dating from the 12th century onwards. They alternate with the chain-line groupings, and are approximately 15–20 mm wide (figure 14). From the 16th century, their inclusion is less frequent, and from the 18th century they appear sporadically. When present, they highlight the growing tendency for chain lines to curve away from their central axes, most noticeably at the edge of the sheet.

A Comparison of Persian and Syro-Egyptian Papers
The development of papermaking in Persia stands in marked contrast to the history of the craft in Syria and Egypt. Persian papermaking is divided into two distinct phases, the first spanning a period of seven centuries (AD 700–1400), and the second dating from the beginning of the 15th century until the beginning of the 19th. The technique of papermaking changes dramatically from one period to the next. However, the development of papermaking in Syria and Egypt is less easily discerned, and progress is gradual rather than dramatic. Until European papers flooded into the Islamic

Figure 13
Detail of a Qur’an leaf, Syria or Egypt, mid 14th century. AD; pairs of chain lines are visible in the margin.
Photo: Don Baker
world in the 19th century, and papermaking machinery was introduced into the papermaking industry, variation in papermaking practice was relatively slight. Any obvious changes were largely restricted to the construction of the mould, and to the distribution of chain and laid lines within it.

Differences in the techniques of paper manufacture across the Islamic world were not distinct until the 15th century. Although familiar to the earliest Islamic papermakers, wove moulds appear to have been used only infrequently from the 12th century onwards. Reed and grass moulds were used extensively, and in terms of laid-line quality and distribution, the construction of both was virtually identical from east to west. The degree of sizing and burnishing of a sheet of paper varied little across the regions. But from the 15th century onwards there was a growing divergence in papermaking practice, with paper made in Persia becoming noticeably thinner and crisper. This could only be achieved with the development of a finer, higher quality pulp, which in turn demanded a greater use of size to compensate for the decrease in paper weight.

Change is symptomatic of an increasing division between Arab and Persian cultures, with the separate development of the papermaking craft in Persia linked primarily to the conquest of the region by Timur (reg. AD 1370–1405). The Timurid Empire spread from the Mediterranean to the Aral Sea, but did not penetrate further south than Damascus, which was taken and sacked in AD 1401. Timur was the last and possibly the most ruthless of the Mongol invaders, bringing to an end 200 years of conquest that had unified the Eurasian world. Despite the damage caused to Persia, the invasions gave almost a century of peace, permitting the exchange of goods and ideas between the far east and the far west on an almost unprecedented scale. Persia and China were, for a time at least, linked culturally, if not politically. Although the Timurids conquered and destroyed with barbarity, their support of the arts was equally legendary. In building their capital at Samarqand, Timur and his successors forcibly resettled craftsmen from all over their Empire; one has only to consider the surviving architecture at Samarqand, and to view Timurid manuscript illustration and illumination, to understand the extraordinary flowering of artistic genius that was encouraged by this amalgamation. It is likely that papermakers also benefited from this exchange of ideas, and that new techniques and methods of manufacture were implemented. Meanwhile, under the powerful control of the Mamluks, Syria and Egypt were spared the devastation that had befallen lands further east, and Arab culture was preserved. But whilst traditions of law, mysticism and literature flourished, these regions were denied the artistic catalyst that resulted in the meeting of China and Central Asia.
With the exception of the change in papermaking practice in the 13th century, progress and development in the Persian craft are not easily discerned through the analysis of dated examples. Impressions in the web of the sheet left by the mould on which the paper was made are subtle, and although it is possible to distinguish reed from grass and from wire, characterisation of papers made on grass moulds is difficult through lack of distinct and regular chain-line patterns. To a large extent, refinement of pulp is indicative of date of manufacture, as is the treatment of the surface of the newly formed sheet of paper. There is noticeable variation in the colour of paper across the centuries, and at either end of the spectrum papers can be classified according to their brown or off-white hue. But most papers dating from the end of the 14th century until the beginning of the 19th are characteristically cream or dark cream in colour.

Syrian and Egyptian papers are distinguished largely by the character of the mould on which they were formed. Although refinement of fibre stock changes little from the 13th century onwards, the quality and construction of papermaking moulds can vary quite dramatically; it is therefore possible to classify papers according to the construction of the mould, and the distribution of laid and chain lines within the sheet. However, there appears to be greater fluidity in the arrangement of chain lines than at first thought, and papers from one century to the next do not necessarily contain different chain line groupings. From the 17th century onwards, there is a noticeable decline in the quality of mould construction: wayward chain lines, sagging and indistinct laid lines, and sporadic rib shadows in a sheet of paper, point to its manufacture in either the 17th or 18th century (figure 15).

On comparison of these selected facets of Islamic paper manufacture, one could surmise that classification of Persian paper is relative to quality of pulp and treatment of the surface of the paper; classification of Syro-Egyptian paper, on the other hand, is generally restricted to the construction of the mould on which the paper was formed. Thickness, colour, and translucency, although intimately related, tell us little about the date and origin of the material. But conclusions such as these are as misleading as they are helpful. If we consider paper manufactured under the Qajars in Persia from the beginning of the 19th century, we see a very thin, crisp paper, sized and burnished to such an extent that it is virtually translucent, and its colour is dulled to a greyish off-white; fibre distribution is uniform, and sheets contain anything up to 15 laid lines per centimetre. Mamluk paper dating from the mid 13th until the 16th century is typically cream; it is a dense and sturdy material, containing distinct chain line groupings, with approximately 8 to 10 laid lines per centimetre;
fibre distribution tends to be uneven, and the paper is generally not heavily sized and burnished. As these examples demonstrate, a typology of paper characteristics is founded upon a series of considerations, and the aim of analysis is the drawing together of these elements. The nature and properties of the fibres, the extent to which they were macerated and subsequently bonded together, the construction of the mould on which the paper was formed, and the manner in which the newly formed sheet was then treated, all determine the characteristics and properties of the resulting sheet. The sum of the parts is greater than the whole.

1. The data presented in this chapter is given in table form in the Appendix; see below, pp. 81–87.
2. Degree of uniformity is, nonetheless, still dependant on the amount of pulp remaining in the vat from which the papermaker is working. If he is using what are in effect the drags at the bottom of the vat, no matter how proficient the papermaker is, the resulting sheet will be considerably less uniform, and will contain more inclusions than the sheet formed from a fresh vat of pulp.
4. Laid lines in reed moulds are generally packed tightly together, and the space between the lines is considerably smaller than the width of the laid lines themselves. Laid lines in grass moulds are thinner and distributed at larger intervals. A set number of laid lines can occupy the same area as an equivalent number of reed lines due to this difference in spacing.
5. Some periods of papermaking have, nonetheless, given us papers of a typical colour: cream-coloured papers from Syria and Egypt are found in the Mamluk period, and many Ottoman Qur’ans of the 19th century are bisaciu coloured. See Baker 1989, p. 67.
6. It is interesting to note that from this time there is an apparent increase in the amount of Persian paper used by Arab scribes in Egypt, Syria and Palestine. Persian papermakers from the 14th century onwards led the way in producing a more uniform paper pulp, and it is possible that with the increased use of Persian paper in the more westerly regions of the Islamic world came a desire to emulate its characteristics in Syrian-Egyptian paper.
8. Khalili Library, Jerusalem, MS.84.469.
11. See Sotheby’s, London, 16 October 1996, lot no. 34.

The composing of books is more effective than building in recording the accomplishments of the passing ages and centuries. For there is no doubt that construction eventually perishes, and its traces disappear, while books handed from one generation to another, and from nation to nation, remain ever renewed... Were it not for the wisdom garnered in books most of the learning would have been lost.1

The introduction and development of papermaking throughout Persia, the Middle East and the Western Mediterranean, is one of the principal technological achievements of Islamic civilisation. In response to varied demands, the ancient craft spread at a phenomenal rate, affecting and reflecting the social, political and economic climates of the time. By the end of the 7th century AD, the book in codex form had been ornamented, treasured, and preserved by Christians and Jews for approximately three hundred years, and Islamic book production was a natural evolution of previous practices. With the introduction of paper, the codex was established as the primary form in which the written, and later the printed word, could be recorded. It was displayed as material evidence of culture and position, and became a vehicle by which the scattered ideas of thinkers could be disseminated across continents. The power of the book for transformation and propagation remains without equal.

The techniques by which the earliest papers were made are naturally vague after a lapse of approximately 2000 years. No records describing the production of the first Chinese papers are known, and our knowledge and understanding of the materials, tools and techniques of the Islamic papermaker, based on a handful of textual accounts, is limited. It is apparent, nonetheless, that the fundamental principles of papermaking by hand have changed little from its inception to the present day, and the basic character of the material has persisted with only slight modification. Paper remains a non-
uniform sheet of locally varying density, porosity and opacity, made from the interweaving of hydrated cellulose fibres under controlled conditions. Its properties include a good mechanical strength, combined with lightness and flexibility, porosity, and an absorbency for liquids such as writing and printing inks. It is naturally white and largely opaque, despite the apparent transparency of its fibres.

There are, nevertheless, appreciable differences in the techniques of maceration, sizing and burnishing, from east to west, and from one generation to the next: change in mould construction is often dramatic. Knowledge of the nature of such contrasts and comparisons is axiomatic to our understanding of the evolution and development of the ancient craft. Although no contemporary examples of the papermaker's mould are known to exist, variation and progression in construction can be traced through the examination of the impressions left in the sheet by its constituent materials. Knowledge of how paper stock was produced can be gleaned through the examination of individual fibres under magnification, or of the whole sheet through transmitted light. An understanding of how a paper's surface was treated is achieved through the physical and chemical examination of residual size and colour, and the identification of indentations left by the burnisher's tool.

Towards a Tentative Typology

On the examination of chain- and laid-line distribution in his own collection of papers from Indo-China, Bengal, and Europe, Dart Hunter concluded,

From this it will be seen that location or period has little bearing on the number of lines found in old papers, and that therefore there is no possible way of cataloguing or indexing these impressions in paper so that a particular time or place of origin may be determined. Ancient paper, both Oriental and Occidental, must be placed by its general characteristics, and not by any list of rules that can be given as infallible.4

There is a great danger of trying to reduce to order that which cannot be ordered. Any attempt to codify, categorise and apply rules to the history of Islamic papermaking is inevitably to discover the exception that disproves the rule. As there is variation in product from east to west, so papers made by the same craftsman on the same mould and with pulp from the same vat, can differ dramatically in respect of their quality and thickness, and all may be found in one manuscript. Variation in paper quality is not always connected with geography and time, but often reflects the papermaker's struggle to achieve his daily quota. The exception is indicative of a manufacturing process that was governed by human nature; the norm is evidence of evolving trends and increasing expertise in a highly skilled craft.

To describe all papers with consistency, precision, and according to objective standards is a practical impossibility; characteristics such as colour and thickness are susceptible of almost infinite gradation within the limits of the medium.1 However, a tentative typology of paper characteristics can be established through the systematic analysis of dated samples, and to some extent paper can be classified according to stated criteria. Information concerning the date and place of manufacture of uncategorised samples can be uncovered through the correlation of collected data. This information is essentially corroborative, and should be used to supplement existing evidence, rather than as a primary means of classification.

However, the study of Islamic paper is as perplexing and frustrating as it is fascinating, and the production of a tentative typology of paper characteristics is but a first step towards a greater understanding of the materials and techniques of the papermaker, and the development of Islamic bookbinding techniques.5 The spread of the craft reflects the complexities and intricacies of the history of a vast and multifaceted people. Growth and decline in the papermaking industry must be viewed as a sequence of responses to social, economic, and political circumstances, and to religious and intellectual stimuli.

Vital questions about the development of the craft remain unanswered. Although not dramatic, there are some characteristics of paper used in Anatolia that distinguish it from paper used in Persia, Syria and Egypt. Examination of Ottoman Qur'ans has revealed a preference for a bright cream and characteristically sturdy paper in manuscript production until approximately the 17th century. If there was no indigenous papermaking in Anatolia until the 18th century, where was this paper imported from? What are the characteristics of Chinese papers dating to the 15th century, and are Chinese papermaking practices reflected in the Persian craft at this time? Only if answers to questions such as these are found, can we further our understanding of the interdependence and independence of development of the craft across the Islamic world, and the spread of learning and technology from east to west.

4. Change rarely occurs in isolation and without implication, and progress in papermaking practices effected changes in book production. For example, the dramatic shift in the nature and quality of Persian papers dating from the 15th century resulted in a variation of sawing technique, due to increased thinness and crispness of the sheet. Sturdy sewing hemp, as used in the binding practices of earlier centuries, was replaced in Persia by thin silk, in order to reduce the potential for tearing and splitting of the paper along the spinal fold.
## APPENDIX

### Table of Results

<table>
<thead>
<tr>
<th>Persian Paper</th>
<th>Syro-Egyptian Paper</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Quality</strong></td>
<td>dense and sturdy, but without a marked stiffness</td>
</tr>
<tr>
<td><strong>Thickness</strong></td>
<td>varies from 0.11–0.22 mm; no average thickness</td>
</tr>
<tr>
<td><strong>Colour</strong></td>
<td>ranging from dark cream to brown</td>
</tr>
<tr>
<td><strong>Surface characteristics</strong></td>
<td>extremely lightly sized and burnished; tending to be rough</td>
</tr>
<tr>
<td><strong>Quality of Pulp</strong></td>
<td>uniform to floccular; fibrous; variable quantity of inclusions; occasional clumping of fibres</td>
</tr>
<tr>
<td><strong>Translucency</strong></td>
<td>medium to opaque</td>
</tr>
<tr>
<td><strong>Mould construction</strong></td>
<td>reed or grass</td>
</tr>
<tr>
<td><strong>Reed mordant</strong></td>
<td>laid, with no chain lines</td>
</tr>
<tr>
<td>- <strong>laid lines</strong></td>
<td>7–7/mm; 1–1.5 mm (occ. 2mm) thick; tending to be distinct; fairly straight; space between lines is less than width of one laid line</td>
</tr>
<tr>
<td>- <strong>chain lines</strong></td>
<td>(none)</td>
</tr>
<tr>
<td><strong>Grass mordant</strong></td>
<td>laid, with no chain lines</td>
</tr>
<tr>
<td>- <strong>laid lines</strong></td>
<td>7–8/mm; 2mm thick; tending to be indistinct; some curving, esp. at head or tail of line</td>
</tr>
<tr>
<td>- <strong>chain lines</strong></td>
<td>(none)</td>
</tr>
<tr>
<td><strong>Rib shadows</strong></td>
<td>none apparent</td>
</tr>
</tbody>
</table>

The information detailed on the following pages is intended as a guide to the characteristics of Persian, Syrian and Egyptian papers from the 6th – 12th centuries AH (12th – 18th centuries AD).

This typology of paper characteristics has been established through the systematic analysis of dated samples, and is indicative of trends in the craft of papermaking over seven centuries. Not all papers will fit this classification—many will be exceptions to the rule.

Therefore, when used as a means of classifying undated papers, the information in the table must be viewed as corroborative evidence, rather than as the primary means of identification.
<table>
<thead>
<tr>
<th><strong>7th Century AH (13th Century AD)</strong></th>
<th><strong>8th Century AH (14th Century AD)</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Persian Paper</strong></td>
<td><strong>Syro-Egyptian Paper</strong></td>
</tr>
<tr>
<td><strong>Quality</strong></td>
<td>dense and sturdy, but without a marked stiffness</td>
</tr>
<tr>
<td><strong>Thickness</strong></td>
<td>varies from 0.11–0.20 mm; no average thickness</td>
</tr>
<tr>
<td><strong>Colour</strong></td>
<td>ranging from dark cream to brown</td>
</tr>
<tr>
<td><strong>Surface characteristics</strong></td>
<td>lightly sized and burnished; tending to be rough</td>
</tr>
<tr>
<td><strong>Quality of pulp</strong></td>
<td>uniform to floccular; fibrous; some inclusions; whole individual fibres seen within the sheet</td>
</tr>
<tr>
<td><strong>Translucency</strong></td>
<td>medium to opaque</td>
</tr>
<tr>
<td><strong>Mould construction</strong></td>
<td>reed or grass</td>
</tr>
<tr>
<td><strong>Reed mould</strong></td>
<td>laid, with no chain lines</td>
</tr>
<tr>
<td><strong>– laid lines</strong></td>
<td>5–7/1 cm, 1–1.5 mm (occ. 2mm) thick; tending to be distinct; fairly straight; space between laid lines is generally less than the width of one laid line</td>
</tr>
<tr>
<td></td>
<td>(none)</td>
</tr>
<tr>
<td><strong>Grass mould</strong></td>
<td>laid, with chain lines visible sporadically</td>
</tr>
<tr>
<td><strong>– laid lines</strong></td>
<td>7–8/1 cm, 1 mm thick; tending to be indistinct; some curving, esp. at head or tail of line</td>
</tr>
<tr>
<td></td>
<td>(none)</td>
</tr>
<tr>
<td><strong>– chain lines</strong></td>
<td>sporadically visible as short single lengths, or very occasionally in pairs; no regular spacing</td>
</tr>
<tr>
<td><strong>Rib shadows</strong></td>
<td>none apparent</td>
</tr>
<tr>
<td><strong>Quality</strong></td>
<td>dense and sturdy, but without a marked stiffness</td>
</tr>
<tr>
<td><strong>Thickness</strong></td>
<td>varies from 0.11–0.26 mm; no average thickness</td>
</tr>
<tr>
<td><strong>Colour</strong></td>
<td>ranging from cream to light brown or biscuit</td>
</tr>
<tr>
<td><strong>Surface characteristics</strong></td>
<td>lightly sized and burnished; tending to be rough rather than smooth</td>
</tr>
<tr>
<td><strong>Quality of pulp</strong></td>
<td>uniform to floccular; fibrous; variable quantity of inclusions; occasional clumping of fibres</td>
</tr>
<tr>
<td><strong>Translucency</strong></td>
<td>medium to opaque</td>
</tr>
<tr>
<td><strong>Mould construction</strong></td>
<td>reed or grass</td>
</tr>
<tr>
<td><strong>Reed mould</strong></td>
<td>laid, with no chain lines</td>
</tr>
<tr>
<td><strong>– laid lines</strong></td>
<td>5–7/1 cm, 1–1.5 mm (occ. 2mm) thick; tending to be distinct; fairly straight; space between laid lines is generally less than the width of one laid line</td>
</tr>
<tr>
<td></td>
<td>(none)</td>
</tr>
<tr>
<td><strong>Grass mould</strong></td>
<td>laid, with chain lines visible sporadically</td>
</tr>
<tr>
<td><strong>– laid lines</strong></td>
<td>7–8/1 cm, 1 mm thick; tending to be indistinct; some curving, esp. at head or tail of line</td>
</tr>
<tr>
<td></td>
<td>(none)</td>
</tr>
<tr>
<td><strong>– chain lines</strong></td>
<td>arranged in groups of 3; occasionally spaced at regular intervals; 0.5–1 mm thick; indistinct</td>
</tr>
<tr>
<td><strong>Rib shadows</strong></td>
<td>none apparent</td>
</tr>
<tr>
<td></td>
<td>laid, generally with chain lines</td>
</tr>
<tr>
<td><strong>– laid lines</strong></td>
<td>8–10/1 cm, 0.5–1 mm thick; increasingly distinct; generally straight, but with some curving at head or tail of line</td>
</tr>
<tr>
<td></td>
<td>arranged in groups of 4, 5, or in alternating groups of 2 and 3; 0.3–1 mm thick; finest, but distinct</td>
</tr>
<tr>
<td><strong>– chain lines</strong></td>
<td>arranged in groups of 3; occasionally spaced at regular intervals; after 1300 papers can include chain lines arranged in groups of 4, or in alternating groups of 2 and 3; 0.3–1 mm thick; finest, but distinct</td>
</tr>
<tr>
<td><strong>Rib shadows</strong></td>
<td>generally present; app. 15–20 mm wide; shadows alternate with individual chain lines or chain-line groupings</td>
</tr>
<tr>
<td>Persian Paper</td>
<td>Syro-Egyptian Paper</td>
</tr>
<tr>
<td>---------------</td>
<td>---------------------</td>
</tr>
<tr>
<td><strong>Quality</strong></td>
<td>noticeably crisper than earlier papers</td>
</tr>
<tr>
<td><strong>Thickness</strong></td>
<td>varies from 0.04–0.15 mm; average 0.09–0.12 mm</td>
</tr>
<tr>
<td><strong>Colour</strong></td>
<td>ranging from cream to dark cream</td>
</tr>
<tr>
<td><strong>Surface characteristics</strong></td>
<td>sized; burnished; smooth; increasingly glossy</td>
</tr>
<tr>
<td><strong>Quality of pulp</strong></td>
<td>before 1450: uniform to floccular; fibrous; some inclusions; clumping of fibres; whole fibres seen within the sheet; later: increasingly uniform; fibrous; occasional inclusions and clumping of fibres; whole fibres seen within the sheet</td>
</tr>
<tr>
<td><strong>Translucency</strong></td>
<td>medium to translucent</td>
</tr>
<tr>
<td><strong>Mould construction</strong></td>
<td>grass (not used)</td>
</tr>
<tr>
<td><strong>Reed mould</strong></td>
<td>(not used)</td>
</tr>
<tr>
<td><strong>Grass mould</strong></td>
<td>laid; chain lines visible only sporadically</td>
</tr>
<tr>
<td><strong>- laid lines</strong></td>
<td>8–12/cm; 0.5–1 mm thick; tending to be distinct; some curving esp. at head or tail of line</td>
</tr>
<tr>
<td><strong>- chain lines</strong></td>
<td>sporadic; visible as short single lengths, very occ. in pairs; no regular spacing</td>
</tr>
<tr>
<td><strong>Rib shadows</strong></td>
<td>none apparent</td>
</tr>
<tr>
<td><strong>- laid lines</strong></td>
<td>predominantly arranged in groups of 3; very occasionally spaced at regular intervals; 0.5–1 mm thick; faint, but distinct</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Persian Paper</th>
<th>Syro-Egyptian Paper</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Quality</strong></td>
<td>crisp; not dissimilar to the feel of fine brown paper</td>
</tr>
<tr>
<td><strong>Thickness</strong></td>
<td>varies from 0.07–0.14 mm; average 0.09 mm</td>
</tr>
<tr>
<td><strong>Colour</strong></td>
<td>ranging from cream to dark cream</td>
</tr>
<tr>
<td><strong>Surface characteristics</strong></td>
<td>sized; burnished; smooth to very smooth; generally glossy; individual fibres increasingly visible on surface</td>
</tr>
<tr>
<td><strong>Quality of pulp</strong></td>
<td>largely uniform; increasingly fibrous; few inclusions; clumping of fibres; whole fibres occasionally seen within the sheet</td>
</tr>
<tr>
<td><strong>Translucency</strong></td>
<td>medium to translucent</td>
</tr>
<tr>
<td><strong>Mould construction</strong></td>
<td>grass (not used)</td>
</tr>
<tr>
<td><strong>Reed mould</strong></td>
<td>(not used)</td>
</tr>
<tr>
<td><strong>Grass mould</strong></td>
<td>laid, with chain lines visible only sporadically</td>
</tr>
<tr>
<td><strong>- laid lines</strong></td>
<td>8–12/cm; 0.5–1 mm thick; tending to be distinct; some sagging and curving esp. at head or tail of line</td>
</tr>
<tr>
<td><strong>- chain lines</strong></td>
<td>visible sporadically as short single lengths, or very occasionally in pairs; no regular spacing</td>
</tr>
<tr>
<td><strong>Rib shadows</strong></td>
<td>none apparent</td>
</tr>
<tr>
<td><strong>- laid lines</strong></td>
<td>predominantly arranged in groups of 3; 0.5–1 mm thick; generally faint and indistinct</td>
</tr>
<tr>
<td><strong>- chain lines</strong></td>
<td>only occasionally present; app. 3–10 mm wide; shadows alternate with chain-line groupings</td>
</tr>
</tbody>
</table>
11TH CENTURY AH (17TH CENTURY AD)

**Persian Paper**

<table>
<thead>
<tr>
<th>Quality</th>
<th>crisp; similar to the feel of fine brown paper</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thickness</td>
<td>varies from 0.06-0.115mm; average: 0.08mm</td>
</tr>
<tr>
<td>Colour</td>
<td>ranging from cream to dark cream</td>
</tr>
<tr>
<td>Surface characteristics</td>
<td>sized; burnished; smooth to very smooth; generally glossy; individual fibres visible on the surface</td>
</tr>
<tr>
<td>Quality of pulp</td>
<td>largely uniform; fibrous; noticeably speckled; few inclusions; very little clumping of fibres; whole individual fibres seen within the sheet</td>
</tr>
<tr>
<td>Translucency</td>
<td>medium to translucent</td>
</tr>
<tr>
<td>Mould construction</td>
<td>grass</td>
</tr>
<tr>
<td>Reed mould</td>
<td>(not used)</td>
</tr>
<tr>
<td>Grass mould</td>
<td>laid; chain lines appearing with greater regularity</td>
</tr>
<tr>
<td>– laid lines</td>
<td>before 1610: 8-10/cm; 0.5-1.1mm thick; tending to be distinct; some sagging and curving esp. at head or tail of line; later: 8-12/cm; from fine to 1mm in thickness; faint but distinct; tending to curve and slig</td>
</tr>
<tr>
<td>– chain lines</td>
<td>regularly spaced when visible; absent from many papers</td>
</tr>
<tr>
<td>Rib shadows</td>
<td>none apparent</td>
</tr>
</tbody>
</table>

**Syro-Egyptian Paper**

<table>
<thead>
<tr>
<th>Quality</th>
<th>firm and fairly crisp</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thickness</td>
<td>extraordinarily variable; from 0.06-0.115mm; no average thickness</td>
</tr>
<tr>
<td>Colour</td>
<td>ranging from cream to dark cream</td>
</tr>
<tr>
<td>Surface characteristics</td>
<td>sized; lightly burnished; smooth to very smooth</td>
</tr>
<tr>
<td>Quality of pulp</td>
<td>uniform to floccular; fibrous; few inclusions; individual fibres occasionally seen within the sheet</td>
</tr>
<tr>
<td>Translucency</td>
<td>medium to translucent; later: increasingly translucent</td>
</tr>
<tr>
<td>Mould construction</td>
<td>grass</td>
</tr>
<tr>
<td>Reed mould</td>
<td>(not used)</td>
</tr>
<tr>
<td>Grass mould</td>
<td>laid, with no chain lines</td>
</tr>
<tr>
<td>– laid lines</td>
<td>8-12/cm; fine to 1mm in thickness; tending to be indistinct; some sagging and curving esp. at head or tail of line; later: 12-16/cm; very fine; distinct; fairly straight</td>
</tr>
<tr>
<td>– chain lines</td>
<td>(none)</td>
</tr>
<tr>
<td>Rib shadows</td>
<td>none apparent</td>
</tr>
</tbody>
</table>

12TH CENTURY AD (18TH CENTURY AD)

**Persian Paper**

<table>
<thead>
<tr>
<th>Quality</th>
<th>crisp; similar to the feel of fine brown paper</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thickness</td>
<td>extraordinarily variable; from 0.04-0.25mm; no average thickness</td>
</tr>
<tr>
<td>Colour</td>
<td>ranging from cream to dark cream</td>
</tr>
<tr>
<td>Surface characteristics</td>
<td>sized; burnished; smooth to very smooth; generally glossy; whole individual fibres occasionally seen within the sheet</td>
</tr>
<tr>
<td>Quality of pulp</td>
<td>uniform to floccular; fibrous; few inclusions; whole individual fibres occasionally seen within the sheet</td>
</tr>
<tr>
<td>Translucency</td>
<td>medium to translucent</td>
</tr>
<tr>
<td>Mould construction</td>
<td>grass</td>
</tr>
<tr>
<td>Reed mould</td>
<td>(not used)</td>
</tr>
<tr>
<td>Grass mould</td>
<td>laid, with no chain lines; mould markings not easily classified</td>
</tr>
<tr>
<td>– laid lines</td>
<td>generally in groups of 3; single lines appear sporadically; 0.5-1mm thick; faint and indistinct; tending away from central axis; not at 90° to laid lines, or parallel to rib shadows</td>
</tr>
<tr>
<td>– chain lines</td>
<td>none apparent</td>
</tr>
<tr>
<td>Rib shadows</td>
<td>appear randomly; app. 15-20/mm wide; shadows alternate with chain lines or chain-line groupings at 90° to laid lines</td>
</tr>
</tbody>
</table>
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