

حَمْدُ اللَّهِ عَالِيَهُمْ

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حَامِدُ اللَّهِ وَمُصَلِّيهِ

مُحَمَّدٍ وَآلِهِ وَصَحْبِهِ وَمُسْلِمًا

سُبْحَانَكَ اللَّهُمَّ

Revolution by the Ream

A History of Paper

2ND CENTURY BC

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Central China

Samarkand

Baghdad

Damascus

Cairo

Kairouan

Fez

Játiva

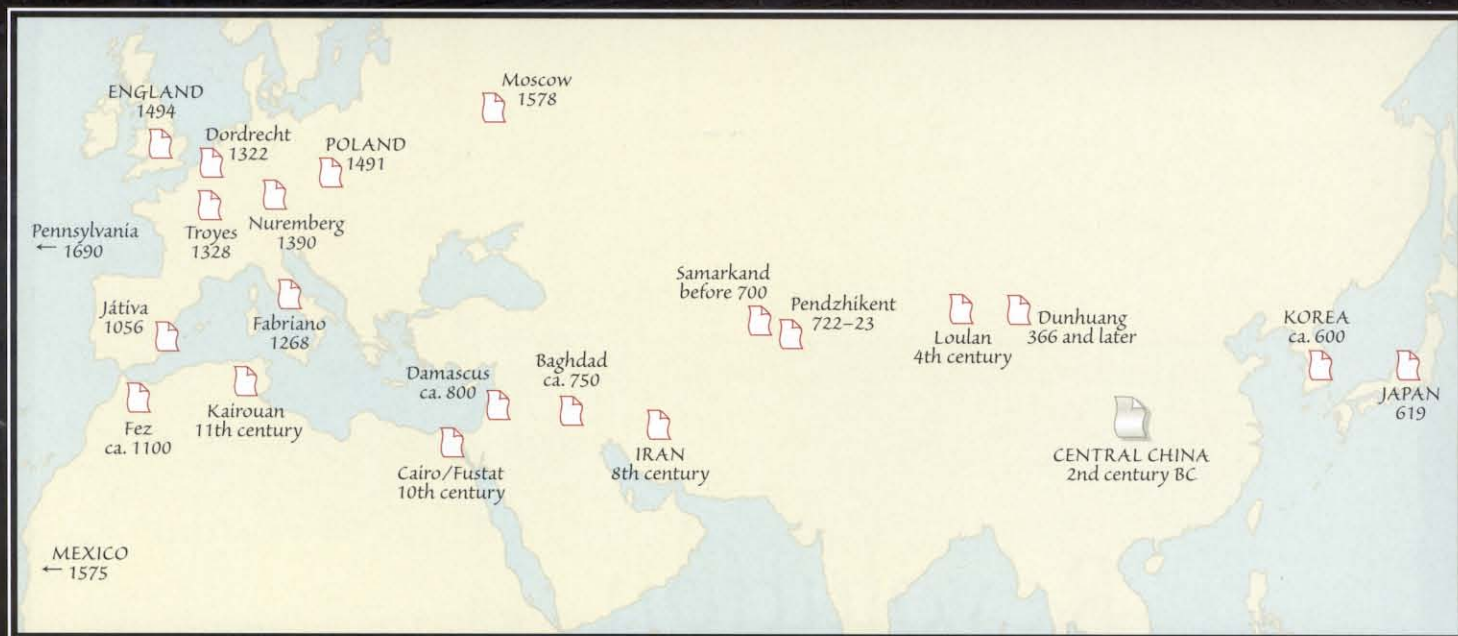
Fabriano

Nuremberg

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14TH CENTURY

WRITTEN BY JONATHAN M. BLOOM



The Paper Trail

Mercantile and missionary traffic carried knowledge of paper and its manufacture eastward and westward from its Chinese origins in a journey that took more than a millennium. From Central Asia, Muslim merchants spread it to the Middle East and North Africa, from where it crossed the Mediterranean in the 11th century.

Paper, one of the most ubiquitous materials in modern life, was invented in China more than 2000 years ago. Nearly a millennium passed, however, before Europeans first used it, and they only began to manufacture it in the 11th and 12th centuries, after Muslims had established the first paper mills in Spain. The German Ulman Stromer, who had seen paper mills in Italy, built the first one north of the Alps at Nuremberg in the late 14th century.

The cultural revolution begun by Johann Gutenberg's printing press in 15th-century Mainz could not have taken place without paper mills like Stromer's, for even the earliest printing presses produced books at many times the speed of hand copyists, and had to be fed with reams and reams of paper. Our demand for paper has never been satisfied since, for we constantly develop new uses for

this versatile material and new sources for the fiber from which it is made. Even today, despite the computer's promise to provide us with "paperless offices," we all use more paper than ever before, not only for communication, but also for wrapping, filtering, construction and hundreds of other purposes.

How did paper get from China to Europe? Soon after its invention, Chinese merchants and missionaries transmitted paper, and knowledge of papermaking, to neighboring lands such as Japan, Korea, and Central Asia. It was there that Muslims first encountered it in the eighth century. Islamic civilization spread knowledge of paper and papermaking to Iraq, Syria, Egypt, North Africa and, finally, Spain. This pivotal role is evident in the way we still count paper in units—today they are units of 500 sheets—called reams. That word came into English via the Old French

rayme from Spanish *resma*, which in turn comes from the Arabic *rizmah*, meaning a bale or bundle.

Most accounts of the history of paper focus either on its origins in China or its development in Europe, and simply ignore the centuries when knowledge of paper and papermaking spread throughout the Islamic lands. Some of this neglect is due to the difficulty of studying Islamic paper, since Islamic papers, unlike later European papers, do not have watermarks (see sidebar, p. 30) and are consequently very difficult to localize and date. Nevertheless, the diffusion of paper and papermaking skill in the Islamic world in the period between the eighth and the 14th centuries wrought enormous changes in such diverse realms as literature, mathematics, commerce and the arts, just as printing with moveable type spurred a conceptual revolution whose effects are still being felt today.

Europeans long debated the origins of paper. Until relatively recently, most people thought that paper derived from papyrus (see sidebar, p. 32) or that Europeans or Arabs had invented it. Indeed, the word *paper*, attested in English since the 14th century, does derive, via Old French and Spanish, from the Latin word *papyrus*.

Previous spread: By the 14th century, Baghdad's papermakers had developed techniques for manufacturing large, polished sheets. This made possible the production of copies of the Qur'an of unprecedented size, such as the magnificent 30-volume manuscript from which this 500-by-350-millimeter (20"x14") page was taken. The texts at top and bottom refer respectively to the chapters included in the volume and the year of the work's completion, 1307. The center inscription is the calligrapher's colophon: "Ahmad ibn al-Suhrawardi al-Bakri, who thanks God and sends prayers and greetings to the Prophet Muhammad, his family and companions."

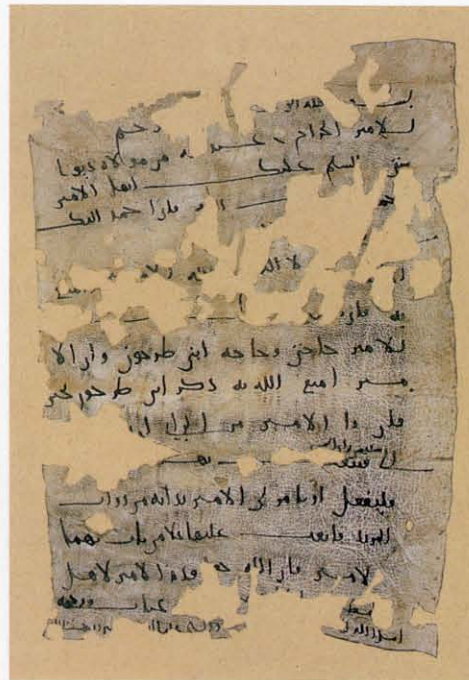
Medieval Muslims, on the other hand, knew that paper came from China. As early as the 11th century, the Arab historian 'Abd al-Malik al-Tha'alibi, enumerating the specialties of different lands in his *Book of Curious and Entertaining Information*, says that "paper is among the specialties of Samarkand, and it looks better and is more supple, more easily handled, and more convenient for writing than papyrus and parchment," the two major writing materials known in antiquity. According to al-Tha'alibi, Chinese prisoners captured by the Arab commander Ziyad ibn Salih introduced papermaking to Samarkand after the battle of Talas in 751. (See *Aramco World*, September/October 1982.) "Then paper was manufactured on a wide scale and passed into general use, until it became an important export commodity for the people of Samarkand," al-Tha'alibi wrote. "Its value was universally recognized and people everywhere used it."

Whether or not one takes al-Tha'alibi's account at face value, paper was undoubtedly introduced to the Middle East through Central Asia. Specimens of very old paper have been discovered at various sites in eastern Central Asia, where the extreme dryness of the climate helped preserve them. In 1900, a Chinese Buddhist monk accidentally discovered more than 30,000 paper scrolls in a cave at Dunhuang, in China's Gansu province. As the cave was first used in 366 and was sealed in the 10th century, the papers—comprising Buddhist, Taoist and Confucian texts, government documents, business contracts, calendars, and miscellaneous exercises written in Chinese, Sanskrit, Soghdian, Iranian, Uighur and Tibetan—must date from this six-century period. In 1907, the British explorer Sir Aurel Stein discovered a group of Soghdian paper documents in a ruined watchtower between Dunhuang and Loulan, farther west. They comprised five almost complete letters and several fragments. The letters, dating from between the fourth and sixth centuries, were found in a refuse heap, and probably represent the contents of a lost or abandoned mailbag. One of the letters was wrapped in silk and enclosed in a coarse cloth envelope addressed to Samarkand, which lay about 2000 miles farther west. The find shows that paper was used by Silk Road merchants throughout the oasis cities of Central Asia even before the coming of Islam.

In 1933, Soviet scholars found several paper documents among 76 Soghdian, Arabic and Chinese texts discovered at Mount Mug, the mountain stronghold, near Pendzhikent in Tajikistan, where Devastich,

lord of Panch, had attempted to escape from the Arab invaders in 722–723, some three decades before the battle of Talas ①. Pendzhikent, just east of Samarkand, is only 500 kilometers (300 mi) from Talas.

This Central Asian diffusion route is confirmed by the first Arabic word for paper, *kaghad*, and by the Turkish word, *kâğıt*, used to this day. Both derive from Soghdian and Uighur words, which themselves derive from the Chinese word *gu-zhi*, "paper made from paper-mulberry bark." *Qirtas*, another early Arabic word for paper, was borrowed from the Greek *chartes* and initially referred to papyrus,



① Early eighth-century Arabic paper documents found in 1933 by Soviet scholars at Mount Mug, in present-day Tajikistan, helped trace the route and the timing of paper's westward diffusion from China.

papyrus rolls and parchment. *Qirtas* appears in this sense in the Qur'an (Sura 6, "Cattle," verses 7 and 91) with reference to writings on separate sheets. Perhaps the most common Arabic word for paper—and the one in use today—came to be *waraq*, literally meaning "foliage" or "leaves," probably as a short form of the expression *waraq qirtas*, "a leaf of paper." Other words derived from *waraq* are *waraqa* ("a sheet of paper"), *warraq* ("stationer," "papermaker," "paper merchant" and, by extension, "copyist") and *wirraqa* ("papermaking"), as well as many compound expressions referring to paper money, lottery tickets, commercial papers, banknotes and such.

By the reign of the Abbasid caliph Harun al-Rashid (786–809), enough paper

was available in Baghdad for bureaucrats to use it for record-keeping instead of papyrus and parchment. According to the great 14th-century North African historian and philosopher Ibn Khaldun, the vizier al-Fadl ibn Yahya introduced the manufacture of paper to Baghdad when parchment was in short supply and he needed more writing materials. The vizier, whose family came from Balkh, now in northern Afghanistan, was probably familiar with paper from his youth. "Thus," Ibn Khaldun writes, "paper came to be used for government documents and diplomas. Afterward, people used paper in sheets for government and scholarly writings, and the manufacture [of paper] reached a considerable degree of excellence." Ibn Khaldun did not mention one of the greatest advantages of paper: Since it absorbed ink, writing could not easily be erased from it, as it could from papyrus and parchment. Documents written on paper were therefore more secure from forgery.

Papermaking and stationery were soon significant businesses in Baghdad. Ahmad ibn Abi Tahir (819–893), the teacher, writer, and paper dealer, was established at the Suq al-Warraquin (the Stationers' Market), a street which was lined with more than 100 paper- and booksellers' shops. Stationers in Abbasid Baghdad must have functioned somewhat like private research libraries, for the ninth-century polymath al-Jahiz is said to have rented stationers' shops by the day in order to read the books they kept in stock. Another famous stationer was Abu'l-Faraj Muhammad ibn Ishaq (d. 995), known also as Ibn Abi Ya'qub al-Nadim al-Warraq ("the Stationer"). He used his extensive professional knowledge to compile the *Fihrist*, an encyclopaedia which remains a mine of information about medieval books and writing.

The new availability of paper in the ninth century spurred an extraordinary burst of literary creativity in virtually all subjects, from theology to the natural sciences and belles-lettres. Religious scholars collected and codified the traditions (*hadith*) of the Prophet, which had been preserved orally following his death in 632, and committed them to ink and paper. New types of literature, such as cookbooks and the tales we know as *The Thousand and One Nights*, were copied on paper for sale to interested readers. Although earlier caliphs had maintained libraries, it was Harun's son and successor al-Ma'mun (813–833) who enlarged the caliphal library, which came to be known as the *bayt al-hikmah*, or "house of knowledge." (See *Aramco World*,



In this modern depiction of an early Chinese paper mill, strips of mulberry bark are scraped (left) and then chopped (background right). The pieces are then pounded into pulp with a counter-weighted step-hammer (background center) and the pulp is stirred into a water-filled vat. The single-screen moulds were hand-dipped, and the resulting sheets were dried under pressure (foreground). Below: A Chinese paper mould dating to the first century.

Paper in One Paragraph

Paper owes its distinctive strength and flexibility to the way the cellulose fibers it is made of are chemically and physically bound together in the papermaking process. In traditional papermaking, the cellulose fibers are extracted from plants, or from rags made from plant fibers, and then beaten in water to make the fibers swell and bond together into a pulp. This pulp is suspended in water, and a mat of it is then collected on a screen and drained. As the mat dries, the fibers physically intertwine and the microfibrils form physical and chemical links with each other. Paper sheets were at first formed with a floating screen, a primitive type of mould made from a woven cloth stretched on a frame onto which the pulp was poured. The pulp remained on the screen until the sheet was dry. The two-piece mould, in which the screen could be separated from the frame and which was lowered vertically into the vat containing the macerated fibers and then raised horizontally, marked a major advance in papermaking. It allowed the just-formed sheet of paper to be removed from the mould while still moist. Other sheets could then be formed in the mould while the first sheet dried. Moulds were traditionally made of smooth bamboo or flax fibers (or, in Europe, of thin brass wire) held parallel by cross-ties of silk, flax, hair or wire. Whatever the materials, paper made with this type of screen generally displays a distinctive pattern of faint parallel lines called "laid lines," and European papermakers quickly discovered that they could weave designs into the screen which would leave faint "watermarks" in the finished paper.



May/June 1982, March/April 1987.) Scholars and copyists translated Greek texts, written on parchment and papyrus, into Arabic, transcribing them onto sheets of paper which were then bound into books.

The new availability of paper also encouraged new approaches to old subjects. At the same time that paper was being disseminated across the Islamic lands, the Hindu system of reckoning with decimal place-value numerals—what we call “Arabic numerals”—was spreading westward from India. Before the Hindu system was introduced, people in the Islamic lands, as elsewhere, did their calculations mentally and recorded intermediate results either on a dust-board—which could be repeatedly erased as they performed successive additions or subtractions—or by the position of their fingers (“finger-reckoning”). The first manual of Hindu reckoning in Arabic was written by Muhammad ibn Musa al-Khwarizmi (ca. 825), whose name has given us our word *algorithm*, meaning the sequence of steps followed to solve a type of problem. According to al-Khwarizmi’s treatise, the fundamental arithmetic operations are performed by placing the numbers one above the other; the process begins on the left. Numbers are erased and shifted, clearly implying that the operations were still meant to be performed on a dust-board. A century later, however, the mathematician Abu al-Hasan Ahmad ibn Ibrahim al-Uqlidisi (“the Euclidian”) altered the Indian scheme of calculation in his mathematical treatise, composed at Damascus in 952–953, to suit the use of ink and paper. Although al-Uqlidisi’s scheme allowed neither shifting nor erasure of numbers—not possible on paper—it did permit far greater flexibility in calculation.

A Greek manuscript now in the Vatican library is believed to be the oldest surviving manuscript written on Arab paper. Consisting of a miscellaneous assemblage of the teachings of Christian church fathers, the manuscript was probably copied at Damascus in about 800, and shows that the use of paper was not limited to the Muslim bureaucracy in Baghdad. It was used also by Christians living under Muslim rule in Syria, a community instrumental in the great translation projects of the time.

Another early paper fragment shows that paper encouraged the copying and transmission of new types of literature. Discovered in Egypt, and now in the collection of the Oriental Institute in Chicago, it is a damaged, folded sheet ② of light brown paper made from linen fibers. It contains the title and the beginning of the text of the earliest known copy of *The Thousand and One Nights*, as well as several other



Al-Uqlidisi’s new
calculation techniques,
published around 950,
clearly assume the use
of paper and ink
instead of the familiar
dust-board.

② In 879, one Ahmad ibn Mahfuz, the owner of what is today the earliest known fragment of *Alf Laylah wa Laylah* (*The Thousand and One Nights*), used the scrap to practice writing legal formulas—and his own name. The book’s title page is to the left of the fold.

The oldest surviving dated book copied in Arabic script on paper is generally believed to be a fragment of Abu ‘Ubayd al-Qasim ibn Sallam’s work on unusual terms in the traditions of the Prophet ③. Preserved in the Leiden University Library, and dated to November or December of 866, the manuscript is on dark brown, opaque, stiff paper; it is strong, of medium thickness, and has clearly undergone some polishing on both sides. Thus, we know that paper was used in the Islamic lands for Christian, secular, and theological manuscripts at least from the ninth century.

There seems, however, to have been some resistance to using this new material for transcribing the Qur’an, the most important and popular book in the Islamic lands, which was normally copied on leaves of parchment. Parchment is made from the wetted,

phrases, texts and a drawing. The arrangement of the writing indicates that the original sheet once formed the first two pages of a manuscript. It had become waste paper by late 879, when a certain Ahmad ibn Mahfuz practiced writing out legal formulas in the margins of all four pages. Because writers in Egypt continued to use papyrus throughout the ninth century, the great Arabic scholar Nabia Abbott ascribed the fragment to Syria and the first quarter of the ninth century, about the same time and place as the Vatican manuscript.



This Italian rendering of a stand of papyrus reeds at Siracusa is painted on a sheet of papyrus. Though the plant grew all around the Mediterranean, papyrus-making was largely restricted to Egypt because, away from the Nile, the plant rarely grew stems thick enough for the purpose.

Papyrus in Two

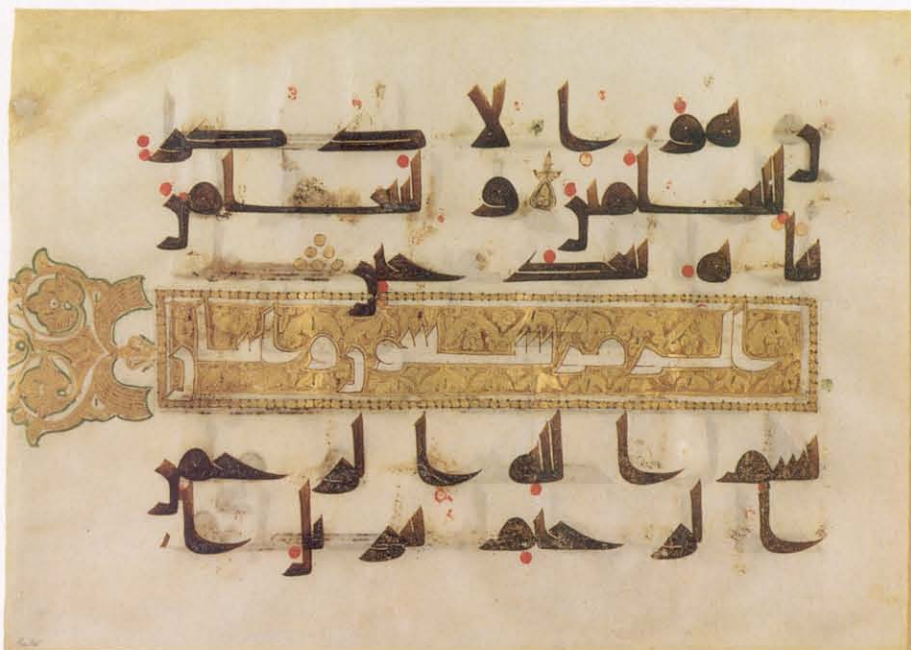
The papyrus plant (*Cyperus papyrus*; its name is the ultimate source of our word *paper*) is a member of the sedge family which once grew throughout the uncultivated marshes of the Nile. In Egypt, the plant could grow to a height of five meters (16') and its stems reach a thickness of five centimeters (2"), but under less ideal conditions the plant yields only modest stems, so that the manufacture of papyrus was essentially an Egyptian industry. By the 19th century increased cultivation had destroyed the reed's native habitat, and it had died out in the Nile Valley, although it still flourished in the Sudan. The papyrus strain currently grown in Egypt was introduced in 1872 from the Jardin des Plantes in Paris.

The first-century Roman writer Pliny the Elder described the manufacture of papyrus sheets in his *Natural History*, although his description is difficult to follow and has given rise to varied interpretations. Surviving papyri, however, give some indication of how sheets of writing material were prepared from the plant. (See *Aramco World*, July/August 1973.)

The papyrus stems were cut into manageable lengths and the outer layer removed from the pith. The pith was then sliced or peeled into very thin strips, normally one to three centimeters wide ($\frac{3}{8}$ "– $1\frac{1}{4}$ "). The resulting strips could be used immediately or dried and stored, in which case the strips were soaked until the fibers loosened. In either case, the strips were then laid parallel, one by one, on a smooth surface, just touching or slightly overlapping each other. Another similar layer, with its strips running at right angles to the first, was laid on top. Pressing or hammering brought the strips together, and the fibers of the two layers intertwined. The whole thus dried into a strong and flexible sheet. Papyrus sheets were pasted end to end with flour paste to form a roll, normally about 20 sheets long. The plant juices remaining in the sheet functioned as a natural sizing, barely allowing carbon ink to penetrate the surface, and erasures could thus be made by wiping or washing away the wet ink, or by using a stone eraser to abrade the dried surface.



③ The oldest surviving dated book written in Arabic on paper is this partial copy of the grammatical work *Kitab Gharib al-Hadith* (The Book of Linguistic Difficulties in the Traditions of the Prophet), completed in late 866.



④ The sanctity of the holy book and the respect accorded its earthly copies meant that the Qur'an continued to be transcribed on expensive parchment, often in the traditional bold Kufic script, well after paper became widely available.

stretched and scraped skins of sheep and goats; it is strong and durable, but expensive to make, for, in addition to the labor of preparing it, the animal must be killed to get its skin ⑤. Eventually paper triumphed as a writing material and, at the same time, the majestic Kufic scripts developed for writing on parchment ④ gave way to angular "new style" and then more flowing, or cursive, styles of writing. In addition, the typical book format changed from horizontal to vertical. The oldest surviving dated Qur'an manuscript on paper was copied by the calligrapher 'Ali ibn Sadan al-Razi in 971–972. The remains of this four-volume, vertical-format manuscript are divided among Ardabil in Iran, the Istanbul University Library, and the Chester Beatty Library in Dublin ⑥. Another paper manuscript of the Qur'an, copied at Isfahan in 993, retains the large horizontal format of parchment manuscripts.

Perhaps the most famous early paper manuscript of the Qur'an is that copied in 1000–1001 by 'Ali ibn Hilal, known as Ibn al-Bawwab, who was then the leading calligrapher of Baghdad. It is a small volume containing 286 folios, each page bearing 15 lines of a rounded *nakshi* hand, the type of script that made Ibn al-Bawwab so famous. The absence of a dedication, combined with the small size and single-volume format, suggest that Ibn al-Bawwab copied this manuscript not as a specific commission but in the hope of selling it on the market.

By the late 10th century, paper had entirely supplanted papyrus, which had been used uninterruptedly in Egypt for four

millennia. Despite the introduction of parchment in Roman times, papyrus had retained its importance throughout Egypt's Greek, Roman and early Islamic periods for letters and documents, as well as for copying literary works. Surviving documents and Arabic sources indicate that papyrus was still made in Egypt during the early Islamic period for local and foreign consumers, such as local governors and the Byzantine and papal chanceries. But from the early ninth century, paper became increasingly important. Writing in 956, the historian al-Mas'udi indicated that papyrus manufacture was not completely defunct in Egypt, but the geographer Ibn Hawqal, who visited Egypt some 40 years later, made no reference to its use as a writing material. And by 985–986, according to the Palestinian geographer al-Muqaddasi, paper had become one of Egypt's major products. The Persian traveler Nasir-i Khusraw, who visited Cairo between 1035 and 1042, mentions that in the bazaars of Fustat (Old Cairo), the greengrocers, grocers and mercers provided free containers to hold or wrap the glassware, ceramics, and bundles of paper they



⑤ To make parchment, goat or sheep skin is wetted, stretched and scraped repeatedly. The word probably derives from the name of the Greek city of Pergamon (now Bergama, Turkey), where the techniques that allowed utilization of both sides of the skin were developed in the second century BC.



⑥ The oldest surviving dated copy of the Qur'an on paper is a four-volume work written in "bent" Kufic script, the pages laid out in vertical format, that was copied by 'Ali ibn Sadan al-Razi in 972.

sold. This suggests that paper had become relatively cheap, although it still wasn't so cheap that it was easily discarded. Used paper was saved so that the fiber could be recycled into new paper.

Like Central Asia's, the extremely dry climate of Egypt is ideal for preserving organic materials, and several great caches of ancient papyri and medieval papers were discovered there in the 19th century. In 1877 archaeologists found more than 100,000 papyrus and paper documents at Akhmim, Arsinoë, and Ashmunayn, including important historical and economic documents from the Islamic period. Most were acquired by Archduke Rainer of Austria in 1884 and formed the basis of the great Vienna Papyrus Collection at the

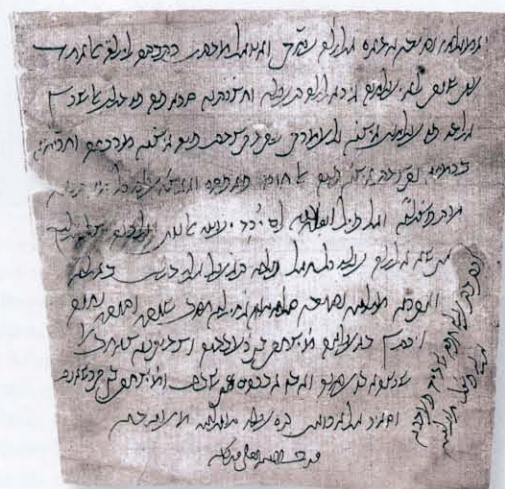
Nationalbibliothek. At approximately the same time, workmen discovered some 300,000 more documents, dating mainly from the mid-10th to the mid-13th centuries, in a storeroom (known in Hebrew as a *geniza*) of the Palestinian Synagogue in Fustat. The *geniza* documents include trousseau lists, commercial documents and personal letters relating to the Jewish community; they had been placed in the storeroom in anticipation of proper disposal, but were forgotten for centuries ⑦. Mostly in Judeo-Arabic—colloquial Arabic written in Hebrew characters—they have become an essential source for reconstructing daily and economic life in the medieval Islamic lands, as well as for the history of spoken Arabic. They also show

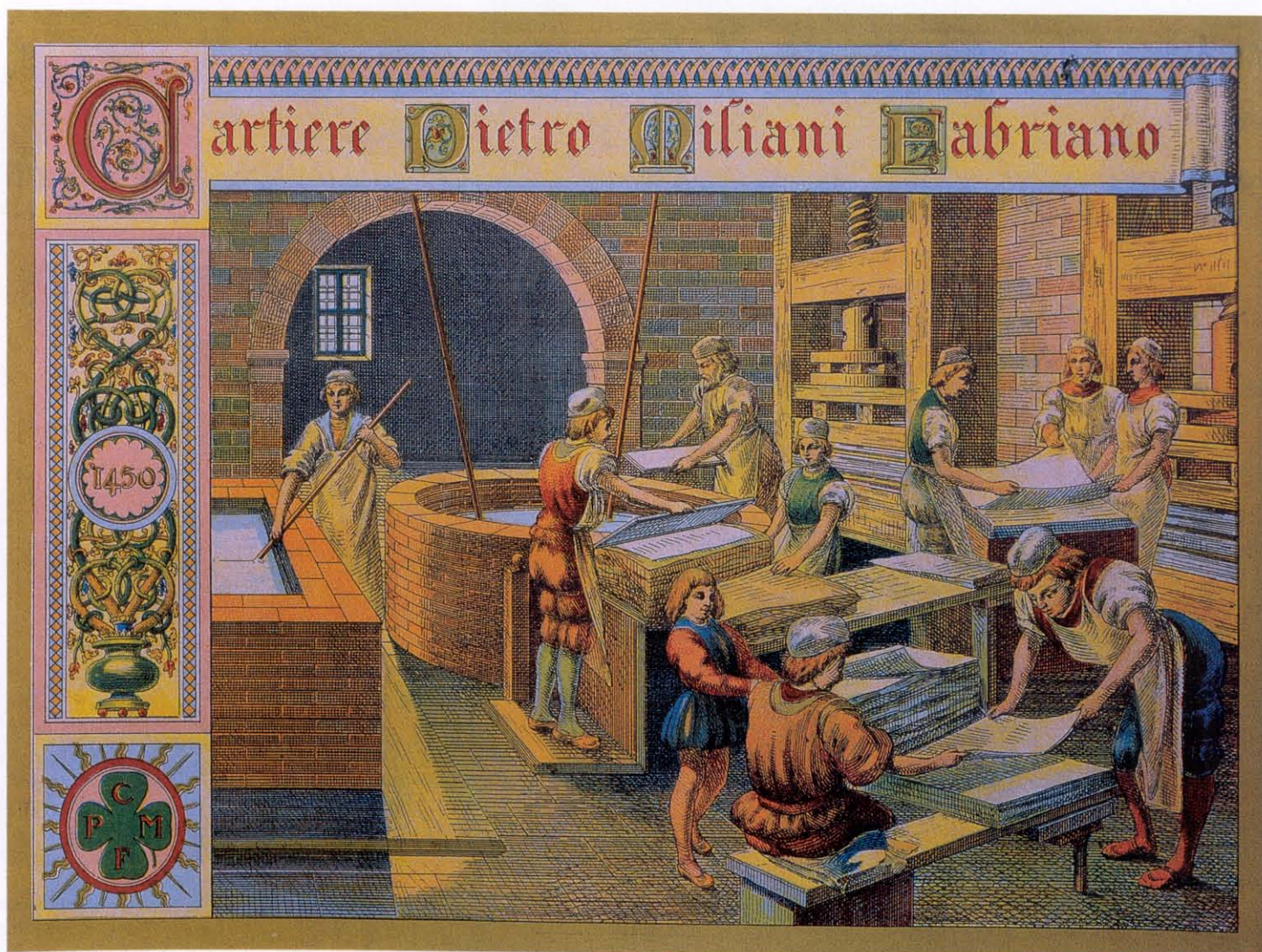
how paper had become an indispensable medium of communication in this commercial society, where bills of exchange, orders of payment, and similar documents, most of them written on paper, were regularly sent back and forth between trading communities located as far apart as Spain and India.

The Zirid prince al-Mu'izz ibn Badis, who ruled in what is now Tunisia and eastern Algeria from 1016 to 1062, included a brief account of medieval papermaking in his book, *Umdat al-Kuttab* (*The Support of Scribes*), the only medieval work on the arts of the book to survive. However, the process of making paper from raw flax on a floating screen, as Ibn Badis described in detail, had been superseded for centuries throughout the Islamic lands, where papermakers had adopted more advanced techniques, using waste rags and old rope as the primary source of fiber, and dipping the paper mould in a large vat of pulp suspended in water. It is possible that Ibn Badis's sources did not wish to share the real secrets of papermaking with him. The rest of his account refers to the sizing of paper with equal quantities of chalk and starch, or with rice starch, and dyeing paper different colors.

Oddly enough, the one manuscript known to have been copied and illuminated during Ibn Badis's lifetime is a copy of the Qur'an transcribed on parchment, not paper, in 1020. According to the *Geniza* documents, Tunisia and Sicily were great centers for leather production, and private letters and documents from that region were still written on parchment well into the 11th century. But papermaking nonetheless spread

⑦ Nearly all of the approximately 200,000 medieval documents found in 1896 in the *geniza* of the Palestinian Synagogue in Fustat (Old Cairo) were written on paper; they are evidence of the wide availability of inexpensive paper in the Islamic lands. Many were written in Arabic using the Hebrew alphabet, like this letter of thanks.





throughout North Africa and Spain. Fez was already an important papermaking center in the 11th century, with 400 paper mills reported by the end of the 12th century, and the first Spanish paper mill is documented at Játiva in 1056. Here too there seems to have been some reluctance to use paper for manuscripts of the Qur'an, even after it had become acceptable in the east. Paper manuscripts of the Qur'an began to appear in the western Islamic world in the 13th century, but parchment ones continued to be produced well into the 14th century.

Ibn Badis' description of colored papers is confirmed by North African documents surviving in European archives, where some are on papers varying in color from red or vermilion to purple or pale pink. These documents are known by the generic term *nasri*, after the Nasrid dynasty of southern Spain, which ruled from the Alhambra in Granada. (See *Aramco World*, March/April 1999.) Perhaps the most striking example is in the Aragonese archives, a blood-red

By the mid-14th century,
North African chanceries
had begun to use
Western papers.

paper made of linen and hemp. Its text is a furious letter written in 1418 by Muhammad VIII of Granada to Alfonso V, protesting that his representative at Alfonso's court had arrogated undue powers to himself; the vivid color may have been intentionally chosen to symbolize the wrath of the writer.

Paper began to be used in Italy at the very end of the 11th century, first in Sicily, where the Normans followed Arab custom, and then in the northern trading cities. In the first half of the 13th century some paper was briefly made near

Genoa, probably following Spanish techniques, but the major center of Italian paper manufacture developed after 1276 at Fabriano, in central Italy (8). The Europeans' ability to harness water power to run paper mills made their product cheaper, if not initially better, than that available in North Africa and Egypt, and imported Italian paper soon began to supplant local production in North Africa and Spain. By the mid-14th century, North African chanceries had begun to use Western papers. A letter dated December 8, 1350 from the Sultan of Tunis to King Peter IV of Aragon-Catalonia is on

(8) The technology used in Pietro Miliani's paper mill at Fabriano in the middle of the 15th century was not dramatically different from that used in China 16 centuries earlier.



⑨ This is the first copy of the Qur'an known to have been produced in the Islamic world—possibly in Iraq—using European-made paper. The watermark indicates that the sheets were made near Venice in the early 1340's, shortly before the Jalayirid sultan Uways granted Genoese and Venetian merchants trading rights in his territories in present-day Iraq and Iran. The zig-zag continuation of the text in the margins of the page may have been an effort to economize on imported paper.

another two centuries there and in Egypt, India and the Ottoman Empire. Before the 13th century, most books written on paper had usually been small, normally no bigger than a sheet of modern office paper, implying that the sheet of paper from which they had been made was about twice as large. A sheet of this size was made in a mould that could easily be held in the papermaker's hands. Larger sheets of paper were more difficult to make and consequently too expensive to use freely. Even when caliphs and sultans needed long scrolls for documents and decrees, they were made from smaller sheets pasted together.

From the 13th century, however, the size and quality of paper available in Iran for books and other uses increased dramatically, but the causes of these changes are not immediately apparent. One possibility is increased contact with China—where papermaking techniques had continued to develop—during the period when Mongol dynasties ruled China, Central Asia, Southern Russia, Iran, and much of the Middle East. (The Mongol rulers of Iran briefly, and disastrously, introduced printed paper currency there in 1294.) It is also possible that techniques for grinding and processing the pulp improved. Whatever the causes, the results of this change can be seen in the great number of large luxury volumes that have survived from this period.

As always, the Qur'an continued to be the most important and popular text, and famed calligraphers penned splendid large copies. Ahmad al-Suhrawardi, for example, completed transcribing a 30-volume copy of the Qur'an at Baghdad in 1307 (see p. 26). The pages measure 500 by 350 millimeters ($19\frac{11}{16}$ " x $13\frac{3}{4}$ "), implying a sheet size of at least 500 by 700 millimeters ($19\frac{11}{16}$ " x $27\frac{1}{2}$ "). The brilliant white paper was beautifully sized and polished so the calligrapher's pen

paper bearing a griffin watermark, which shows that it had been exported from Italy. At much the same time, Egyptian papermakers also began to face serious competition. In addition to better-quality papers from Fabriano and Treviso, cheap papers "of the worst kind"—in the estimation of the 14th-century Egyptian writer al-Qalqashandi—were also imported. Although some paper continued to be made in Egypt until the 17th century, French and Italian papers were dominant in Egypt from the 16th century.

European papers also began to make their way east, although they faced stiffer competition from the local product there. A single-volume manuscript of the Qur'an in the Nour Collection ⑨, for example, was transcribed on Italian paper datable to the 1340's.

Heavily watermarked with a double-key design surmounted by a cross, the paper is almost identical to examples from Arezzo and Torcello near Venice. The European paper confirms that Genoese and Venetian merchants like Marco Polo had carried Italian goods, including paper, to Iraq and Iran, where they may have traded them for carpets, silks, and spices to bring home.

The appearance of European paper at this date in Iran and Iraq, in contrast to North Africa and Egypt, is all the more surprising because local production was then at its apogee. From the 13th century, the availability of large sheets of locally manufactured fine white paper in Iran had spurred a second revolution in the Islamic book, the effects of which would continue to be felt for

Larger sheets of paper allowed larger and more monumental examples of the calligrapher's art, but also allowed use of more and larger illustrations.

was able to glide effortlessly over its smooth surface. Even larger is the dispersed 30-part manuscript of the Qur'an copied for the Mongol sultan Öljaitü between 1306 and 1309 and bequeathed to his mausoleum at Sultaniyya ¹⁰. The pages measure a whopping 720 by 500 millimeters (28¹¹/₃₂" x 19¹¹/₁₆"), implying that the sheets of paper from which the folios were made measured approximately 1100 millimeters (43¹/₄") in their long dimension. The manuscript has only five lines of text per page, so the entire set of 30 volumes would have comprised over 2000 folios. Monumental calligraphy was indeed appropriate for a volume meant to be read publicly in a mosque.

Larger sheets of paper allowed larger and more monumental examples of the calligrapher's art, but they also allowed production of books with increased numbers of larger illustrations, and from the early 14th century the illustrated book became a major form of art in the Islamic world. In previous centuries several types of books had been illustrated with relatively small drawings and paintings to clarify specific points in the text. Thus, books on astronomy would have been practically useless without small diagrams of the constellations, and books on pharmacology might have been dangerous without small illustrations of the useful plants the author discussed. In the 13th

century, a few literary works began to be illustrated, but in the 14th century larger books, such as Rashid al-Din's *Compendium of Chronicles*—the first truly universal history of the world—and the great copy of the *Shahnamah* (*The Book of Kings*), the so-called Great Mongol *Shahnamah*, copied for the Ilkhanid rulers ¹¹, were prepared with paintings as large as 250 millimeters (10") on a side. In contrast to earlier illustrations, these images do not simply illustrate the text but also elaborate on it in new and dif-



¹⁰ This page is one of some 2000 similarly ornate folios that comprise a 30-part copy of the Qur'an produced in Baghdad for the Mongol sultan Öljaitü in 1306 or 1307.

چو زود زوان چون می افتد در افاد در قفسه آه از شیر آیا که می کشد و بان تیر که با هم گاه و گاه می کشد هستی گفت با من خداوند شبه و کفر و بیه بر نهاد مخالت اندون ما زو بخا زان ناسا زان زمین تان بود بسیار کوشش زان زان کاه شاید نکلان یک دله گاه حکما چاک زان زان زان زود زان زان زان زان زبان زان زان زان زان	زیر که ناکت خوش شاد بیکبار زان زان زان زان زیر هر زان تابش و صحن در نهایی کنه زان زان هران بد که اندیشه بران بود ز کمال و زان زان زان زین ناله کوش و با کف آبی زهر که نه تان زان زان یکی با و زان زان زان که این کاه زان زان زان که زان زان زان زان	هوا زان زان زان زان که با زان زان زان زان که بهمن زان زان زان زوان آسلا زان زان زان بگو شش زان زان زان هستی که زان زان زان زین کوش زان زان زان همان زان زان زان زین کوش زان زان زان زین کوش زان زان زان زین کوش زان زان زان	چو شد جاد زان زان زان کوزان زان زان زان بسیار زان زان زان لحا که ای زان زان زان که ما زان زان زان زان زان زان زان خوشان زان زان زان زین کوش زان زان زان زین کوش زان زان زان زین کوش زان زان زان زین کوش زان زان زان	شاه باک اندام زان نشان زان زان زان زهر زان زان زان دلش که زان زان زان حیران زان زان زان شاه که زان زان زان نشان زان زان زان نشان زان زان زان خدا که زان زان زان همه زان زان زان چو کوش زان زان زان شاه زان زان زان یانی زان زان زان
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11 The paintings included in the "Great Mongol Shahnameh," a large-format, 14th-century manuscript of the Book of Kings, were among the first to go beyond mere ornamentation of a narrative text to elaboration of it. Some scholars attribute a political subtext to the illustrations and see the manuscript as a work of propaganda intended to legitimate Mongol rule of Persia.

Designs once stored
in the craftsman's
head were now increas-
ingly fixed on paper.
The artist and artisan
might now be different
people, and designs in
one medium could now
be used in another.



⑫ Among the earliest examples of wood-block printing in the Islamic world is this fragment of an inexpensive amulet from 11th- or 12th-century Cairo. Printing with movable type, however, faced two hurdles in the Arabic-speaking world. A complete font of Arabic type required more than twice as many pieces as a European font; and the very great value placed on writing in the Arab world set standards of technical and esthetic perfection that moveable type could not fully meet.

ferent ways, using complex and deep landscapes and facial expression and gesture to portray human emotions. (See *Aramco World*, July/August 1997.) Although such paintings are called "Persian miniatures" today, in their own time they must have seemed quite monumental. Persian painters did not continue to use these pictorial devices in later centuries, but the ideal of the luxury book copied on large sheets of exquisite paper lived on for generations.

The increased availability of paper from the 13th century also spurred another artistic revolution in the Islamic lands. Architects and artists began to take advantage of the medium to work out designs before the work of art was actually executed, and for transmitting designs from one place to another. The most obvious new role for paper was in architectural plans.

Builders in antiquity had, of course, sometimes used plans and drawings, and there are occasional references to plans in the first seven centuries of Islam, but most construction was based on empirical knowledge transmitted by the spoken word, by gesture, and by memory from one builder to another and from one site to another. From the 14th century, however, builders in the Islamic lands increasingly took advantage of plans and drawings to supplement their traditional skills. Within each cultural orbit, the result was an increased uniformity in architecture, as the new method of representing architecture allowed someone working in the capital to design a building for a provincial city he might never have visited. The clearest example of this new approach comes from the Ottoman Empire, where, after the conquest of Constantinople in 1453, the office of the chief court architect in Istanbul became

responsible for designing buildings, bridges, and aqueducts for sites throughout the realm, to be constructed by local workmen. Ottoman architects were thereby able to achieve an impressive uniformity in their work, and the Ottoman presence in a particular region was immediately visible as hemispheric lead-covered domes and pencil-thin minarets defined the skyline.

The increased availability of paper in the Islamic lands also spurred a change in the other arts, such as metalwork, ceramics and particularly textiles, as artists increasingly created designs on paper that artisans applied to their work. In traditional craft practice throughout the first centuries of Islam, the artisan had also been the designer, working out the design of the finished piece from memory or creating it as he or she went along. A metalworker, for example, would draw out the design on a brass tray before scraping away parts to be inlaid. A potter might practice his decorating on the backs of tiles before beginning to decorate an important plate, but the design on the finished piece came out of his head. A weaver would pattern her carpet with designs she had learned as a child from her mother, never with ones she had seen in a book.

Now the increased presence of designs on paper led some artisans to work in different ways: Potters learned their designs from pattern books and weavers learned to follow the encoded instructions in large cartoons or smaller graphs. Not only did this development signal a split in the traditional unity of artist and artisan, but it also meant that old and new designs were free to be attached to whatever medium the artisan chose: Similar designs, for example, might now appear on textiles, ceramics, metalwork and in book illumination.

In both China and Europe, the start of paper manufacture was quickly followed

by the development of printing, first with wooden blocks and then with moveable type. Block printing was also known in the Islamic lands, perhaps as early as 10th-century Egypt, where it was used for decorating textiles and producing inexpensive amulets ⑫, but it seems to have died out in the 14th century. Why was the idea of printing books or literary texts not seriously entertained in the Islamic lands until the 18th century? It was difficult to design a complete font of Arabic type, since some 600 sorts, or separate pieces of type, might be needed, as compared to 275 for a European language, including italics, points and figures. Furthermore, typeset Arabic would inevitably compare unfavorably with the fluid handwork of a calligrapher—indeed, it is still considered inferior today. Finally, traditional Islamic society accorded great respect to calligraphers and their work.

Thus printing came late to the Islamic lands. The first book printed in Arabic script was printed in Europe, and is believed to be the edition of the Qur'an that Paganino de' Paganini printed in Venice in 1538, of which a single copy was discovered in 1987. (See *Aramco World*, March/April 1992.) Only in the 18th century were the first presses established, with European help, at Aleppo and Istanbul. Knowledge had thus come full circle: Having given paper to Europe, the Islamic lands learned printing from Europeans. ●



Art historian Jonathan M. Bloom is author or co-author of several books on Islamic art and architecture. He has been researching the role of paper in Islamic art for several years, and his book *Paper Before Print* will be published next year by Yale University Press.