NEW DISCOVERIES IN CHINESE CERAMICS

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THE BEGINNINGS OF TRADITIONS ARE ALWAYS interesting, and one useful way of regarding ceramic history is to divide the ceramic traditions of the world into those that are 'creative', and those that are 'reactive'. This is a broad but workable approach that tends to ignore subsequent developments, but looks instead at the circumstances that led to the production of a particular ware in a particular place or at a particular time. On this basis, the ceramics of China must be regarded as by far the most influential in the world. It is hard to imagine, for example, how Middle Eastern ceramics would have developed without the impact of imported Chinese stonewares and porcelains - and this was a situation that was repeated some centuries later when large quantities of Chinese ceramics began to reach Europe.

In the Islamic world this process took the form of three waves of Chinese porcelain importation - in the 8th/9th, 11th/12th and 14th/15th centuries AD - and these influenced, successively, Iraqi tin-glazed earthenwares, Egyptian and Iranian stonepastes, and some radical developments in the Islamic underglaze tradition.[1] In Europe, particularly in the 17th and 18th centuries, imports of decorated Jingdezhen porcelains, and Yixing stonewares lead directly to the great porcelain factories of Europe and Scandinavia, and to the red stonewares of Saxony, the Netherlands and England. In a similar way plain white and cream-coloured porcelains from the Dehua kilns in Fujian province were imitated at early European soft-paste factories - and also in some white saltglaze stoneware workshops in north Staffordshire. Even now, in the late 20th century, we are still using, in porcelain factories throughout Europe, fine china and porcelain recipes that have changed little in their constitution since their development in the early and mid 18th century, as direct responses to the influence of imported Chinese wares.

East Asian ceramics too (particularly those made in Thailand, Korea, Japan and Vietnam) owe an enormous debt to China in the materials and the forms adopted by their potters. And when China's own ceramics are examined by this same process we have a very complex picture of 'creative-reactive' events within China itself - from north to south, from south to north, and from one major kiln-complex to another.

Influence, of course, is rarely one way, but in China the ceramic ideas absorbed from the West and the East have tended to be stylistic, rather than technical. The two exceptions to this rule, most often cited, are the transfer of underglaze cobalt-blue painting techniques from the Middle East to China in the late 1320s, and the adoption in China of an opaque overglaze enamel palette for porcelain, from Europe in the early 1720s. However, even these conventional wisdoms have recently been modified - in the light of research in both China and in the West.

Figure 1. Pou, with 'sifted' ash glaze, Western Han dynasty, 2nd century BC, probably from northern Zhejiang province, south China, ht. - 26.5 cm, Haags Gemeentenmuseum, The Hague.

UNDERGLAZE DECORATION IN COBALT

When Chinese porcelain first reached Iraq, the local potters responded by improving their existing tin glazes, applied to the local dolomitic earthenware clays, to make superficial copies of the plain, but very strong, imported Chinese wares. Before long (later 8th C. AD) these white Iraqi earthenwares were enhanced by painting cobalt-blue pigments on top of the dry tin-glaze before firing, to produce blue-and-white earthenwares of great character.[2] In the 12th century, most probably in Damascus, less opaque glazes were developed for use with cobalt-blue painting *beneath* the glaze, and this is generally regarded as the start of the world's great underglaze-blue tradition.

However, this latter idea has been shaken somewhat by the excavation in the Chinese city of Yangzhou, in Jiangsu province, of small pieces of Chinese-made underglaze-blue painted porcelains from the northern kiln-site of Gongxian.[3] These Chinese blue-and-white wares have been dated to the later part of the Tang dynasty (Tang: 618-907 AD) and show underglaze-blue painting of surprising detail. The Gongxian kilns supplied white porcelains and lead-glazed *sancai* wares to the Islamic market in the later Tang dynasty. The kilns also made lead-glazed funerary wares, produced mainly for the nearby late Tang capital of Luoyang. The lead-glazed earthenwares made at Gongxian included those with plain cobalt-blue glazes, as well as *sancai* ('three-

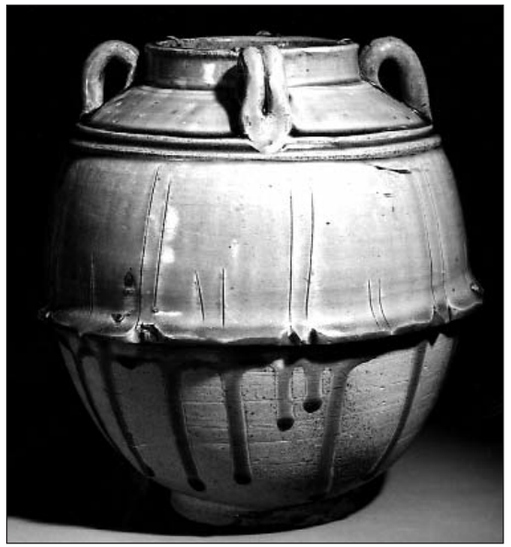

Figure 2. Olive-green glazed oviform stoneware jar, north China, 6th century AD, ht. 25.5 cm, Christies.

coloured') wares with cobalt-blue details.[4&5]

Analysis has shown that the cobalt-blue pigments used on the Gongxian underglaze-blue wares were of an unusual type, being mainly cobalt, with traces of iron and copper. Sulphur was found in association with the cobalt, and this has lead Chinese scientists to suggest that the original pigment was probably a cobalt-iron sulphide, such as the minerals linneite (Co_3S_4), or cattierite (CoS_2). The Chinese researchers are unsure of the origin of this pigment, but note that cobalt sulphides of this type can be found in north China, amongst other places in the world. However linneite has also been suggested as a source for the blue painting seen on some early blue and white wares found in Iraq,[6] so a Middle Eastern origin for the Gongxian blue pigment is far from impossible.

A curious feature of Gongxian blue-and-white is that it did not found any underglaze-blue tradition in north China, and the technique disappears from Chinese ceramics soon after its brief appearance in the late Tang. Occasional examples of underglaze blue painting are known in south China from the Northern Song dynasty (960-1127 AD), this time with a local manganese-cobalt ore, but, once again, these are isolated occurrences rather than the beginnings of substantial traditions. The great 'explosion' of blue and white painting that began at Jingdezhen in about 1328 happened at time when China was part of the Mongol empire, and connections with the Middle East were extremely strong - indeed much of the underglaze-blue porcelain made in China at this time was destined for Middle Eastern markets,[7] and the iron-cobalt pigment used at Jingdezhen in the 14th century probably came from the Middle East. The position now seems to be that China invented underglaze painting with cobalt-blue in the Tang dynasty, largely forgot about the technique, and then re-discovered the process through its Middle Eastern connections in the Yuan dynasty.

Jingdezhen opaque porcelain enamels

In a similar way to blue-and-white, our ideas about the Chinese adoption of opaque porcelain enamels in the 18th century have needed some adjustment in the light of new research. As is well known the appearance of Chinese overglaze-enamelled porcelain changed radically in the early 1720s, following the adoption by Chinese porcelain-painters of an opaque white enamel, an opaque yellow enamel and a translucent rose-pink. Hitherto most Chinese enamel colours had been transparent. The new white enamel was opacified with lead arsenate, the yellow by the mineral lead stannate, and the pink was coloured with colloidal gold. The use of pink in the new overglaze palette led to the term *famille rose* being applied to these new wares by French connoisseurs.

The most popular theory about these new colours was that they were introduced to China from Europe by Jesuit specialists at the court of the Kangxi Emperor in Beijing, where many craft workshops operated in the Forbidden City, supplying the court with spectacular examples of Chinese craftsmanship. The gold-pink enamel was certainly known in Europe at the time, where it was used on some of the earliest, Böttger-period, Meissen porcelains. However, work in Oxford in the late 1980s has suggested another possible source for two of the new colours - namely the lead-arsenic white and the lead-tin yellow. Glasses using these colourants were shown to have been used on Chinese *cloisonné* wares of the 17th century and the overall compositions of the Chinese *cloisonné* glasses were very similar to some Jingdezhen porcelain enamels of the Qianlong period, analysed in the USA in 1985.[8&9] *Cloisonné* workshops certainly existed in the Forbidden City, at the time when some Jingdezhen porcelains were decorated there, very late in the reign of the Kangxi emperor (r. 1662-1722), and would have provided a useful contact-point between Chinese *cloisonné* and Chinese ceramic traditions.

The origin of the *famille rose* palette is therefore still far from clear, particularly as the Chinese pink enamel was often coloured solely with gold, rather than the gold-tin mixture preferred in Europe. Plain gold-ruby glasses have been known in the Middle East since at least the 11th century AD,[10] so even the *famille rose* pink enamel is not necessarily a European introduction to China; it may have come instead from the Middle East or even from India.

Western understandings of Chinese porcelain technology

Figure 3. Early white porcelain jar, north China (Henan or Hebei province), 7th century AD, ht. 30.1 cm, The British Musem.

Tang underglaze blue-pigments and famille rose enamels were applied, respectively, to north Chinese and to south Chinese porcelains. But what are the differences between these two large groups of Chinese wares, and how did they develop in the country? Given the importance of porcelain in world ceramics, it is something of a surprise to discover that full answers to these questions were not achieved in the West until the early 1980s - and that the geographical origins of high temperature ceramics, such as the first glazed stonewares of China's Bronze Age, are still under active research within China itself.

To some extent, the fact that we often know far more about the ceramics that Chinese wares inspired, than the original Chinese wares themselves, has been due to the turbulent history of China for most of this century. Until the end of the Cultural Revolution in 1976, this had prevented much of the important work on ceramics, that had been taking place within China since the 1950s, from being transmitted to the outside world. It was not really until 1982 that the situation changed, when a large international conference took place in Shanghai, attended by leading scientists and art historians from China, Hong Kong, Japan, Thailand, Singapore and the West. The Shanghai conference began a new era of cooperation between ceramics experts in China and the rest of the world, and resolved, in a single meeting, many of the outstanding questions on the natures of Chinese stonewares, porcelains and earthenwares. The full proceedings of the Shanghai meeting were published in Beijing in 1986, and these 70-odd papers represent the essence of Chinese and Western research on this subject from the 1950s to the early 1980s.[11]

Since 1982, four more large international conferences of this type have been held in China, with three taking place in Shanghai and one in Beijing. These later meetings have reinforced many of the ideas presented at the First International Conference on Ancient Chinese Pottery and Porcelain, whilst adding a wealth of new detail and discovery to the subject.[12,13,14&15]

Chinese porcelain

Chinese porcelain was a major theme at Shanghai in 1982, and it became clear as the conference progressed that two distinctly different types of early porcelain had been made in the country - and that these wares were reflections of the very different geologies that occur above and below a natural geographical division just north of the Huai river.[16]

This division is known to geographers as the Nanshan-Jinging divide, after two mountain ranges that occur along its length. It separates the wheat and millet areas of north China's Great Central Plain and loess plateau from the mainly rice-growing south; it also divides two very different areas of mean-temperature and rainfall. At various times in China's history the divide has served as a political boundary, and it still represents, in Chinese consciousness, the division between the north and the south of the country. One of the most important late 20th C. discoveries in Chinese ceramics has been that geological differences above and below this divide account for the profoundly different technical characteristics that are evident in northern and southern Chinese stonewares and porcelains.

Of the two types of Chinese porcelain, the northern variety was the earlier to appear, in the late 6th-early 7th C. AD. These porcelains were based on natural sedimentary clays, often associated with north China's coalfields. Their production sites tended to follow the foothills of the Taihan Shan mountain range as they run northwards from Henan province, through Hebei province, and onwards to the Great Wall.[17] Coal, limestone and clay are all accessible in these areas and many of the old porcelain and stoneware sites have been replaced by modern cement, coal-mining and refractories-making industries, exploiting this same sedimentary geology, laid down in Permo-Carboniferous times.[18]

Because northern porcelain clays consisted largely of true clay minerals, they showed smooth textures and excellent plasticity in making, which encouraged fine details and expressive forms. The high kiln-temperatures needed to fire these materials (1280-1370°C.) often supplied unusual fired strength. On the debit side the translucency of northern porcelain tended to be low or absent, and their fired colours were often less than white. They shade imperceptibly into northern stonewares, and much early 'northern whiteware' is of this indeterminate type. However the best productions

of the northern kilns (the wood-fired Xing wares of the Tang dynasty, and the coal-fired Ding wares of the Song and Jin) were of outstanding quality, and they still represent some of the most sophisticated approaches to the making and firing of porcelain in China's ceramic history. Study of raw materials found near to these kiln sites suggests that these northern porcelain clays were used, after suitable refining, very much as found.[19&20]

The slightly later southern porcelains (early 10th C.) were of an entirely different nature, and were made largely from pulverised volcanic rocks - suitably refined by levigation and by sieving. These southern wares were very low in true clay minerals, but unusually rich in quartz and mica - with the finest mica flakes in the rocks providing some degree of plasticity to the prepared porcelain 'clays'. These southern wares show a characteristically sugary fracture from the high quartz contents of the original rocks.

The rock-based southern porcelains first appeared in south China, at sites such as Yangmeiding and Hutien (near to Jingdezhen in Jiangxi province), in the early 10th century. These particular kiln-sites were already making grey-bodied, ash-glazed stonewares when they converted to plain white porcelain production, sometime in the Five Dynasties period (907-960 AD). It seems that this change in material was managed simply by the potters' exploiting an abundant local rock - probably a bedded volcanic ash, rich in quartz and mica, with a small natural clay content, and unusually low levels of the colouring oxides of iron and titanium.[21]

Despite the technical and aesthetic merits of northern porcelains, their production declined steadily between the later 12th and the mid 14th centuries - due largely to a series of damaging invasions from northern tribes, culminating in the Mongol invasion of 1234. Southern porcelain, by contrast, went from strength to strength, with Jingdezhen eventually becoming the 'porcelain capital', of China and the world. From the fourteenth century through to the nineteenth century this huge riverside kiln-complex in Jiangxi province manufactured domestic and export-porcelains on a vast scale, with the export-wares eventually being shipped from China to sites as various as Turkish palaces, Borneo long-houses, Japanese temples, Saxon castles and West Indian sugar plantations. This very successful technology, based on quartz-mica rocks, led to similar materials being identified and exploited in Korea, from the later 10th C., in Vietnam from the 14th-15th C., and in Japan from the early 17th C.[22] All these Far Eastern porcelains used essentially similar rocky raw materials, many of which were laid down during the same period of intensive volcanic activity, some 140 million years ago.[23]

Development of Chinese porcelains

We know now that the three waves of Chinese porcelain production, exported to the Middle East, also represent three important stages in the development of

Figure 4. Large porcelain jar of *guan* form with underglaze cobalt-blue painting, probably Jingdezhen c. 1350 AD, Yuan dynasty, ht. 48 cm, The British Musem.

Chinese porcelain itself. The first porcelain exports from China were clay-based wares of the northern type, often from the Xing and Ding kilns in Hebei, but also from the northern kiln-complex at Gongxian in Henan province, mentioned in connection with the Tang blue-and-white wares.[24] These were often sent to Mesopotamia (now Iraq) as secondary cargoes in ships carrying silks, and were of a relatively low grades by Chinese standards. In Iraq these wares encouraged the development of tin glazed earthenware - a technology that eventually spread to Egypt, Syria, Persia, Spain and Italy - and then throughout northern Europe. Tin-glazed earthenware remained the dominant European whiteware material until it was displaced by European porcelain in the eighteenth century.

The second large export-wave (c.12th-13th) consisted of translucent Jingdezhen porcelains of the southern crushed-rock type, known today as *yingqing* (shadow-blue) wares. These exports were joined later by Longquan celadon-wares from Zhejiang province, also made largely from quartz-mica materials, although of lower purity than the Jingdezhen wares.[25] These southern porcelains were copied in Egypt, Persia and Syria with artificial mixtures of sand or crushed quartz, white sticky clays of the montmorillonite type, and crushed soda-lime glass. These 'stonepaste' bodies were essentially white earthenware materials, glazed with

Figure 5. Large 'goldfish bowl' showing scenes of porcelain manufacture, including an 'egg-shaped kiln', painted in *famille rose* overglaze enamels, (interior decorated with carp and plants), Qianlong period, c. 1735, ht. 40.5 cm, Haags Gemeentemuseum, The Hague.

ground-glass powders, usually modified with additions of lead and tin oxides, and probably fired to temperatures below 1100°C.[26]

Exports of Chinese porcelains flourished particularly in the 14th and early 15th centuries, and included in their number Jingdezhen dishes of exceptional size and thickness, often decorated with crowded and complex designs in underglaze painting in iron-cobalt blue or arsenical-copper red.[27] The porcelain bodies themselves were made from mixtures of pulverised porcelain stone, with about 20% of *gaoling* - a primary clay washed from weathered rock. These large thrown and pressed dishes from Jingdezhen were imitated and developed by the earthenware potters of Syria, Egypt and Persia - with Turkey later contributing the most sophisticated stonepaste bodies of all, in the form of the Isnik wares of the mid-sixteenth to the seventeenth centuries.[28]

By the time Jingdezhen porcelains were arriving in large quantities in Europe (17th-18th centuries), the main Jingdezhen recipes had changed once more, and now contained up to 60% of *gaoling,* mixed with porcelain stone - the last major change in traditional Jingdezhen porcelain recipes.[29] At this stage a true porcelain was finally produced in the West, at Saxony in the first decade of the 18th century, although, curiously, Böttger's clay-rich lime-fluxed porcelains were far closer to the long abandoned porcelains of north China than they were to the Jingdezhen wares of the early eighteenth century.[30]

Gaoling in Chinese porcelain

It is often thought in the West that *gaoling* (or kaolin as we call it) is an indispensable ingredient in Oriental porcelain - but we now know, from accumulating analytical evidence, in China and the West, that Jingdezhen was unusual in its heavy use of the material.[31] Most other southern Chinese porcelain kiln sites (such as Dehua, and the south Chinese kilns making 'Swatow' wares) seem to have managed most of their production without recourse to kaolin - simply using their local quartz-mica porcelain stones after suitable crushing and refining. Porcelain kilns in Korea and Japan also seem to have operated this 'low kaolin or no-kaolin' principle. Dishes and jars of massive scale were often made at these sites, so kaolin does not seem to have been an essential material for larger porcelain pieces.[32]

What kaolin did provide at Jingdezhen was great flexibility in the maturing temperatures of its porcelain bodies, as the material was blended with porcelain stone in various proportions. This was a particularly useful principle for wares that were fired in the unusual Jingdezhen 'egg-shaped' wood-burning kilns, used at this kiln site from the late Ming dynasty until the 1950s.[33] These kilns (shaped like half an egg lying on its side, and about fifteen metres long inside) showed a substantial fall-off of heat from their fireboxes towards their chimneys - from about 1320-1000°C. within a single kiln. This unusual distribution of heat allowed Jingdezhen potters to fire thousands of porcelain pieces simultaneously to a wide range of temperatures, with a variety of glazes, all within a single firing. Plain white glazes for later enamelling would be placed in the hottest part, followed by underglaze-blue wares, and then by high-temperature monochromes, such as celadons and copper-reds. At the 'cooler' end, nearer to the chimney, plain porcelains would be re-fired with low-melting glazes, fluxed with lead or potassium oxides. More than eighty such kilns were still working at Jingdezhen in the mid 1950s,[34] and couple of wood-fired *zhenyao* kilns still operate in the city today.

Origins of northern porcelains

With the main outline of China's porcelain history now well established, Chinese scientists and archaeologists are looking again at the origins of their high-temperature ceramic traditions. One surprise from this recent work has been the discovery that the unusual white-firing clays, used for making northern porcelains and white stonewares, were used occasionally as earthenware materials in China as early as the third millennium BC, often for hand-building the dramatic three-legged Neolithic vessels of the Longshan culture.[35&36] In Neolithic times these white clays were fired to low earthenware temperatures (c. 1000°C.), which left them unusually soft and brittle. Similar clays were used in the later Shang dynasty (c. 1300-1100 BC) for making unglazed Shang stonewares, with finely-carved ornament, reminiscent of contemporary designs on carved ivory and bone. Shang whitewares of this type were always unglazed, but the kilns occasionally reached temperatures high enough (c. 1150°C.) to develop mullite in the clay bodies - a ceramic mineral characteristic of fired stoneware and porcelain. However

these firing temperatures were still too low for any signs of translucency to develop in the wares.[37]

Between the use of these clays for Neolithic and Shang whitewares, and their re-appearance as porcelains in the Sui/Tang period (Sui: 589-618 AD), exists a long and baffling gap of some two thousand years, when little, if any evidence can be found for the use of high-temperature clays in northern ceramics. This applies not only to northern glazed porcelains, but also to northern glazed stonewares, which are closely related materials - and only a century or so earlier in their establishment than the northern porcelains themselves.

This comparatively late beginning for high-temperature glazed ceramics in north China is in contrast to south China, where glazed stonewares first appeared in the early Shang dynasty (c. 1500 BC) - although, as we have seen, the gap between glazed stoneware and true white porcelain production in the south is also wide, with true porcelains only appearing in the south in the early 10th century AD.

What has obscured proper understanding of this complex subject, until relatively recently, has been the excavation in north China over the last few decades of many examples of greenish-yellow glazed stoneware, often from major Bronze Age sites, such as the cities of Zhengzhou and Luoyang, in Henan province. It was naturally assumed when they were found that these Shang and Western Zhou glazed stoneware were early experiments in north China with high-firing stoneware clays and with true stoneware glazes.

It was not until the Shanghai conference in 1982 that this idea was challenged, when a paper was presented that suggested, on the evidence of the body materials used, that some Western Zhou (c. 10th C. BC) stonewares in the Louyang Museum in north China (and excavated in the city itself) were probably not made in north China at all, but were actually imported from southern China in the Bronze Age.[38]

Since this radical idea was presented in 1982 many more examples of 'northern' Bronze Age glazed stonewares have been subjected to chemical and microstructural analysis - and these too have displayed typical south Chinese compositions, including some of the very earliest finds of glazed stoneware in China, from the early Shang site at Yuanqu in Shanxi province.[39] Stranger still, no examples have yet been found of Bronze Age glazed stonewares, that are indisputably made from north Chinese materials. Unglazed Shang whitewares, however, are still believed to be true northern productions, and they remain the only examples so far discovered of ceramics approaching stoneware quality that were made in north China before the 5th/6th C. AD.

Perhaps the best recent evidence for a southern provenance for 'northern' Bronze Age glazed stonewares was presented at the latest Shanghai conference, in 1995,

Figure 6. Ash-glazed stoneware vessels, Western Zhou period (11th C.-770 BC), excavated in Louyang, but probably made in South China, Louyang Museum, Henan province, width, c.22cm.

by the physicist, Professor Chen Tiemei.[40] Instead of looking solely at the common elements in the northern finds of glazed stoneware, and their southern equivalents, Chen and his colleagues used a process called neutron activation analysis that also counts the incidence of rarer elements, such scandium, thorium and uranium in the fired clay bodies. This a more respectable approach scientifically as particular balances of these rare elements tend to be very local. The 'northern' samples tested all proved to be typical of south Chinese wares in their rare-element concentrations, and Chen suggests the Jiangxi site of Wucheng as a possible source for most northern finds. However, as more Shang kiln sites are excavated in the south, southern sites other than Wucheng will doubtless emerge.

Northern and Southern glazes

As with high temperature clays, Chinese glazes too show some major differences from north to south. In southern China the clay bodies (or materials very similar to them) were the main ingredients in stoneware and porcelains glazes - and this approach to glaze-design can be traced from the early Bronze Age to the present day. In north China the potters made very little use of body-clays in their high-fired glaze recipes, preferring instead fusible loessic clays for their blackware glazes, and some complex igneous rocks for celadon and porcelain glazes.

Origins of Shang glazes

Shang stonewares bear some of the earliest examples of high-fired glazes found anywhere in the world and analysis suggests that these glazes were based on wood ash, which makes a natural stoneware glaze when applied to clay and fired above about 1170°C.[41] The effect is due mainly to a high-temperature reaction between the calcium oxide 'flux' in the wood ash with the glass-forming oxide silica, and the glass stabilising oxide, alumina, in the clay body. These combine during firing to produce a stable glazes of the 'high lime' (i.e. high calcium oxide) type.

The first use of wood ash for making stoneware glazes probably occurred when south Chinese potters noticed

Figure 7. Yue-type stonewares and the earliest style of south Chinese porcelain, intermixed at the Yangmeiding kilnsite, near Jingdezhen, Jiangxi province, Five Dynasties period (907-960 AD)

the natural ash glazes that tended to build up on wood-fired ceramics, and on the inner walls of kilns, as the kilns were fired to higher temperatures towards the beginning of the Bronze Age. This observation lead to the deliberate application of pure wood-ash (and then, later, clay and ash mixtures) to the surfaces of their ceramics. In some later southern stonewares (Han dynasties 206 BC - 220 AD) southern potters seem to have sieved dry wood ash over their wares before firing, to give characteristic 'fading' glazes that are confined to the upper halves of the wares.[42]

After the Han dynasties, mixing of the pots' body-clays with wood ashes in about 3:2 proportions displaced this technique, and the resulting clay-ash slips were applied to the wares by pouring, dipping and brushing. This often resulted in grey-green or yellowish-green glazes - sometimes with frosty surfaces, caused by a haze of fine lime-rich minerals forming in the cooling glaze. With more rapid cooling, or higher firing temperatures, the same glazes could display a characteristic greenish glassiness.[43]

With the benefit of hindsight, we can now appreciate how far-reaching this principle of mixing a body-clay (or a closely related material) with a calcia-rich powder, became in south Chinese ceramics - indeed it has been the main principle behind the construction of southern high-fired glazes from the Bronze Age to the present day. It was used for the huge range of 'greenware' glazes, made across southern China, from about the 4th-11th - and the technique seems also to have been employed for the Changsha and Qionglai oxidized ash-glazes made in Hunan and Sichuan provinces respectively, particularly in the late Tang dynasty. Some examples of Changsha and Qionglai wares show creamy-white effects caused by the high phosphorous contents of the wood ashes used, while others are coloured green with copper oxide, amber with iron oxide, and purple-brown with natural manganese-iron oxide mixtures.[44&45]

With blackware glazes too, body-clay/wood-ash mixtures seem to have been the standard recipes at many sites in south China, particularly for glazing the small teabowls, produced in enormous quantities at southern kilns from the late 9th to the 14th centuries AD. At the Jizhou kilns in Jiangxi province the local clays were low in iron - which meant that extra iron oxide had to be added to the clay-ash mixtures to produce brown and black glazes.[46] In northern Fujian province, by contrast, the local stoneware clays used for tea-bowl making contained nearly ten percent iron oxide. Fine streaky blackware glazes resulted from mixtures of these ferruginous Fujian clays with wood ashes - giving the famous 'hares fur' temmokus of the Jian ware kilns. [47&48]

Southern porcelain glazes

When many stoneware kiln sites converted to porcelain-making in south China, in the 10-11th centuries, they continued with the ancient principle of using their body-materials (now natural porcelain stones) as their major glaze ingredients. A few provincial porcelain kilns also used wood ash as their prime glaze fluxes, and at Korean and Japanese porcelain kilns wood ash remained the primary glaze-flux until at least the late 19th C. However, at the major Chinese porcelain and celadon centres at Jingdezhen, Dehua and Longquan the potters adopted pulverised or burned limestones (calcium carbonate) as cheaper, purer and more convenient sources of calcium oxide.[49]

At Jingdezhen in the 13th century, a further evolution in southern glazes took place when potters began to use special 'glaze-stones', instead of porcelain bodies, in their glaze recipes. The glaze-stones contained essentially the same minerals as the rocks used for clay bodies, but the proportions of soda feldspar to mica were higher, making the materials more fusible in the kiln.[50] Glaze-stone/limestone mixtures proved particularly useful, from the late Ming onwards, in the big *zhenyao* kilns at Jingdezhen.[51,52&53] By varying the ratios of these two materials, the glaze-makers of Jingdezhen were able to match their glazes' maturing temperatures to the various temperature-zones within their kilns, and porcelain glazes of this type were still in general use at Jingdezhen in the 1950s.

Conclusion

The work that has been carried out on Chinese glazes, summarised above, shows again the essential simplicity that lies behind many of the famous qualities seen in Chinese ceramics - and if there is one principle above all that has characterised the technology of high-fired ceramics in China it is this remarkable directness in the exploitation of local geologies. Chinese potters were blessed with high quality porcelain or stoneware raw materials, but they also show exceptional subtlety and

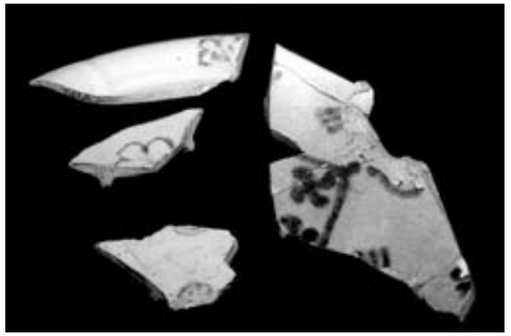

Figure 8. Shards of underglaze cobalt-blue painted Gongxian porcelain, late Tang dynasty (618-907 AD), excavated in Yangzhou, Jiangsu province.

invention in their use. To these important factors can be added the early establishment of division of labour as a manufacturing principle in China, and a quite remarkable sense of design in the wares produced.

From the late Tang dynasty onwards, high-fired wares were the main ceramic productions within China, and they were made on a scale that allowed a large export trade to develop with the rest of the world. It was the products of this trade in stoneware and porcelain that inspired and directed the course of ceramic history beyond China - a process that was most active in the thousand-year period, from the eighth to the 18th century AD.

NOTES

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4 Rawson *et al*, 1989
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23 Hatcher et al, 1985
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41 Zhang, 1986
42 Wood, 1989
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44 Zhang, 1987
45 Zhang, 1989
46 Dai, et al, 1985
47 Girel, 1988
48 Chen et al, 1986
49 Guo, 1987
50 Tite et al, 1984
51 d'Entrecolles, 1743
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