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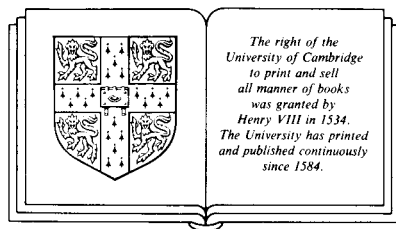
CHEMISTRY AND CHEMICAL
TECHNOLOGY

PART I: PAPER AND PRINTING

BY

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32. PAPER AND PRINTING

(a) INTRODUCTION

Of all the products from the ancient world, few can compare in significance with the Chinese inventions of paper and printing. Both have played a profound role in shaping world civilisations; and both have exerted a far-reaching impact for a very long time on the intellectual as well as the daily lives of countless people everywhere. Paper has proved to be the most satisfactory material on which human thoughts are committed to writing, and when printing came to be allied to it, the ideas of one individual could be communicated to a multitude of others separated across great stretches of space and time. In short, the printed message has brought about changes in the intellectual mode of the human mind, and paper has provided the most economical and convenient means for its transmission. But of course paper has other uses than for writing and publishing; it has penetrated into every corner of ancient and contemporary society to become an indispensable article in daily life. Even though new media of communication have developed in recent times, the unique combination of paper, ink and printing are still the basic, permanent, portable, and perhaps the least expensive and most accessible communication device known to us today.

(1) ORIGIN, DEVELOPMENT, AND MIGRATION OF PAPER AND PRINTING

It is common knowledge that paper was invented in China some time before the Christian era. From early in the +2nd century its manufacture became improved, using new materials and superior techniques. By the +3rd century it had become widely used in China itself and had begun to migrate across the Chinese borders; it reached the Western world only just prior to the modern age. Printing from woodblocks was first practised by the Chinese around +700, and movable type several centuries earlier than Gutenberg. Even the indelible ink of lampblack, prized by scholars and artists throughout the centuries in the East as well as the West, and which has been manufactured in the West under the misnomer 'Indian Ink', can be traced back to antiquity in Chinese civilisation. It was the introduction of these ingenious elements that made possible mass production of written records for wide circulation. Of the materials and techniques for the modern book, printed with black ink on white paper, the Chinese have contributed most to its development.

Paper is a felted sheet of fibres formed from a water suspension process using a sieve-like screen. When the water escapes and dries, the layer of intertwined fibres becomes a thin matted sheet which is called paper. Over the span of the two millennia which have elapsed since the inception of the idea of papermaking, the

craft has changed and the tools have become more complex, yet the basic principles and processes remain the same.

Traditionally, the invention of paper was attributed to Tshai Lun early in the +2nd century, but recent discoveries of very ancient paper fragments in North and Northwest China have pushed back the date of this invention at least some two to three centuries before him. Indeed, as we shall see, the invention of paper in China is now believed to have originated from a process of pounding and stirring rags in water several centuries before the start of our Era. It is very likely that an accidental placing of fibres from the rags on a mat with water draining away, may have suggested the idea of making a thin sheet of paper. But paper was not invented expressly for writing, as has often been presumed. It was extensively used in China in the fine and decorative arts, at ceremonies and festivals, for business transactions and records, monetary credit and exchange, personal attire, household furnishings, sanitary and medical purposes, recreations and entertainments, and so on. What is more, all these non-literary applications were common in Chinese society before paper was introduced into Europe in the +9th century.

Paper was not used for writing until perhaps early in the +1st century, and even then did not entirely replace the more cumbersome bamboo and wood slips as the chief materials for making books until the +3rd century. But when it came, the use of paper enabled books to be cheaper and more portable, though their extensive production and wide distribution was not possible until the invention of printing. It is uncertain when and where the first book was printed in China and who was the earliest printer, but probably the process developed gradually.

There is a long history of pre-printing techniques in China, including the use of seals for stamping on clays and later on silk and paper, of stencils to duplicate designs on textiles and paper, and of the inked impressions taken from stone inscriptions. All these processes gradually led to more efficient methods of the mechanical multiplication of copies and, as archaeological and literary evidence indicates, by the +7th century or around +700, printing began in China. Movable type was introduced by the middle of the 11th century and multi-colour printing some time in or before the 12th century. The movable type was first made of earthenware, but later various other materials, including wood, metal, and a variety of ceramics, were also adopted repeatedly and intermittently in the following centuries.

Because of the great number of characters in written Chinese, woodblock printing was used far more often than movable type for book production in China until recent times. Wood blocks were simpler and more economical, and could be stored easily and were readily available when a reprint was needed; movable type was preferred only for large-scale production of voluminous books. Nevertheless, both wood blocks and movable type have gradually given way, since the mid-19th century, to the modern printing press.

After papermaking was perfected, it not only became popular in China but spread in all directions throughout the world, first eastwards in the +2nd century,

then westward during the +3rd century. However, it did not reach India until the +7th century, and only became popular there in the 12th. Paper arrived in Western Asia in the middle of the 8th century, and to Africa in the 10th. The Arabs monopolised paper-making in the West for some five centuries. Only in the 12th century was it manufactured in Europe, and it did not reach America until the 16th century and Australia in the 19th. Thus it took more than fifteen hundred years for paper to spread from China to almost every part of the world.

Whether or not typography in Europe was influenced by the Chinese is controversial, but it is certain that Chinese printing and printed materials from China were known in Europe before printing began there. As might be expected, there are many theories about how printing reached Europe. Some suggest that it travelled from China to Europe along routes similar to those taken by paper, others, emphasising the differences between European and Chinese printing, suggest that European typography was independent in origin. However, there is strong evidence from cultural considerations of a close connection between them. Certainly there is no doubt that paper-making originated in China, and was already a fully developed craft before it spread over the rest of the world. It is probably the most complete of all the inventions China has given to civilisation.

(2) FACTORS CONTRIBUTING TO THE EARLY INVENTION OF PAPER AND PRINTING IN CHINA

The prerequisites for a useful invention include both the physical and the mental readiness for the event; besides a creative mind and a popular demand, proper materials and the essential basic techniques must be available. Since all the material facilities for the invention were present in Europe as well as in China, several questions arise. Why did the invention occur in one civilisation but not the other? What were the factors responsible for such development? What was it that made these two great inventions appear very early in Chinese culture but only after a long delay in the West, at least a thousand years for paper, six hundred years for wood-block printing and four centuries for movable type? In an attempt to find the answer, we shall discuss and compare the conditions that led to these developments.

The key elements for the manufacture of paper are water, fibres, and a mould. The first was present almost everywhere and fibres were available from rags or hemp or linen just as soon as textiles were woven in the ancient world. The use of the two together was common enough, but not so the process of turning rags into separate fibres through maceration, and using a screen mould to hold these fibres while allowing the water to drain away. Perhaps, as will become evident later,^a the Chinese tradition of washing rags in water and allowing the fibres to form a felted sheet on the mat was responsible for this discovery in ancient times. The earliest

^a See pp. 36 ff. below.

mould is believed to have been made of a piece of cloth stretched with frames to support the macerated fibres and to let the water escape through its meshes.

The invention of paper-making was, of course, a continuing process rather than a single event. An important step came with the introduction of new and fresh raw fibres, allowing unlimited production. Here the discovery of the suitability of the paper mulberry (*Brousonetia papyrifera*) was certainly significant. It is a plant that is native to China, though it has been cultivated extensively in many other temperate and tropical zones throughout the world. Its bark, after being beaten into a cloth, was used for clothing in China as well as in other regions along the equator, and ancient Chinese literature provides evidence that it was manufactured and traded by native tribes in the southern part of China, as we shall see.^a The invention of paper-making with tree bark attributed to Tshai Lun in the early +2nd century was possibly influenced by the acquaintance of the people in his area with the paper mulberry.^b Tshai Lun was a native of Lei-yang in what is now Hunan province, and it was here that the bark was made into cloth by beating and then into bark paper after maceration.^c Since, then, the maceration process of turning rags into pulp was already known in China, it was very likely that the people in the south of the country were the first to convert paper mulberry bark into a pulp for paper-making. Neither paper mulberry nor bark cloth was, it seems, used in Europe, where its cultivation appears to have been unknown, even in the +18th century; indeed among the numerous kinds of plant tested for paper-making by European scientists at this time, paper mulberry was not included.^d Furthermore, it was described with curiosity by the early Jesuit missionaries to China, and they suggested its transplantation to France.^e

The popular demand for a better writing material was another important factor leading towards the invention and utilisation of paper. In China, paper was a much cheaper and more ideal writing medium than expensive silk and the clumsier bamboo or wood. But in Europe, paper did not have too many advantages over papyrus or parchment. Papyrus was plentiful, simple to prepare, inexpensive, and perhaps as light and convenient as paper. Parchment, although it cost more,^f had a smoother surface and was more durable than paper. Indeed, in the early days, paper was not much cheaper than parchment, in contrast to silk, and not any more portable than papyrus, in contrast to bamboo and wood. Because of its fragility,

^a See pp. 56 ff. below.

^b See Ling Shun-Sheng (7), pp. 1 ff.

^c Lu Chi of the +3rd century said that the bark of paper mulberry was used by the people south of the Yangtse River to make cloth or was pounded for making paper; see discussion of *tapa* and paper clothing, pp. 109 below.

^d Searching for new materials for paper-making, Dr Jacob Schaffer (1718–90) tells of how he tested over thirty kinds of raw material including moss, asbestos, potato, wood, and various other plants, for use in paper making to be mentioned in his six-volume work published between 1765 and 1771, but he did not include paper mulberry or bamboo, which had been major raw materials used in paper making in China and other nations in east and south Asia; see Hunter (9), pp. 309 ff.

^e See Batteux & Briquigni (1), ed., *Mémoires* . . . (15 vols., Paris, 1776–91), vol. II, p. 295.

^f In 1367, 31 quires of parchment, each containing three dozen sheets, cost 76 livres, 5 sous, 8 deniers in Tours; in 1359, two quires of paper cost 18 deniers; and in 1360, four quires of paper cost 2 shillings, 4 deniers; see Blum (1), pp. 62–3, note 2.

paper was even banned for official documents in Europe.^a It was also not a welcome commodity when it was first introduced to Europe from the Arab world, since Europeans were distrustful of anything from a hostile land during and after the Crusades; its use was even attacked by clergymen like the abbot of Cluny.^b Not until the spread of printing in Europe during the second half of the fifteenth century did a great demand for paper arise, although it had gradually come into use for manuscripts and household records before then. The situation was so different in China, where paper established its supremacy as a popular medium for writing even before it was officially adopted by the court in the early +2nd century.

The basic materials needed for block printing included wood, ink, and paper. The same kinds of wood, including pear, boxwood, or other deciduous trees, were used for woodblocks for printing in both China and the West. Ink of lampblack was probably discovered very early by people of all civilisations, since soot was naturally collected when fire was controlled. The use of black ink or a carbon mixture in China can be traced back to remote antiquity,^c and a similar ink of lampblack mixed with an aqueous solution of vegetable gum was used by Egyptian scribes as early as -1300; it spread to Western Asia a little later.^d The Greeks also made an ink of soot consisting of the same basic ingredients of lampblack and gum and in the same solid form as the Chinese ink.^e

Of the three basic necessities for printing, paper was perhaps the most important. Without a soft and absorbent medium, it would have been impossible for printing to develop, and the prior use of paper by the Chinese certainly contributed to the early invention of printing in China. Clearly, the late introduction of paper to Europe had a significant effect on the slow development of printing in the West.

However, paper was certainly not the only essential prerequisite for this invention, for printing did not appear in China until paper had been used for writing for at least six or seven hundred years, and there were still four printless centuries after the arrival of paper in Europe. Printing developed quite naturally from techniques developed in making and using seals and stamps, engraving on stone and metals, and taking inked rubbings from stone and other inscriptions. Religious and secular demand for a great numbers of copies, however, called for some mechanical means to replace hand copying.

Seal inscriptions in a mirror image, from which a correct position was obtained by stamping on clay and later on paper, embody the technique closest to that which eventually led to the invention of printing. The use of seals began in antiquity in both Chinese and Western civilisations. In China, seals cast in bronze with designs and inscriptions in relief survive from the Shang dynasty. Other seals

^a Paper was forbidden for official use by King Roger of Sicily in 1145 and again by Emperor Frederick II of Germany in 1221; cf. Blum (1), pp. 23, 30.

^b Cf. Blum (1), p. 30.

^c See further discussion on pp. 233 ff. below.

^d Cf. J. H. Breasted (1), pp. 230-49; Wiborg (1), p. 7.

^e Cf. Wiborg (1), pp. 71-2.

made of metals or carved on stone, jade, ivory, horn, earthenware, and wood have continued in use until this day. They are characterized in general by a flat surface, square, oblong, or occasionally in other shapes, bearing inscriptions of characters in relief or intaglio of personal names or official titles, always in reverse. They have been used always to indicate ownership, authenticate documents, and establish authority.^a

The use of seals in Western culture began and flourished in Mesopotamia and Egypt, perhaps even before the invention of writing.^b These seals made of stone, ivory, shell, or metals were of two principal types, cylinders and stamps. The cylindrical type was used in Mesopotamia and in areas under Babylonian influence. Their designs, primarily of deities, heroes, animals, celestial bodies, instruments, and emblems, were impressed by rolling the cylinder over a flat surface of clay, mortar, cement, or wax.^c The stamp seals have a variety of shapes. Those used in Egypt were of scaraboid form with a beetle on the back, a sacred symbol of resurrection and immortality. Their bases are flat and engraved with designs or inscriptions of mottoes, personal names and titles of officials.^d These had strong religious overtones as well as practical functions. Both the cylindrical and stamp forms of seals were also used in Asia Minor, Syria, and Palestine. Their use was discontinued after the fall of the Western Roman Empire but revived in the second half of the +8th century. Since then, round or oval seals engraved with designs and legends have been employed in the West until modern times.

Generally speaking, the seals developed in Chinese and Western cultures bear some similarities and differences. They were both made of the same kinds of materials, impressed originally on the same kind of surfaces, and used primarily for the same purposes. But there were some major diversities which led perhaps to development in different directions. Chinese seals were mostly made in a square or rectangular shape with a flat base, inscribed with characters in reverse, and used to stamp on paper. These characteristics are very close to those of block printing. Although the surface and inscriptions of most seals were small or limited, some wooden seals were as large as printing blocks and were inscribed with texts more than one hundred characters long.^e

The seals of the West, on the other hand, were cylindrical or scaraboid, round or oval, and inscribed primarily with pictures or designs and only occasionally with writing. The cylindrical seals used to roll over clay had no potential to develop into a printing surface.^f While the scaraboid seals were flat-based, their primarily religious nature was predominant over their functional aspects as a tool of multi-

^a The use of seals in China is considered to be one of the most important technical prerequisites for the invention of printing in China; Cf. Carter (1), pp. 11 ff; see also pp. 136 ff. below.

^b Cf. Chiera (1), p. 192.

^c For the development of cylindrical seals, see Eisen (1), Frankfort (1), and Wiseman (1).

^d For scarab seals and their religious meaning, see Newberry (1) and Ward (1).

^e See *Pao Pho Tzu, Nei Pien (SPTK)*, ch. 17, p. 23a; tr. Carter (1), p. 13.

^f This could be considered as the forerunner of the rotary press, which was certainly not developed directly from this practice.

plication.^a Furthermore, seal inscriptions always took a positive position, the impressions being made primarily on stiff material such as wax, rather than on a flexible medium such as parchment or paper. Such different usage discouraged any development in the West of the idea of printing from seals.

The use of seals as symbols of authority and authenticity was similar in standing to that accorded to coins. In ancient times, the circulation and acceptance of metal money depended upon official sponsorship, which was usually indicated by marking on the coins their value, place of minting and, sometimes, the official symbol of approval. These numismatic inscriptions were made either by casting in a mould, or by stamping or punching the face of the coins. From very early times in China coins in spade, knife, plate, and circular shapes were cast from moulds.^b But in the West, they were first made by stamping and later by casting, a technique which was subsequently borrowed by bookbinders, who cast separate metal characters for stamping titles on a book. This craft was eventually adopted by printers to cast metal type and thus was the forerunner of typography in the West.^c

The technique of engraving on stone tablets is close to that of carving on wood blocks, and taking inked squeezes or rubbings from stone inscriptions is very similar to the process of block printing. Inscripting on stone was developed very early in both China and the West. Chinese inscriptions on stone survive from the Chou dynasty, and subsequently stone became the most popular medium for commemorative and sacred writings, and for the preservation and standardisation of the canonical texts. The Mesopotamians also used stone in addition to clay tablets for writing, the Egyptians used it for tomb inscriptions and it was adopted for monuments by the Romans as well as other peoples in the ancient world,^d but inscriptions in the West were neither as extensive nor as refined as they were in China, and were never in scale with those of the Chinese, where hundreds of thousands of characters of Buddhist, Taoist, and Confucian texts were carved on stone throughout many centuries.^e Moreover, stone was used in the West more as an artistic material than, as it was in China, for writing. Such differences in the nature, scope, and content of stone inscriptions caused them to develop in divergent directions in China and in the West.

Taking inked squeezes or rubbings from stone inscriptions is similar to printing in principle and purpose, but different in process and end-product.^f Both result in duplication on a sheet of paper of an engraved object, but their different methods

^a See Miller (1), pp. 14–26.

^b The earliest metal coins cast with inscriptions may have first been made in the Shang or early Chou; see Wang Yü-Chhüan (1), p. 114; for the development of Chinese numismatic inscriptions, see Tsien (2), pp. 50 ff.

^c Cf. Blum (2), p. 21.

^d Cf. Diringer (2), pp. 44–5, 82, 358.

^e Cf. Tsien (2), pp. 64 ff.

^f A. C. Moule, in his review of Carter (1) in *JRAS* (1926), p. 141, expressed doubts about the influence of rubbing on printing because the two processes are essentially different. However, the difference in one respect does not preclude influence in another, as can be seen in the fact that special reference to stone inscriptions was made when Confucian classics were first printed from woodblocks in the 11th century; see discussions on pp. 143 ff. and p. 370 below.

result in different kinds of reproduction.^a The technique of taking inked rubbings from stone, and eventually from all kinds of hard surfaces, can be traced back to the +6th century or earlier in China. Yet it does not seem to have been used in the West until perhaps the 19th century, when antiquarians and artists began to experiment with the use of a crayon-like agent in tracing designs from memorial brasses, tombstones, brick walls, carved wood, and sewer-plates.^b The duplications they obtained were, however, far less sophisticated than those of the inked squeezes originally made by the Chinese, and it was the combination of this skill in making duplications by inking and rubbing on a sheet of paper coupled with the art of carving seals with a mirror image in relief that resulted in the methods of block printing.

Besides the necessary materials and techniques, there were also social and cultural factors which had a great effect on the application or rejection of printing. Since printing is a mechanical extension of writing, the system of writing used is one of the most important factors affecting the development of printing. Chinese writing was from the very beginning characterised by an ideographic script which is basically composed of numerous separate strokes of different shapes.^c Since each character has a definite and distinct form, the writing of characters tends to be elevated to an art and is thus more complicated and time-consuming than alphabetical writing, especially when a special style is sought in a formal and respectable text. On the other hand, Western writing, ever since the Phoenicians developed the rudiments of an alphabetic language, has evolved into a system of symbols representing sounds. Its written components are merely substitutes for their spoken counterparts, and have tended to evolve into simple signs composed of continuous lines.^d Copying in an alphabetic language is easier than in an ideographic script. It is likely, therefore, that the slower and more complicated process of copying Chinese resulted in a greater demand for mechanical aid in duplication in China than in the West. It is also natural that movable type was more acceptable to an alphabetic language, while block printing was more suitable to the Chinese writing system.

Religion is another cultural factor that has played a great part in the long history of the development of printing; religious zeal in spreading sacred writings to all believers has created a demand for a ready means of reduplication, and Buddhism, Islam, and Christianity all exerted an influence. Buddhism even teaches that mass production of its *sutras* is a way to receive blessing from the Buddha. Indeed, the Buddha is said to have remarked, 'Whoever wishes to gain power from the *dharani*

^a See discussion of the methods of making inked squeezes in Tsién (2), pp. 86 ff., and on pp. 143 ff. below.

^b Cf. K. Starr (2), p. 3. An archaeologist said in 1930 that she learned a most satisfactory method employed by Orientalists to make rubbings from inscriptions and decorations, 'even the finest of lines appear most distinctly'; see Margaret Ashley (1).

^c Chinese characters have been composed of one to more than thirty independent strokes or dots, straight or curvilinear lines, and squares since their development into the clerical and regular styles from around the advent of Christian era in the Chhin and Han dynasties.

^d For a comparative study of word-syllabic and alphabetic systems, see Diringer (1), Gelb (1); for development of written forms, see Anderson (1).

[charms] must write seventy-seven copies and place them in a pagoda. . . . This *dharani* is spoken by the ninety-nine thousand *koti*^a of Buddhas and he who repeats it with all his heart shall have his sins forgiven.^b The enthusiasm of the Buddhist devotees for producing a great multitude of sacred texts was highly influential in the birth of printing in China, which occurred during the high tide of Buddhism in the early Thang. This religious motivation is further confirmed by the earliest printings of the *dharani* discovered in Japan and Korea.

In the West, on the other hand, the demand for multiple copies was not strong as early as it was in China. Hand-copying by slave scribes could produce more texts than were needed in the Roman Empire. In the Middle Ages the reading public was very small, and the copyist tradition was carried on in monasteries and churches. Such demand as there was for books could be met with handmade copies prepared by scribes; there was no incentive to produce them in large quantity. Not until the renaissance and the Reformation did the demand for Bibles and other reading materials significantly increase.

Another factor in the relatively slow development of printing in Europe may have been the influence of the growth of various kinds of craft unions and guilds. First organised in Greece and Rome to facilitate the sharing of common interests by skilled men, by the Middle Ages they had gained political power and took on the role of protecting the professional skills and livelihood of their members.^c These guilds naturally became very strict and exclusive as far as their membership was concerned. For instance, the block printers who engraved and printed playing cards and religious images belonged to the company of painters or artists, which represented such craftsmen as scribes, illuminators, sculptors, stonecutters, glass-makers, and wood-engravers. Typographers were not admitted as members of that society.^d As late as 1470, guilds of scribes and illuminators in France still forbade multiplication of religious images by means other than by hand-copying.^e And between 1485 and 1590, among all the early typographers of Antwerp, it seems that only one was probably admitted to guild membership as a wood-engraver, and this most likely on account of his illustrations printed with his text.^f This power of the guilds in the Middle Ages to limit membership to certain crafts may well have had a negative effect on the early development of printing in Europe.^g

To sum up, then, the early use of printing in China was chiefly due to the early invention of paper, the specialised use made of seals and rubbings for duplication, the greater need for mechanical aid in duplicating texts written in a complex ideographic script, the standardisation of Confucian texts used for civil service examinations and, finally, the demand for great quantities of copies of Buddhist

^a A *koti* is variously put at one hundred thousand, one million, and ten million; cf. Carter (1), p. 53, note 15.

^b See translation of the *dharani* cited in Carter (1), p. 50.

^c Cf. Frey (1), pp. 9-17.

^d Chatto & Jackson (1), p. 121.

^e Bliss (1), pp. 10-11.

^f Chatto & Jackson (1), p. 122.

^g Cf. C. R. Miller (1), pp. 53 ff.

scriptures which could not be met by hand-copying. In the West, paper was not introduced until a rather late date, seals were not used as duplication devices, rubbing was not known until fairly recently, while printers were restricted by craft unions or guilds, and added to all this, the relative simplicity of the alphabetic script lessened the need for a mechanical duplication aid. Thus the materials and techniques necessary for the invention of printing were either not developed, or did not lead in the direction of a printing process. Furthermore, there was no such incentive or demand for huge quantities of copies as developed in connection with Buddhism; the needs that did exist could be met by hand-copying. Until all these factors were changed in the middle of the 15th century, the threshold for the invention of printing was not reached in Western society.

(3) INFORMATION ON PAPERMAKING AND INKMAKING IN CHINA

Sources of information for the study of paper and papermaking include paper specimens, scientific and field reports, early records, and secondary sources. We shall take these in order.

Paper specimens are important because they can be subjected to microscopic, chemical, and physical analyses for determining their composition, technique of manufacture, and other features. Since the turn of the century, tens of thousands of early paper specimens have been found within China and outside it, including some fragments from the —2nd century which are at present the oldest known papers in the world. A few specimens bearing characters of perhaps the +2nd century attest to the use of paper for writing before or at this time.^a

Paper fragments and documents found in modern Sinkiang by various expeditions were primarily products of the Three Kingdoms, Chin, and Southern and Northern Dynasties from the +3rd to 6th centuries, when paper began to be used widely and to travel across Chinese borders.^b Paper rolls dating from the 4th to the 10th centuries discovered at Tunhuang represent the best examples of paper and paper books in a roll form before and during the Thang period.^c From this time on, specimens of different varieties of paper survive in books, documents, works of painting and calligraphy, in stationery, paper cutting, and other paper products. In addition, certain old paper documents extant outside China testify to their early diffusion worldwide.^d

^a Up to the present time (1983), at least seven discoveries of old paper fragments of the Han period have been reported, but only one or two said to have been dated to the Later Han bear some writing; see discussion on pp. 38 ff. below.

^b Cf. Tsiên (1), pp. 142–58; see also discussion on pp. 43 ff. below.

^c A grotto library of some 30,000 rolls of paper books and documents in Tunhuang was first visited by Aurel Stein in 1907 and later by many others; see Stein (4), Giles (13), Pelliot (60), Chhen Yüan (5), and a summary of the documents by Fujieda (2).

^d Some 12,500 paper documents discovered in Egypt, dating from +800 to 1388, are now preserved in the Erzherzog Rainer Collection at Vienna, and many Chinese papers of the Sui and Thang periods survive in Japan and Korea.