

# The Packing of Medieval Floor-Tile Kilns

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*PREVIOUS work on medieval tile kilns firing square or rectangular floor tiles has used diagrammatic packing plans to reconstruct practice and to estimate kiln capacities. Simple practical experiment shows that these systems are unstable and impractical. A stable and reliable packing plan has been devised which takes into account many of the packing scars and damage found on the tiles in the English Heritage collection at Cleeve Abbey, Somerset. Whilst it is not suggested that such a plan was universally used it does accord with data from a range of other sources.*

This paper describes practical experiment in packing and firing a medieval tile kiln carried out by the authors at Cleeve Abbey, Somerset, as part of an educational project run by English Heritage, Somerset County Museums Service and the Bickley Ceramics Project looking at the technology of medieval floor tile production.<sup>1</sup> Children from three local schools produced approximately 280 decorated tiles. All the tiles were 150 mm square and approximately 25 mm thick with the sides bevelled back so that the upper surface overhung the lower. The backs were cut out to leave four circular depressions. The tiles were made from Valentine's Sanded Red body; the white decoration inlaid with Potclays' White Earthenware. The tiles were raw-glazed either with white lead or with litharge.

A brick two-firebox rectangular kiln was built. The ware chamber had a floor area of 800 mm × 900 mm. The height of the chamber should have been similar, giving a capacity of 400 tiles, but was left lower to accommodate the smaller number actually produced. The kiln was open topped, capped prior to firing with broken 19th-century clay double-roman roof tiles. Firing was with pallet wood over eleven and a half hours to 950°C, the kiln having been preheated gently overnight.

The problem explored in this paper is how to pack 280 150 mm square floor tiles of raw clay with bevelled edges and lead glaze on one face into a rectangular ware chamber without the use of any specialized kiln furniture. This needed to be done in such a way as to leave no scars or damage on the glazed faces. Any scars elsewhere on the tiles should conform as closely as possible with those found on the medieval tiles at Cleeve Abbey.

<sup>1</sup> The Bickley Ceramics Project was founded by the authors in 1981 and has built many experimental updraught kilns using archaeological and ethnographical material as evidence with which to explore the practicalities of past technology.

## OBSERVATIONS

Tiles from the Cleeve Abbey collection were examined for firing scars to provide evidence for their packing. The collection contains tiles of a number of periods and types. No attempt was made to quantify the variations observed. There is in the collection a small amount of kiln debris and some wasters. Little about these pieces seemed to contribute to the present study. The majority of the tiles have undercut bevelled edges. Many of the edges are so obscured by mortar as to make it impossible to search for firing scars. Others show no evidence of marks or scars at all. Those that did show scars tended to show three main types:

Packing scar type 1 (Fig. 1, top). Two small glaze contact scars on two opposite edge surfaces. Some tiles showed two brownish areas of lead vapour marking or spatters of glaze indicating the position of the neighbouring tiles in a similar way. The marks are spaced regularly and aligned at or close to right angles to the face. These are common.

Packing scar type 2 (Fig. 1, centre). These are essentially similar to type 1 but placed at  $45^\circ$  rather than at right angles. These are also relatively common.

Packing scar type 3 (Fig. 1, bottom). Large irregular contact scars on one edge only. These are aligned obliquely and can extend right along the tile edge. Glaze runs are extensive and the scars often have lumps of material adhering. A number of examples are also distorted and overfired. These are much less common than type 1 or 2, but not rare.

The absence of damage on the glazed faces is very apparent. Occasional examples of fragments adhering to the faces were too few to show a pattern and suggested accidents.

From the type-1 and -2 scars, it would appear reasonable to assume that the tiles were fired on edge and that each tile was overlain by two others either at right angles or at  $45^\circ$ . The type-3 scars, particularly when associated with distortion and overfiring, could be interpreted as indicating those tiles in contact with the kiln floor. This assumes a kiln floor with parallel slots, as found for instance at Norton Priory and Clarendon Palace.<sup>2</sup> It is interesting to note that Eames has pointed out similarities in the tiles from Cleeve Abbey, Muchelney Abbey and Clarendon Palace.<sup>3</sup>

## PREVIOUS WORK

The only major practical investigation of the firing side of tile-making technology has been that carried out at Norton Priory in Cheshire in the 1970s by Barry Johnson and Pauline Bearpark.<sup>4</sup> This was geared to the production of

<sup>2</sup> J. P. Greene, B. Johnson, B. Noake and P. Bearpark, *Medieval Floor Tiles. How They Were Made* (Runcorn, 1979); T. B. James, A. M. Robinson with E. Eames, *Clarendon Palace, Part III, The Tile Kiln and Floor Tiles*, Soc. Antiquaries Res. Rep. XLV (London, 1988).

<sup>3</sup> E. Eames, *English Tilers* (London, 1992), 37–9.

<sup>4</sup> J. P. Greene, B. Johnson, B. Noake and P. Bearpark, *op.cit.* in note 2.

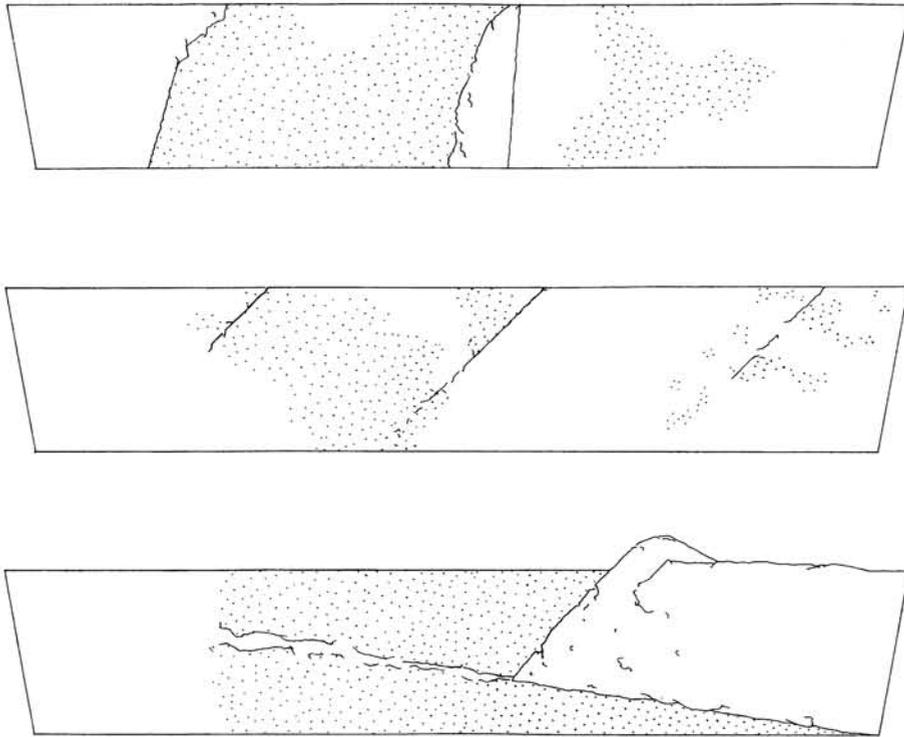


FIG. 1

Packing scars found on medieval floor tiles from Cleeve Abbey, Somerset. Type 1 (top) and type 2 (centre) occur on opposed edges of many tiles and indicate edge contact, either at right angles or at  $45^\circ$ , with neighbouring tiles during firing. Type-3 scars (bottom) occur on one edge only and might suggest contact with the kiln floor. Grey areas show extent of glaze spread.

elaborately shaped mosaic tiles. Such tiles are associated with specially adapted kilns and kiln furniture. The best known kiln-site of this type is at Meaux Abbey in Yorkshire where Elizabeth Eames based a reconstruction of an elaborate internal structure on extensive remains of the kiln fabric and furniture.<sup>5</sup>

Excavated examples suggest that kilns for firing the more conventional square tiles were simpler and operated largely without kiln furniture. Various suggestions have been put forward as to how tiles were packed in the kilns. Work on the subject has been summarized by Elizabeth Eames in the catalogue of the British Museum collection.<sup>6</sup> The range of suggested packing methods are all fairly similar, taking their evidence from scarring and from the few examples of waster tiles that remain fused together. One should observe at this point that the former is valid evidence of stacking whilst the latter may be the chance result of a failure of stacking.

<sup>5</sup> E. Eames, 'A Thirteenth Century Tile Kiln Site at North Grange, Meaux, Beverley, Yorkshire', *Medieval Archaeol.*, 5 (1961), 137-68.

<sup>6</sup> E. Eames, *Catalogue of lead-glazed earthenware tiles in the Department of Medieval and Later Antiquities, British Museum. I. Text and Catalogue* (London, 1980).

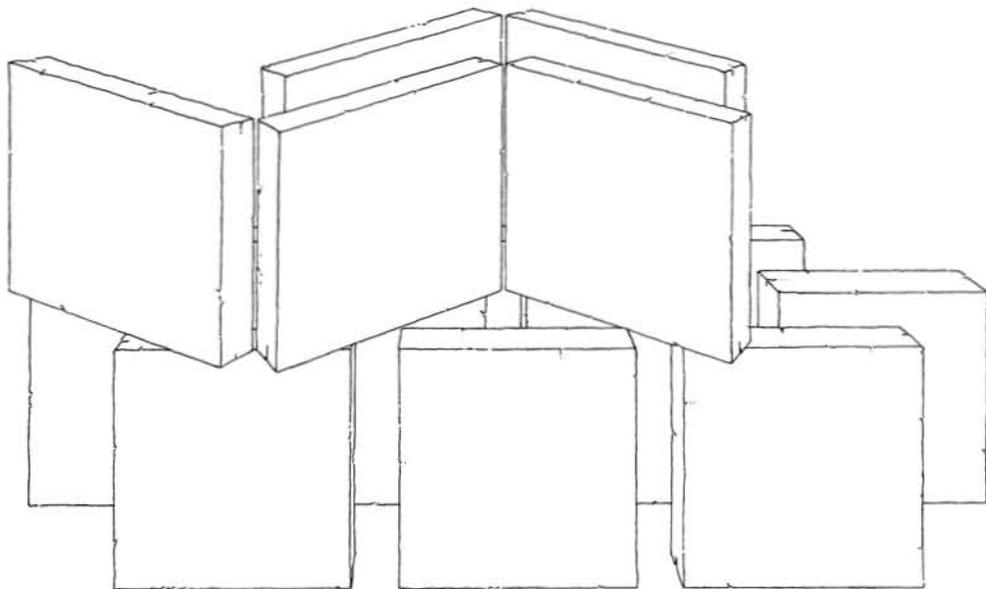


FIG. 2

The tile-packing pattern shown in Elizabeth Eames's reconstruction of the tile kiln at Meaux Abbey, Yorkshire.

The Meaux reconstruction drawings include a suggested packing arrangement for rectangular tiles (Fig. 2).<sup>7</sup> They are arranged vertically in straight rows and chevrons in two layers resting at oblique angles to one another. They seem disturbingly awkward in the irregular space provided. One of the finest excavated kilns for firing the more conventional square floor tiles is Kiln 1 at Danbury in Essex.<sup>8</sup> The kiln was found almost intact. The excavators suggested that, from the scars on the tile edges, they were fired vertically in courses set at right angles to one another, spaced about 20–30 mm between tiles.<sup>9</sup> Such an arrangement differs little from that suggested at Meaux except that the tiles are set at right angles to one another and would mean that each tile pair carried another pair immediately above them. At both sites the tiles are described as having undercut bevelled edges, as is common — and this is a major problem. In the British Museum catalogue, Elizabeth Eames, arguing more generally, states that the tiles were placed face to back in tiers slightly off the right angle to the level below but confessed '*One cannot help thinking that this method of stacking was rendered more difficult by the bevels that were cut on the edges of the tiles.*'<sup>10</sup> Attempts at employing these methods prove this observation only too true.

<sup>7</sup> Eames, *op. cit.* in note 6, 159, and revised in E. Eames, *English Tilers* (London, 1992), 15.

<sup>8</sup> P. J. Drury and G. D. Pratt, 'A late 13th- and early 14th-century tile factory at Danbury, Essex', *Medieval Archaeol.*, 19 (1975), 92–164.

<sup>9</sup> *Ibid.*, 143–48.

<sup>10</sup> E. Eames, *op. cit.* in note 6, 23.

## PRACTICE

The stacking methods outlined above brought with them two essential problems. Firstly, it was impossible to produce a stable pack because of the bevelled edges. Secondly it was difficult to avoid the glaze faces touching at some points — the chevron patterns meant that every tile touched the face of its neighbour along one edge. It has been suggested by the excavators at Danbury, who recognized this problem, that straw was packed between them.<sup>11</sup> This would, of course, only solve the problem until the straw burnt out, then the pack would collapse.

Any solution to the problem of packing tiles needed to take the above into account. In addition, a requirement of any packing scheme is that it must allow a free flow of gases evenly throughout the kiln (this is another argument against the straw). This implies a systematic pattern of some kind rather than a random pack.

## A WORKABLE ALTERNATIVE

An obvious starting point was the 15th-century Flemish drawing used as a frontispiece to Elizabeth Eames's British Museum paperback.<sup>12</sup> The drawing is full of practical detail which suggests a real awareness of the processes involved, as for instance in the end-braces and splayed legs of the brick/tilemaker's table. It shows a very convincing kiln — albeit embellished with round towers and a spiral stair — and a series of different stacking methods for bricks or tiles. None of them seemed applicable to glazed ware, but they share one significant feature: they are all logically self-supporting. It would seem that a method of this kind was essential. The other factor that we felt was crucial to face up to was the bevelled edge. It was the root of the instability problem and yet at the same time is a common feature of many medieval tiles. It must therefore be accommodated within the process rather than being an annoying restriction placed on the process.

Amongst the patterns shown in the drawing is a lattice made by resting the centre of each tile against the edge of the previous one (Fig. 3). If such a pattern is modified by replacing each single unit with two facing each other, glaze to glaze, something interesting happens (Fig. 4). The bevel causes them to lean backwards and rest on the flat of the bevel so that the glazed faces do not touch. They can be spaced slightly to avoid contact with each other. This reduces the contact area to a minimum without affecting stability. In practice it becomes evident that, with this system, the bevel is no longer a problem. It simply does not interfere, and square-edged tiles would pack just as easily. In both cases packing slightly off the vertical is probably the optimum, maintaining rigidity whilst minimizing contact.

This solution was then tried in practice and produced a remarkably stable pack. Each pair occupies a 150 mm cube resting against two other pairs at right angles. The pattern holds fast provided it is contained within a rectangular space to support the outer tiles in the pattern. In practice, if the floor of the kiln consists of parallel slots then the pattern must be set on the diagonal to maintain stability

<sup>11</sup> P. J. Drury and G. D. Pratt, *op.cit.* in note 8, 145.

<sup>12</sup> British Library, London. Add. MS 38122, f. 78V; E. Eames (1992), *op. cit.* in note 7, title page.

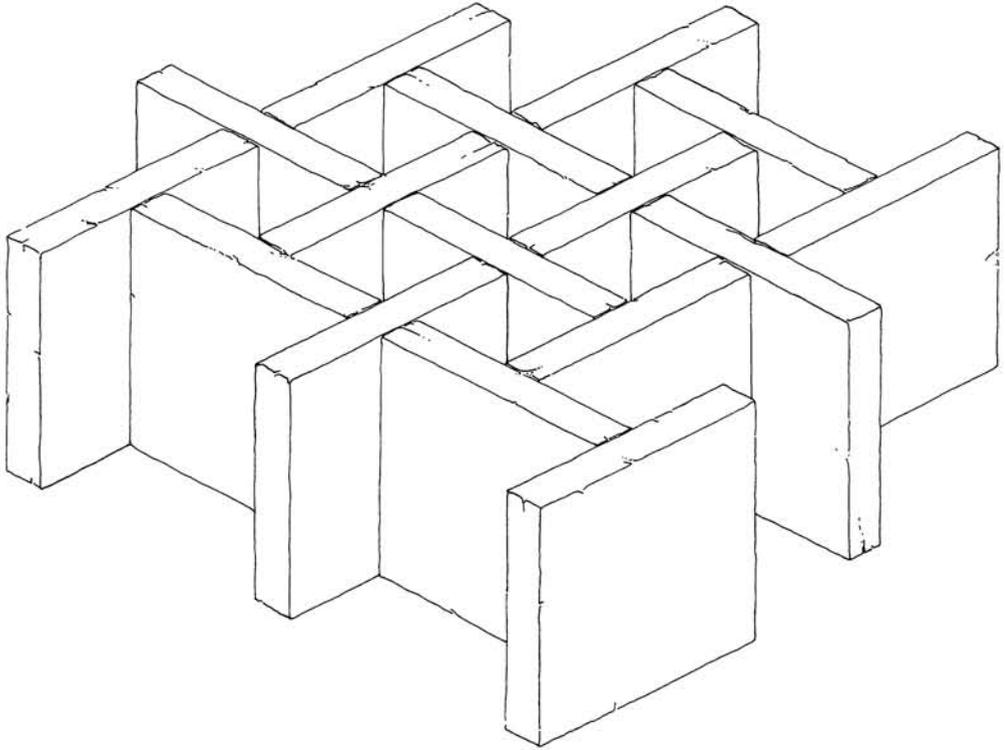


FIG. 3

Lattice tile-drying pattern from a 15th-century Flemish drawing.

(Pl. 1). A second layer is easy to pack on top, reversing the pattern sequence. Each pair of tiles thus carries another pair running at right angles. No difficulty was found in packing four layers and none envisaged in packing the six that would have represented the full capacity of the kiln. The pattern uses the same amount of space relative to the number of tiles as that envisaged by Drury and Pratt at Danbury.

Such a pack produced good parallels for the type-1 pattern of scarring (Fig. 1, top) found on many of the original Cleeve tiles, both the paired marks at right angles to the upper and lower bevel faces of the main body of the pack and large oblique sticky scars on those at the bottom (Fig. 5). The large messy scars resulted from the bottom tiles becoming stuck to the floor by glaze runs made worse by the fact that their bevel edges were in full contact. The other tiles, if packed carefully, lay at right angles to one another vertically and made contact only on the projecting upper edge of the bevel face.

Glaze-face faults were caused by two main factors. Firstly clumsy packing — allowing pairs of tiles to touch along the lower edge — which could be easily avoided and was not found amongst any of the medieval tiles from Cleeve Abbey. The second was the adhesion of fragments from tiles that exploded due to air pockets in the clay. The spaces between pairs of tiles were somewhat inclined to



FIG. 4

The tile-stacking pattern devised at Cleeve Abbey, 1997.

retain such debris which could then become fused to the glaze. A few possible examples of this were found amongst the Cleeve Abbey tiles. Some damage resulted from a minor collapse of the pack at the rear of the kiln caused by over-eager pushing in of a thermocouple. Whilst this particular problem would not have affected medieval tilers, collapses must have occurred. In this case some pairs of tiles fell against one another and stuck face to face whilst others suffered less serious blemishes.

Some of the scarring, particularly that on the bottom level could be avoided by using a more carefully designed floor. Ribs running across the floor (diagonally?) would make for a better return from the bottom level and it is interesting to note that kiln furniture consisting of long narrow unglazed tiles is known from a number of sites including Danbury. A fragment of kiln material found at Cleeve consists of the larger part of a heavily sanded, unglazed, rectangular tile with part of another

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## PLATE I

The tile kiln at Cleeve Abbey, Somerset, with the capping removed after firing, 1997. *Photo: D Dawson.*

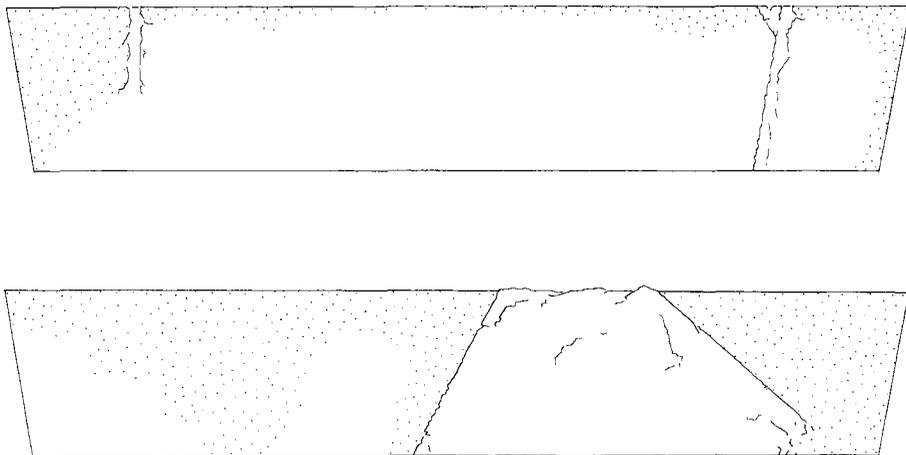


FIG. 5

Typical packing scars found on many of the tiles fired at Cleeve Abbey in 1997. Top, tiles from the upper part of the pack. Bottom, tiles from the floor level. Grey areas show spread of glaze.

fused to it. On its upper face a section of glazed tile adheres to it by one edge. Other damage suggests that at least two other tiles were once fused to it (this piece represents the remains of a fairly serious collapse and is therefore of limited use as evidence for packing method beyond the use of specialized tiles). Occasional adhesion to such supports would give damage patterns similar to that found amongst the Cleeve Abbey tiles.

#### CONCLUSION

Given that the tiles from Cleeve Abbey are of a number of periods and types, it is likely that a number of different approaches to production were employed. Nonetheless, the stacking scars on the tiles at Cleeve Abbey are in no way unusual and suggest that simple but effective packing techniques were employed for dealing with square and rectangular tiles. Previous suggestions as to what these might be have been are unsatisfactory. Whilst the system demonstrated above (Fig. 4) is clearly not a universal answer, it would seem to be a practical and straightforward method that is consistent with many of the stacking scars found at Cleeve and amongst floor tiles from other sites.

It is possible that a variant on this system could provide a parallel for the 45° angled scars recorded on some of the Cleeve tiles (Fig. 1, bottom), for instance by alternating between courses at right angles to the kiln walls and courses at 45° to them. Amongst modern Italian tiler's practices illustrated by Andrew Middleton in his recent paper on Roman tiles, a hackstead pattern illustrated suggests, albeit not clearly, another means by which such marks might be arrived at.<sup>13</sup> In the background of the same photograph, the tiler's sand table is remarkably similar to that in the Flemish drawing illustrated by Elizabeth Eames.

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<sup>13</sup> A. Middleton, 'Tiles in Roman Britain', in I. Freestone and D. Gaimster (eds.) *Pottery in the Making. World Ceramic Traditions* (London, 1997), 159, fig. 1f.