

Totternhoe Stone and Flint in Hertfordshire Churches

By EILEEN ROBERTS

THIS paper, after examining briefly the geology of the chalk formation, describes the characteristics of Totternhoe stone. The history of the quarries is traced, mainly from accounts of the king's works, and from the St. Albans Abbey chronicles. Profiles of mouldings taken from a dated and documented church tower in Bedfordshire are compared with profiles of mouldings from Hertfordshire with a view to identifying a Totternhoe style. Drawing upon the evidence of maps, paintings, verbal descriptions and photographs, the topography of the medieval quarries is reconstructed, and their manner of working and the problem of transporting the stone are discussed. The method of building a flint-rubble wall is described. The study concludes with an assessment of the influence of the use of Totternhoe stone and flint on the style of church architecture.

GEOLOGY

THE COUNTY OF HERTFORDSHIRE forms part of the geological region of London and the Thames valley (popularly known as the London basin), which includes also Essex, Middlesex, Buckinghamshire, Berkshire and Oxfordshire, with portions of Wiltshire, Hampshire, Surrey and Kent.¹ The chief characteristic of the region is a chalk escarpment running from SW. to NE., entering the area near Calne and leaving at Royston.² The W. part of the escarpment is unnamed, but N. and E. of the Thames it is called the Chiltern Hills. One of its highest points is Hackpen Hill, 887 ft., but it descends to 525 ft. near Royston. The escarpment is intersected here and there by valleys: at Goring, where it is cut by the Thames, at Wendover, Tring, Luton and Hitchin, forming routes through the high ground.

This chalk escarpment was a sedimentary formation laid down in cretaceous times, and probably was organic in origin.³ It is divided into the lower, middle and upper chalk. Although there is little sign of bedding, the chalk changes markedly from top to bottom. In places, on the NW. face of the scarp, the different strata are exposed (PL. XXI, A). Totternhoe (Beds.) is one of the few places where a layer of unusual hardness occurs, halfway down the lower chalk, above the sticky layer of the chalk marl.⁴ This hard layer, 15 to 17 ft. thick, called Totternhoe stone, has in the past been used much for building.⁵

¹ Sherlock (1960), 1. For key to shortened references see List of Abbreviations, p. 88 f.

² *Ibid.*, 3.

³ *Ibid.*, 20; J. A. Howe, 'Chalk', *The Encyclopaedia Britannica* (11 ed., New York, 1910-11), v, 806; K. P. Oakley and H. M. Muir-Wood, *The Succession of Life through Geological Time* (7 ed., London, 1967), 39; Warnes (1926), 20 and 22.

⁴ Only at Burwell (Cambs.) does the middle chalk attain a hardness suitable for building.

⁵ Howe (1910), 261.

Some geologists class Totternhoe stone as clunch,⁶ but, in the strictest geological sense, true clunch occurs only in the harder bands of the chalk marl series of Cambridgeshire. It is clearly differentiated from Totternhoe stone in such physical characteristics as specific gravity, weight and crushing resistance.⁷ Builders and masons, however, do refer popularly to all chalk rocks which can be used for building, including Totternhoe stone, as clunch.⁸

THE PROPERTIES OF THE STONE

Totternhoe is a compact and fine-grained limestone, composed largely of calcite in the form of minute polygonal cylinders of the shell *Inoceramus*,⁹ which give it a granular appearance. The presence of sand contributes its gritty texture and its comparative hardness; the colour, light greenish grey, derives partly from fine grains of glauconite (iron pyrites). These components are set in a calcareous matrix of crystalline structure.¹⁰ Like the fine-grained Caen stone and Magnesian limestone, it is classed as a freestone. It is so soft when first quarried that small pieces can be crumbled in the fingers and large blocks cut with a knife or wood-saw; this ease of working contributed to its popularity.¹¹ The test for Totternhoe stone is to scratch it with the thumb-nail; it is the only building stone which can be marked in this way.

In a building it is essential that the bedding layers of the stone used be placed horizontal to achieve resistance to water penetration, and improve weathering qualities;¹² and Totternhoe stone, as a sedimentary rock, does have bedding layers, although these are not clearly apparent when freshly quarried. However, since the joint-planes of Totternhoe stone are not vertical but zig-zag, it cannot be used successfully as ashlar.¹³

The porosity of chalk sets it apart from the more compact limestones; it absorbs water easily, although the volume retained is not great. The pores in the stone are so fine that a high surface tension is achieved, making the water difficult to extract. Totternhoe stone, when first quarried and full of water, is described as 'green' and is quite hard. After standing for a short period it becomes soft and can very easily be hewn, dressed, cut into mouldings or carved. After being cut, however, a very long period is required for drying out before it can be set satisfactorily in a building. First a crust forms, and this gradually thickens until it is hard throughout. If any attempt is made to work the stone after it is dry it tends to shatter.

⁶ Warnes (1926), 59; Howe (1910), 261.

⁷ Warnes (1926), 60. If his figure of 166 lb. is the correct weight per cubic foot, the specific gravity would be 2.68, not 1.86; Watson (1911), 317.

⁸ Watson (1911), 197.

⁹ British Museum (Natural History), *British Mesozoic Fossils* (3 ed., London, 1967), pls. 56-8, 60.

¹⁰ Warnes (1926), 59; Howe (1910), 261 and pl. vi, i.

¹¹ Kalm (1892), 294 and 297 f.

¹² A local builder involved in church maintenance work, Mr. Peter Handy of Puckeridge, estimates that wrongly laid clunch will disintegrate in ten years, but good quality clunch, correctly laid, will last for three or four centuries.

¹³ The main example of medieval ashlar in Herts., Sir William Say's chapel at Broxbourne, is of a harder limestone. Cheshunt tower and Ashwell Church are of irregularly coursed, squared rubble.

The water holding property of Totternhoe stone causes it to weather badly, as the absorbed moisture freezes, expanding and flaking it. When loose layers or scales fall away, forming large hollows, this process is known as exfoliation (PL. XXIII, B). The oxidization of the iron pyrites forms red patches and hastens decay.¹⁴ In an exterior position it is extremely vulnerable unless protective measures are taken, such as using a good damp-proof course, covering it with a protective layer of lime-wash, and deflecting the weather by an overhanging roof.¹⁵ Used inside, it is adequate, provided the interior is free of damp and atmospheric pollution. It cannot safely be used as flooring (but see p. 72), as it would soften and reduce to sediment should water ever stand on it.

Inside the quarries at Totternhoe, vertical fissures in the rock form a striking feature,¹⁶ but these should not be confused with the joint-planes of the stone. When plants grow on the surface above the chalk, their roots penetrate the soil allowing moisture in the form of humic acid to percolate down minute openings. This moisture collects, eroding the chalk, until vertical fissures are formed as much as 6 in. across and very deep. Down these the water trickles, and permanent springs are formed. In open pits chalk is difficult to quarry, as the excavations fill with water and have to be abandoned in winter,¹⁷ but where a vertical cliff-face is entered by tunnels, as at Totternhoe, the quarries can be drained more easily.

EARLY HISTORY OF THE QUARRIES

The history of Totternhoe is shaped by its geographical setting: to the S. and W. sweeps the Aylesbury plain, while to the N. and E. runs the dramatic scarp of the Dunstable downs (FIG. 18). In this scarp, just to the W. of Dunstable, occurs a promontory called the Knolls, rising above the flat plains beyond. Near by is the Icknield Way, the 4,000 year old series of trackways running below the crest of the scarp;¹⁸ while in the iron age was evolved a scheme of valley and cross-valley highways. The Romans made the latter permanent,¹⁹ and the Ver valley route from London to the midlands, the future Watling Street, was most useful for the local quarrying industry. The Romans certainly used Totternhoe stone, for a block of it was found built into the Roman road under the present Edgware Road in London,²⁰ and a large Roman villa at Totternhoe had internal walls constructed of the local stone.

The Anglo-Saxons contributed the suggestive place-name, Totternhoe (*Totenehou* in the Domesday Book), meaning 'promontory with a look-out house', an accurate description of the Knolls.²¹ The only Anglo-Saxon churches in

¹⁴ Warnes (1926), 59 f.

¹⁵ Purcell (1967), 28.

¹⁶ Kalm (1892), 293 f.

¹⁷ Purcell (1967), 25.

¹⁸ E. S. Wood, *Collins Field Guide to Archaeology in Britain* (2 ed., London, 1968), 129 f.

¹⁹ R. E. M. Wheeler, 'Belgic Cities of Britain: Wheathampstead and Verulamium', *Antiquity*, VII (1933), 33; Dr. Prior, 'Dunstable and the Watling Street', *Assoc. Archaeol. Soc. Rep.*, XI (1871-2), 150-5.

²⁰ T. Codrington, *Roman Roads in Britain* (London, 1903), 68.

²¹ A. Mawer and F. M. Stenton, *The Place-names of Bedfordshire and Huntingdonshire* (English Place-name Society, III, 1926), 139.

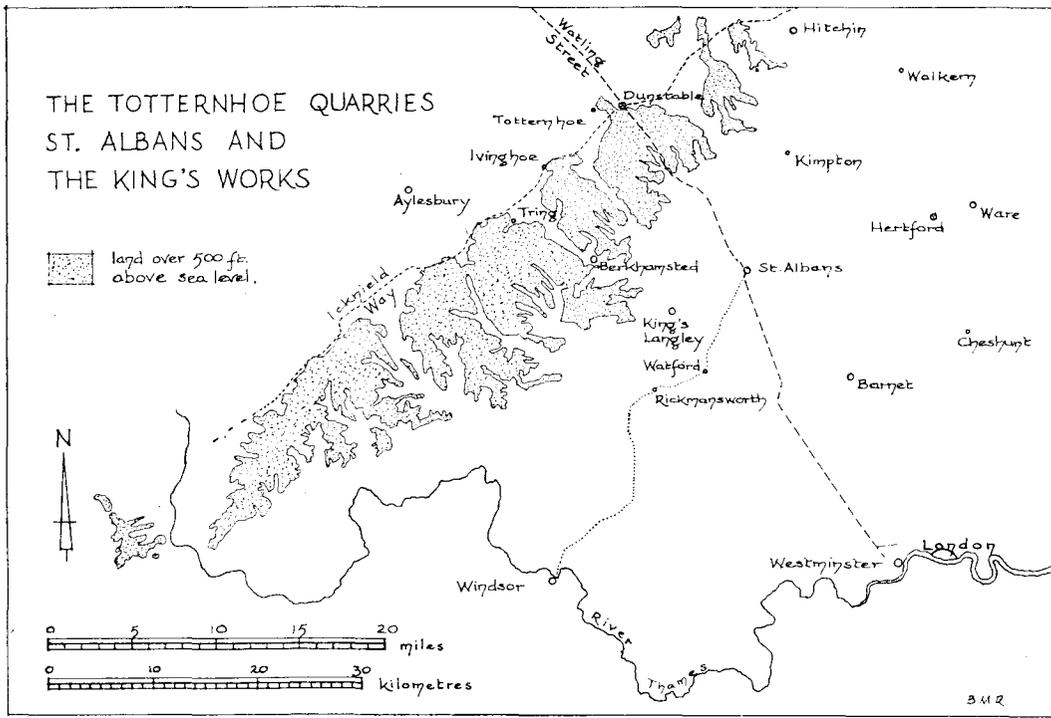


FIG. 18
LOCATION MAP OF TOTTERNHOE
and other places mentioned in the text (pp. 69 ff., 78)

Hertfordshire which survive are those of the more durable Barnack stone,²² but the Saxon road at Walkern is certainly carved from chalk; it may have been carted eastwards along the Icknield Way and down the Hitchin gap (FIG. 18).

The Normans crowned the Knolls with a motte-and-bailey earthwork,²³ one of the two strongest castles in Bedfordshire, exploiting the natural advantages of the site and protecting the valuable quarries (FIG. 19). About 1132 a charter of Henry I established a monastic house of Austin canons at Dunstable, where the Icknield Way crosses Watling Street,²⁴ and among other lands it was endowed “. . . de Tothenho, et quadrarium eiusdem uillae” as a valuable asset. Thirty miles due S. lay Windsor where, during the reign of Henry II, a programme of building works was begun. The accounts for these works refer to “stones from *Eglemunt*

²² Anglo-Saxon long-and-short work is seen at Reed and Westmill. See also R.C.H.M., *Hertfordshire*, (London, H.M.S.O., 1911), 10.

²³ William gave the land of the English thegn Levenot in NW. Bedfordshire and at Totternhoe to a family of Flemish adventurers known as de Wahull. Their main stronghold was at Odell, but they granted Totternhoe to a man called Osbert. See J. Godber, *History of Bedfordshire, 1066-1888* (Beds. County Council, 1969), 23.

²⁴ Sir W. Dugdale, *Monasticon Anglicanum*, ed. J. Caley *et al.* (London, 1830), VI, pt. i, 239 f.; Godber, *op. cit.* in note 23, 45; V.C.H., *Bedfordshire* (1904-14), I, 371.



FIG. 19

MAP OF THE TOTTERNHOE AREA (pp. 69 ff., 78, 84)

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sent for the work of the King's houses of Windsor" and to 100s. 8d. paid for them;²⁵ there are other similar entries. The name *Egremunt* for the castle mound appears for the first time in 1166;²⁶ this the English Place-name Society considers to be a picturesque name given by the Normans meaning 'eagle's hill'. The word is spelled *Egremont* in other documents and J. H. Harvey, noting the steep precipice on the W. side of the promontory,²⁷ believes this the more correct form, derived from *acer mons*.

The Norman abbey at St. Albans, 14 miles S. of Totternhoe, was built mainly of Roman brick collected from the ruins of *Verulamium*.²⁸ Totternhoe stone apparently was used first under Abbot John de Cella (1195-1214), when the then existing W. front was demolished and the mason Hugh de Goldcliffe put in charge of the rebuilding. Although the stone used is not named, the description of its reaction to weather suggests a poor quality chalk used with insufficient care: "And as the

²⁵ Hope (1913), I, 15 f. and 20; Knoop and Jones (1938), 20 f.

²⁶ Mawer and Stenton, *op. cit.* in note 21, 140 f. When Hope wrote *Windsor Castle* in 1913, he could not locate Egremont: *op. cit.* in note 25, I, 20. It was first identified as Totternhoe in V.C.H., *Beds.* (1904-14), III, 448.

²⁷ W. Camden, *Britannica*, ed. R. Gough (London, 1789), I, 331.

²⁸ R.C.H.M., *A Guide to Saint Albans Cathedral* (London, H.M.S.O., 1952), 8.

walls were left uncovered during the rainy season the stones, which were very soft, broke into little bits, and the wall, like the fallen and ruinous stonework, with its columns, bases and capitals, slipped and fell by its own weight; so that the wreck of images and flowers was a cause of smiles and laughter to those that saw it."²⁹ From the end of the 12th century Totternhoe stone was used almost universally for dressings and interior work in the parish churches of S. Bedfordshire and Hertfordshire. It is well adapted to the carving of stiff-leaf capitals, of which examples can be seen at Offley (Herts.), Eaton Bray (Beds.) and Ivinghoe (Bucks.).³⁰

The stone of *Eglemont* continued to be used in the king's works. A royal palace had stood at Langley, for example, 5½ miles SW. of St. Albans, at least since 1279.³¹ On 22 September 1318 the sheriff of Bedfordshire was allowed £40 for "the wages of four men working in the quarry of *Eglemont* in his bailiwick, and in carriage of stone thence to *Langele*, by virtue of the king's order to provide four men to work in the quarry and to carry the stone to *Langele*, and to pay them their wages".³² On 24 February 1344 Hugh of Kimpton (Kymton) was "to take as required in the counties of Bedford and Hertford sufficient carriage for stone of *Eglemound* which the king has ordered to be purveyed in those counties for the same works".³³

Important royal works were proceeding at Westminster in the 14th century. The mason William Patrington was employed on carving images at St. Stephen's Chapel from 1351 to 1358; he ordered stone from *Eglemont* to the value of 10s. for the statue of St. Stephen.³⁴ On 16 August 1355 we read of the "appointment of Thomas de Cantuarria, 'mason', to buy 20 cartloads of stone of *Egremont* by Dunstable for the works in the palace of Westminster and to take carriage for the same; to be paid for at once out of the king's moneys".³⁵ Only in 1358 is the quarries' location actually given and their extent indicated; in a charter of Edward III to Dunstable Priory there is reference to half an acre and half a rod of quarry lying in "*le Newequarer de Eglemond in campo del North de Totornho*" of which 1½ rods lay beneath the "*forlong*" next the quarry of Richard Pour, mason, and one rod lay in the same field on the hill called "*quarehul*".³⁶ The pre-enclosure map of Totternhoe parish, drawn up in 1829 before the medieval open-field system had been altered, clarifies this charter.³⁷ The village of Totternhoe, which now straggles along from Lower End through Middle End to Church End, originally was concentrated in Church End alone. The quarries lay N. of this, at the end of a footpath called Quarry Way which ran roughly N. and S. (FIG. 19); along this the quarrymen

²⁹ *Gesta Abbatum*, I, 219, translation in Salzman (1967), 376. There is no mention of Totternhoe in the *Building Accounts of King Henry III*, ed. H. M. Colvin (Oxford, 1971), although masons from, or with the surname of, Dunstable and St. Albans appear. The term 'white-cutters' is frequent (p. 7), apparently used synonymously with 'stone-cutters' (p. 467) with no implications of working in clunch.

³⁰ N. Pevsner, *The Buildings of England* (Harmondsworth, 1953-68), *Hertfordshire*, pl. 21, a; *Bedfordshire*, pl. 29; and *Buckinghamshire*, pl. 10, a.

³¹ Colvin (1963), II, 970 f.; D. S. Neal, 'Excavations at the Palace and Priory at King's Langley, 1970', *Herts. Archaeol.*, III (1970), 31.

³² *Calendar of Close Rolls*, 22 Sept. 1318, p. 16.

³³ *Calendar of Patent Rolls*, 24 Feb. 1344, p. 283.

³⁴ Colvin (1963), I, 521; Harvey (1954), 206.

³⁵ *Cal. Pat. Rolls.*, 16 Aug. 1355, p. 277.

³⁶ Bagshawe (1968), I, 5; V.C.H., *Beds.*, III, 448.

³⁷ Beds. Record Office, map BW 1004/1 and 2.

doubtless went to their daily work. The 1358 charter shows some quarries to be in private hands, and one in particular held by a mason; Knoop and Jones gathered other examples of medieval masons who dealt in stone commercially.³⁸

Edward III continued work on Windsor Castle, and in the week beginning 3 March 1354 the sum of 100s. was paid to Sir Simon of Swanland for a vault of *Egremont* stones bought in bulk for the treasury.³⁹ This chamber, still *in situ*, demonstrates the suitability of this light porous stone for vaulting, much as the Romans had used tufa.⁴⁰ The entry states that Sir Simon was to receive 16s. 6d. for carriage of the *Egremont* stone "*de Horfelde usque Wyndesore per xii leucas*". The exact location of *Horfelde* has yet to be established; presumably it was in the Totternhoe area. From Windsor it was 12 leagues distant, or 36 miles, taking a league as 3 modern miles. This information casts light on the route of transport. A study of the physical map reveals the scarcity of deep water channels between the Thames and the Ouse; the most economical route to Windsor appears to have been by road, along Watling Street to St. Albans and then SW. through Watford and Rickmansworth to Windsor (FIG. 18). Such a route is, in fact, about 36 miles from Totternhoe.

St. Albans Abbey, although it used Totternhoe stone from an early date, waited more than two centuries before it actually purchased a quarry in the time of Abbot Michael de Mentmore (1335-49): "Among other benefits which he devised for his monastery and contributed, he acquired a large section of the stone quarries at *Egremont*; where, without cost or grudging, they could extract adequate supplies of stone ready for the various building works for the monastery, as often as necessary."⁴¹ The fabric of the abbey church, other than the insertion of the Perpendicular windows and the addition of turrets and battlements, was by this time largely completed. Doubtless stone from the abbot's private quarry provided materials for improvements to the conventual buildings in the next century and a half. Abbot Thomas de la Mare (1349-96), for example, "pulled down the wall of the Refectory adjoining the cloister, which was weak and ruinous, and caused it to be supported internally and strengthened with stouter columns cut from large blocks of stone of *Egelmounde*, as is clear to all who now see it."⁴²

The Dominican Priory at King's Langley was largely built of flint and Totternhoe stone. In 1360 the king assumed responsibility for completing these building works, and the royal accounts show that two masons, Walter atte Forde and William le Rede, acted as auxiliaries at the *Egremont* quarry in the period from 1366 to 1377, to supervise drawing out and rough dressing the stone.⁴³ At Langley Palace, a layer of London, John Smith, paved the bath-house in 1368-9 with Totternhoe stone and erected a fireplace of the same material in the king's chamber.⁴⁴

The king and the abbot of St. Albans were the most eminent clients of the Totternhoe quarries, but a considerable market existed in the parish churches.

³⁸ Knoop and Jones (1967), 93 f.

³⁹ Hope (1913), I, 150 and 166, n. 185; Colvin (1963), II, 875.

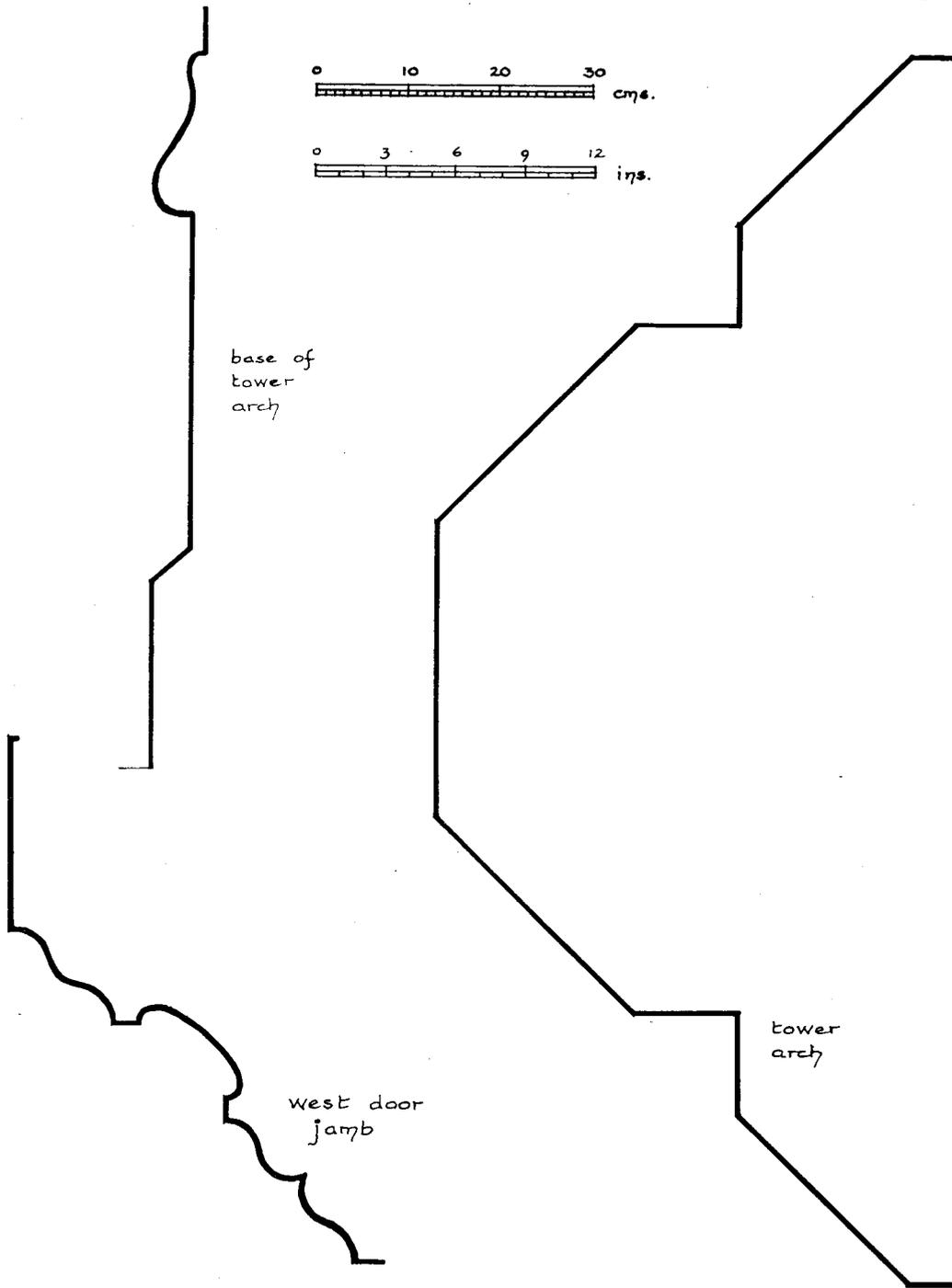
⁴⁰ Howe (1910), 262.

⁴¹ *Gesta Abbatum*, II, 361.

⁴² *Gesta Abbatum*, III, 386; Salzman (1967), 399.

⁴³ Colvin (1963), I, 259 and 263.

⁴⁴ Colvin (1963), II, 974, but see p. 68.



B.M. Roberts, 1971.

FIG. 20

ALL SAINTS' CHURCH, HOUGHTON CONQUEST, BEDS.

Profiles of mouldings used in the W. tower, which Philip Lessy and William Farele contracted to build in 1392 (p. 75)

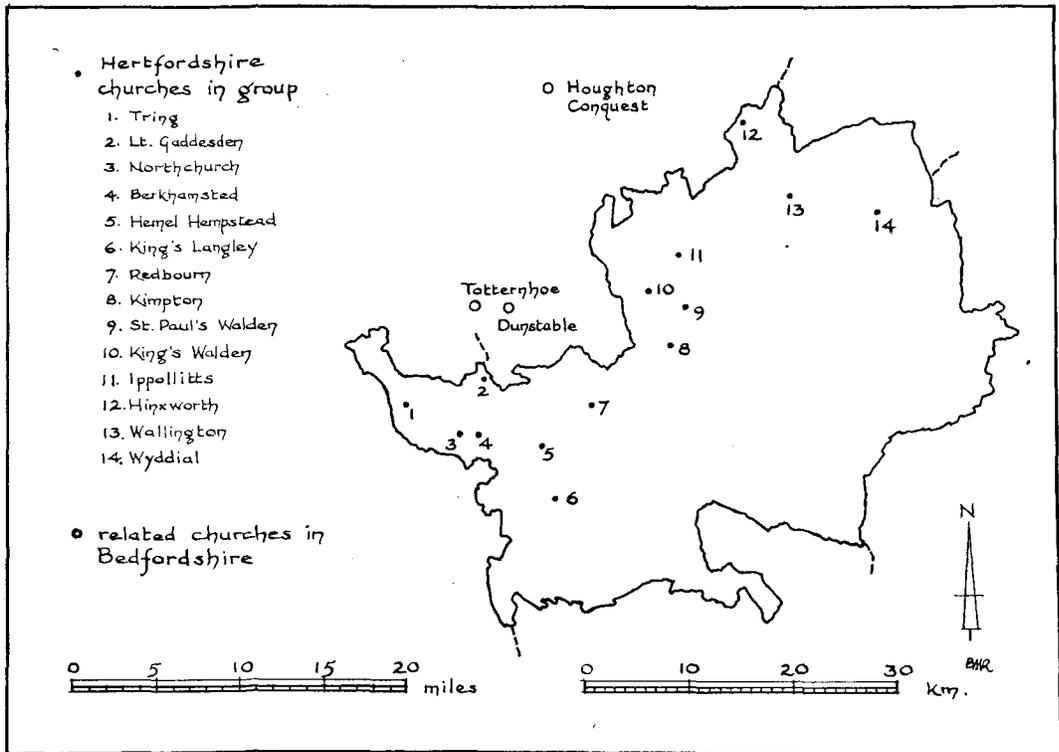


FIG. 21

MAP OF SOME CHURCHES

showing characteristics of the style of Philip Lessy and William Farele (p. 75)

Records at this level rarely survive, but the church of All Saints', Houghton Conquest (Beds.) is an exception. In a document dated 1 November 1392, William Farele, mason of Dunstable, and Philip Lessy, mason of Totternhoe, contract with the rector and others to build the 'belfry' (tower) within three years. They were to receive 10s. a foot for the foundations, and from the ground up 13s. 4d. a foot plus six quarters of wheat ("*frumenti*").⁴⁵ The estimated total cost was to be £40. All Saints', Houghton Conquest, appears to be built of a reddish sandstone rubble with dressings of Totternhoe stone (PL. XXIII, A). It is interesting to note that Philip Lessy of Totternhoe had been working in 1368 on the king's manor of Chiltern Langley for 5½d. a day,⁴⁶ and that the W. window tracery of Houghton Conquest Church is similar to that of All Saints', King's Langley, and to a S. window in St. Giles, Totternhoe (PL. XXIII, B). Houghton Conquest church is impressive on account of its rich colour, angle buttresses and tall tower, forming a landmark on

⁴⁵ H. T. Wake, *Catalogue(s) of Books, Antiquities, etc. on sale by H. T. Wake* (Derby, 1882). Medieval payments, such as corn-rents, etc., commonly involved wheat as a counterpoise to inflation of currency, as Mr. J. H. Harvey pointed out to me.

⁴⁶ Harvey (1954), 166.

the flat plain on which it is located; the range of mouldings, however, is not outstanding (FIG. 20). The tower arch is moulded with a simple double chamfer, its base with an inverted wave. The W. door, which has no label, is moulded with a wave, fillet, casement, fillet and double-ogee; the wave is basically a Decorated element which persisted into the Perpendicular period in provincial areas. The mouldings could be described as simple and unadventurous. If comparable mouldings are looked for elsewhere in Hertfordshire, there is a number of churches in the N. where are found similar characteristics (TABLE I, p. 76; FIG. 21). Whether they reflect the personal style of Lessy and Farele, or represent a 'Totternhoe style' must remain a matter for speculation. Masons from the Totternhoe area apparently found no shortage of commissions in the county, but they would not qualify as pace-setters or leaders of style.

On 28 July 1394 John Dany, a "*quareour*" of "*Toternowe*", who had been born in Ireland, was granted a license costing 20s. allowing him to remain in England for the rest of his life.⁴⁷

Meanwhile, work continued at St. Albans Abbey. Abbot John Moot (1396–1401), "when he became abbot, took down the parapet of the Greater Gate of the monastery, of *Eglemounde* stone, fragile and broken, and put up a parapet of hard Kentish stone, very lasting".⁴⁸ In the time of Abbot John of Wheathampstead, who ruled for two terms, 1420–40 and 1452–65, the word *Eglemunt* is superseded by the older name, Totternhoe; for his extensive works, additional quarries were needed, and in his accounts there are entries: "*Item, in perquisitione unius querrerae de Willelmo Hunt, apud Toturnho, xii^{li}. Item, in perquisitione unius alterius querrerae ibidem, de Thoma Jakes, viii^{li}.*"⁴⁹ This is one of the last medieval references to the quarries.

THE TOTTERNHOE QUARRIES DESCRIBED

There are no original records that describe the appearance of the medieval quarries or the method of extracting stone, and the coming of the railway and the modern cement industry have greatly altered the site. The last pit was closed in 1914 and the galleries are now sealed off as unsafe for entry.^{49a} Unusually interesting source material exists, however, from the 18th century onwards. If this is used with due caution and interpreted in the light of the medieval documentary research of Knoop, Jones and Salzman, it is possible to reconstruct from it a picture of the quarries that supplied the medieval stone masons of Hertfordshire.

The record of Peter Kalm, the Swedish Academician and botanist who visited the Totternhoe caves in 1748, is the most valuable modern source; an English translation was published in 1892.⁵⁰ His detailed account, which verges on the pedantic, describes everything he observed at the quarry, inside and out. Three centuries separate Kalm's visit from the late middle ages but, judging by modern standards, social change was relatively slow during that period. Knoop and Jones, studying the English medieval quarry, concluded that methods then were not

⁴⁷ *Cal. Pat. Rolls*, 28 July 1394, pp. 453 f. and 459.

⁴⁸ *Gesta Abbatum*, III, 447; Salzman (1967), 402.

⁴⁹ Amundesham, *Annales Monasterii Sancti Albani* (ed. H. T. Riley, Rolls Series, London, 1871), II, 266.

^{49a} But see addendum, p. 890.

⁵⁰ Kalm (1892).

TABLE I
CHURCHES WITH CHARACTERISTICS OF PHILIP LESSY AND
WILLIAM FARELE

	Angle buttresses	Base of tower arch with inverted wave moulding	Door or arch with wave, fillet, casement, fillet, double-ogee moulding	Window tracery with dagger motif	Tower arch chamfered	Base course with chamfered fillet and ogée	Two-light window with single reticulation above	Window with chamfered mullion	Window jamb chamfer, with casement, fillet, hollow moulding
Houghton Conquest, Beds.; tower; 1392	×	×	×	×	×	×	×	×	×
Berkhamsted, Herts.; <i>passim</i>	×			×			×	×	×
Lt. Gaddesden, Herts.; tower and N. aisle	—	×	—	×	×	—	×	×	×
Hemel Hempstead, Herts.; S. aisle and transept	—	—	—	×	—		×	×	×
Hinxworth, Herts.; tower; 1364/5	×	—	—	—	×	—	×		
Ippollitts, Herts.; tower	×			×			×		
Kimpton, Herts.; tower	×	—	—	×	—	×	×		×
King's Langley, Herts., tower	—	—	×	×	—	—	×	×	
Northchurch, Herts.; tower <i>etc.</i>	×	—	—	—	×	—	×		
Redbourn, Herts.; <i>passim</i>	×	—	×	—	—	—	×		
Tring, Herts.; tower <i>etc.</i>	×	×	—	—	—		—	×	×
King's Walden, Herts.; tower	×	—	—	—	—	×	×		
St. Paul's Walden, Herts.; tower	×	—	—	—		×	×		
Wallington, Herts.; tower <i>etc.</i>	—	×	—	—	×	×	×		×
Wyddial, Herts.; tower	—	×	—	—	×		×	×	×

Key
 × = present
 — = absent
 blank = indeterminate
 or inapplicable

substantially different from those practised today, except for the use of explosives and water pumps.⁵¹

Among other sources a water colour by G. Shepherd, dated 1813, showing in detail the entrance to the stone quarry is of special interest (PL. XXI, B).⁵² Slightly later in date is the Totternhoe pre-enclosure map of 1829, which includes

⁵¹ Knoop and Jones (1938), 36.

⁵² Beds. Record Office, X 254/88/249.

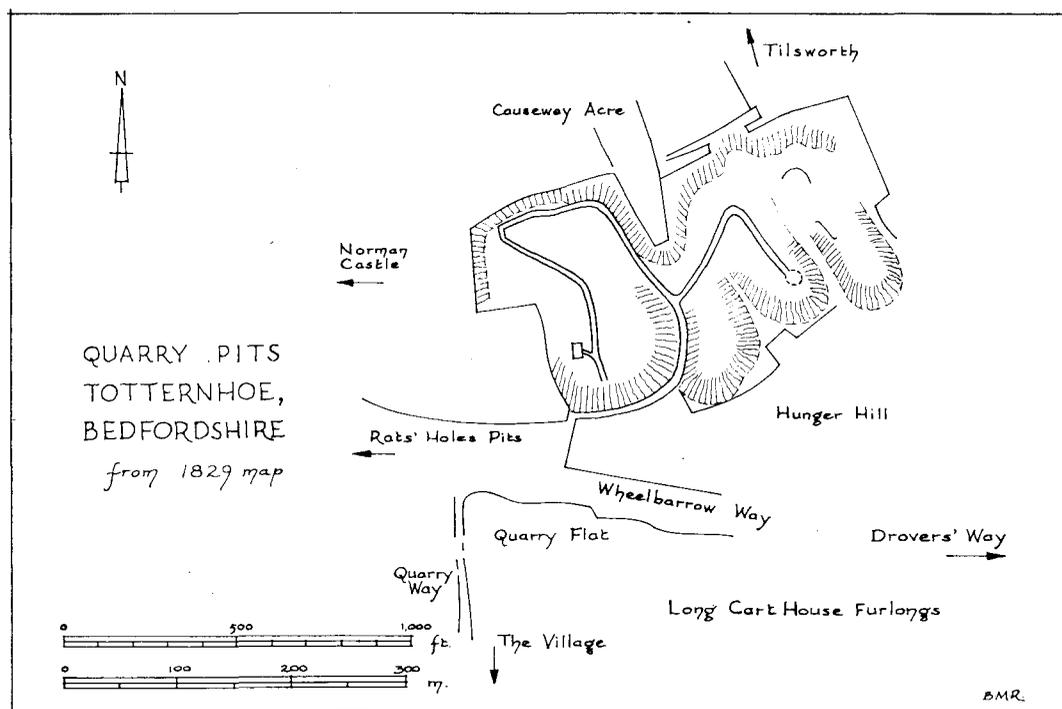


FIG. 22
TOTTERNHOE, BEDS.
Quarry pits from a map of 1829 (p. 75)

most of the parish and has an accompanying register of all the lands, listed furlong by furlong; the place-names used on this map, and the disposition of paths and roads now lost, form an invaluable record (FIG. 22).⁵³ That the medieval open-field system should have persisted so late in the agricultural sphere suggests that the quarry itself may not have substantially altered.

An oil painting by W. Nicholls painted *c.* 1840, unfortunately no longer in this country, illustrates the interior of the galleries.⁵⁴ The Bedfordshire Architectural and Archaeological Society entered the quarries during a visit in 1871 and J. Wyatt recorded their observations.⁵⁵ In 1878 the first Ordnance Survey was made of the area, and the results published in 1888;⁵⁶ this too is a useful reference, although the Leighton Buzzard and Dunstable branch of the L. & NW. Railway had already disturbed the landscape. An aerial photograph taken by Aerofilms

⁵³ Beds. Record Office, map BW. 1004/1 and 2.

⁵⁴ This is believed to be in the possession of Mrs. Phyllis Jane Stanley of California, U.S.A., and Eversholt, nr. Bletchley, Bucks. It is reproduced by Bagshawe (1968), i, 5.

⁵⁵ 'The Twenty-fourth Report of the Bedfordshire Architectural and Archaeological Society', *Assoc. Arch. Soc. Rep.*, xi (1871-2), 1-li and 149-50.

⁵⁶ The date of field survey may precede that of publication by up to two decades; see J. B. Harley and C. W. Phillips, *The Historian's Guide to Ordnance Survey Maps* (The National Council of Social Service, 1964), 7. The scale of these maps is 6 in. to one mile, and the relevant portions are NW. Herts., part of sheet xviii, and Beds., sheet xxxii.

Ltd. in 1948 and another by Cambridge University in 1971 show the modern aspect of the terrain,⁵⁷ while useful pictures of the interior of the mine were obtained by the Manshead Archaeological Society when the quarry was entered, probably for the last time, in 1959 (PL. XXII, A-B).

Drawing from all these sources, and organizing the information in the form of a perambulation, an attempt may be made to reconstruct a picture of the quarries. Leaving Dunstable by the Icknield Way, the A505 (FIG. 18), and travelling SW. there is reached, after $\frac{3}{4}$ mile, Green Lane, a narrow bridle path, once called Drovers Way, branching off to the right; this probably was the route of the stone-laden carts bound for St. Albans, Windsor and other building sites (FIG. 19). Farther along, the Icknield Way branches off the Totternhoe road, which runs W. for 1 mile before forking; the S. fork leads to Church End, the original Totternhoe village; its parish church is dedicated to St. Giles, patron saint of cripples (though the quarrymen claimed that few were injured through falling rock).⁵⁸ The other fork, Castle Hill Road, leads NW., with the ground rising sharply on the right to form Hunger Hill: a great mound of soft chalk, 500 ft. above sea level, covering the hard Totternhoe stone stratum. About a mile ahead are the Knolls, crowned by the Norman motte. In the depression between these heights is the winding, chalky, deeply-rutted footpath known as Quarry Way; it goes steeply uphill almost due N., and probably represents the route of the villagers who worked in the quarries. In recent years the upper chalk has been removed completely from a great rectangular area, forming a vertical section through the former Hunger Hill (PL. XXI, A). The surface of the Totternhoe stone stratum has been scraped almost bare, and where the medieval gallery roofs have subsided as a result of moisture penetration, protective fences have been erected.

At the end of Quarry Way is a field called Quarry Flat and, beyond, a common, apparently a service-area. Here modern alterations have been extensive, and the 1829 map is required to reconstruct the earlier scene. Under Castle Hill on the left are open diggings called Day Light Pit; in the earliest times the stone would have been quarried in open pits, the hill being entered by shafts only when the overburden became too great. The approaches to the main medieval quarries, the Quarry Pits, occupy more than 16 acres to the right; the quarries themselves tunnel under Hunger Hill (FIG. 22). A broad thoroughfare called Wheelbarrow Way ran across Hunger Hill in an ESE. direction; it is still visible in the 1948 aerial view, but it is now obliterated completely. Taking a narrow footpath running ENE. along the cliff edge the visitor would find himself in the position of the uppermost group of figures seen in Shepherd's painting, when the sheer fall of the cliff was 120 ft. below (PL. XXI, B).⁵⁹ Looking N. across the Quarry Pits, the ground slopes gradually away towards Tilsworth. Beneath, the Quarry Pits themselves seem like the deep impress in the earth of a gigantic hand, the depression of each finger the entrance to a quarry. To reach these entrances footpaths, looping in a

⁵⁷ Aerofilms reference number A14292; University of Cambridge Committee for Aerial Photography, numbers 147/989224-147/991224.

⁵⁸ Kalm (1892), 298.

⁵⁹ *Ibid.*

great m-curve and following the ridges between the 'fingers', effect a gentle but circuitous descent to the mouths of the caves. At the lowest level the footpath becomes a deep channel or trackway for carts leading to the quarry entrance; Kalm mentions these adits or horizontal passages at the approach to the caves; they survive most clearly in the pits farthest from the castle. Now the cliff rises steeply above. The scale is impressive even today, though 80 ft. of upper chalk have been removed.

Falls of rubble or deliberate dumping completely cover the quarry entrances at present, but W. G. Smith, the Dunstable antiquary, reported in 1904 the existence of ruined entrances,⁶⁰ and T. W. Bagshawe remembers a filled-in adit, with only a few feet at the entrance open.⁶¹ The 1959 entry was effected through vertical shafts let into the quarry from above.⁶² The Shepherd water colour shows a broad, level, apparently much used road and this continues into the chalk cliff. The 12 ft. of walling described by Kalm to prevent the *hurlok* (the local name for the middle chalk) from sliding down and filling up the entrances is also clear in the painting (PL. XXI, B).⁶³ The scale of the human figures shows the cave entrance to be twice the height of a man, with very strong jambs and lintel.

At the entrance to the caves lights were lit by those wishing to enter, for according to Kalm, inky blackness prevailed about 40 ft. inside the quarry.⁶⁴ Niches were cut into the walls to hold candles. If these were accidentally extinguished, persons could be lost for several days before being rescued. A torch is seen in Nicholls' painting of c. 1840, consisting of a horizontal tube for fuel, ignited at the end.

Inside, the quarry consisted of a main gallery or passage cut into the living rock, called an 'adit' by Kalm and 'street' by the local people (PL. XXII, A). Near the entrance its shape was described as a 'gothic arch',⁶⁵ a picturesque reference to the tall parabola which is the most stable form of tunnel in this soft stone.⁶⁶ Farther in, however, the adits become rectangular, this less stable shape no doubt contributing to the unsafe condition of the galleries today. The adits generally ran horizontally or sloped slightly downwards; in Gough's edition of Camden's *Britannia* they are said to "descend by winding ways to a great depth".⁶⁷ Kalm followed one adit for a distance of 660 ft., while Jim Linney, a quarryman born in 1884 and interviewed in 1949, said the longest adit was about a $\frac{1}{4}$ mile long.⁶⁸ According to local legend, they stretch to Dunstable 2 miles away. The effect, wrote Kalm, was of a gallery supported by pillars of clunch varying in thickness from 18 in. to 6 ft., square or rectangular in section, left in position to carry the roof. Posts of wood provided additional support, at least by 1840. J. Wyatt reported in 1871 that

⁶⁰ W. G. Smith, *Dunstable: Its History and Surroundings* (London, 1904), 123.

⁶¹ Bagshawe (1968), ii, 5.

⁶² Matthews (1962), 33.

⁶³ Kalm (1892), 292.

⁶⁴ *Ibid.*

⁶⁵ Matthews (1962), 33. When a tunnel is thrust through the chalk, with its zig-zag joint-planes, pieces falling from the roof tend to be triangular.

⁶⁶ Through sandstone a tunnel could be gently arched; whilst a very strong stone, like granite, would be quite stable with a horizontally-roofed tunnel.

⁶⁷ *Loc. cit.* in note 27.

⁶⁸ Bagshawe (1968), i, 5.

'excavators' had recently found old workings, apparently abandoned through the caving in or collapse of the strata above.⁶⁹ As to the dimensions of the passages, in Kalm's day they were 6 ft. wide and 7 ft. high, but a century and a half later Linney reported them to be 10 to 12 ft. wide and 8 to 10 ft. high. The roofs and walls were uneven because of the quarrying of the stone. In places they were on two floors with steps going to the upper galleries.⁷⁰ At the sides, other adits branched off at all angles, but the miners sealed off many of these when exhausted with loose rubble. The effect was described as a maze, labyrinth, honeycomb or meander, in which it was extremely easy to get lost; recent visitors have used cords as guides. No plan of the galleries has been traced,⁷¹ although the modern chalk quarrymen are reported to have surveys of the quarries. Aerial photographs taken at the end of April 1971 revealed little of the plan of the galleries, for they are hidden by the spread of new top soil.⁷²

According to Kalm, the stone inside the quarry was grey or clay-coloured and, when worked with iron tools, had a very bad odour like a '*Stink-stein*'.⁷³ The quarry masons brought in shoots of wild thyme and sweet briar which they stuck into the walls of the passages; these would stay fresh for months in the moisture-retaining chalk. In winter the water trickled down from above through the fissures in the roof, which Kalm wrongly interpreted as the joint-planes of the stone. He was much struck by their width, varying from very narrow to 6 in. across, and by their depth: a 4-ft.-long stick could go in without touching the ends. The quarrymen used the trickling water for sharpening their tools. The speed of the water filtering down from the roof was noted by Wyatt in those parts "just one the line of saturation".⁷⁴ In winter the adits were very sticky and muddy, but never so much as to require closing. In a lease of 1870 there is a reference to 'water-courses'⁷⁵ and in Shepherd's painting a pond is seen in the right foreground; these must have been constructed to assist drainage. Despite the dampness, the quarrymen did not find their health affected, and in summer the interior was very dry.

An efficient master mason would select personally in the quarry the stones he wished to use in his building.⁷⁶ Kalm tells us that the only tools used in the mine were specially sharpened pickaxes, ordinary iron wedges and mallets.⁷⁷ The stones were trimmed on the rock face, and evidence for this was noted in 1959. Kalm describes how the quarryman had to make only the horizontal divisions in the stone, as the vertical fissures existed already; a horizontal line was first hewn with

⁶⁹ Wyatt (1871-2), 149 f.

⁷⁰ Matthews (1962), 33.

⁷¹ Mr. Roger Bates, managing director of the Totternhoe Lime and Stone Company, reported that his father had possessed a plan of the quarries, but that it was loaned to a scholar and never returned.

⁷² The national grid reference to the area over the tunnels is SP 986225.

⁷³ Kalm (1892), 294 and 298. He uses the Swedish word *orsten*. Howe (1910), 261, claims that the stone is white when freshly broken.

⁷⁴ Wyatt (1871-2), 150.

⁷⁵ This lease, dated 14 March 1870 from Earl Brownlow to Philip de Berenger (Beds. Record Office, BW. 855), marks the end of quarrying by individual owners and the beginning of lime burning, Bagshawe reports. On the 1829 map, such names as 'water mill furlong' and 'well head furlong' appear.

⁷⁶ The upper 9 ft. of the Totternhoe stone strata tend to be soft and poor in quality, the best stone occurring in two lower beds 4 ft. thick: Howe (1910), 261.

⁷⁷ Kalm (1892), 297.

the pick in the desired position, and then wedges of iron were knocked into it. The block could then be sprung loose horizontally to any depth required. A newly-cut block ready to be removed from the quarry was observed on the visit of 1959 (PL. XXII, B). The stone at this stage should have been marked with its bedding planes to ensure that these would rest horizontally in the finished building.

The stone next had to be removed from the quarry. Kalm reports how the quarrymen loaded it on low wagons or trucks made of solid oak timbers, resting not on wheels but on two rollers of ash one foot in diameter. These were then pulled out by ropes. Just such a wagon is illustrated in Shepherd's painting (PL. XXI, B). Judging from the scale of the attendant figures, the stone measured roughly 5 ft. by 3 ft. by 3 ft.; according to Howe, blocks of up to one ton in weight could be quarried.⁷⁸ Kalm said that smaller pieces were taken out by wheelbarrow; one is seen in Nicholls' painting. In 1959 the Manshead group photographed a block of stone on rollers ready to be hauled away, and saw on the chamfered corners of the vertical shafts rope burns, with evidence in places that these had been skilfully repaired (PL. XXII, B). In *Dunno's Originals* the stone is said to have been drawn out on sledges with low wheels.⁷⁹ Up until 1890, when T. and A. Marshall the stone-masons of Dunstable had a thirty year lease on the quarry, employing twenty men there and fifty in their yard at Dunstable, the stone was loaded on low trollies 3 to 4 ft. wide, standing 1 ft. off the ground, and pulled out of the quarries by horses.⁸⁰

Kalm reports that in his day, if a stone had to be raised up the hill at the entrance of the mine, it was "wound up along the road with a windlass", a contrivance for hauling and hoisting consisting essentially of a horizontal roller and beam on supports, with ropes or chains wound round.⁸¹ And so, Kalm continues, the stone was "drawn to the place where they intend to hew and work at it", but he does not define exactly where this was done. C. L. Matthews speaks of "stone chippings outside the caves",^{81a} suggesting that certain work was done here at some period. No one is shown by Shepherd actually working on a block of stone. Kalm is quite specific about the quarrymen's lodges: "There was a house or two here built of this stone thatched with straw, in which the workmen took their meals, kept their tools and worked in bad weather."⁸² This verbal description is matched by Shepherd's water-colour (PL. XXI, B); on the right is a stone cottage with a thatched roof in which a fire is burning, while on the left is a very large barn-like building whose scale can be determined by the human figures standing on the knoll to the right and in front. Masons' lodges at York in 1370 were used for exactly these functions, the taking of refreshment, the storage of tools and the carrying-out of work.⁸³ This building, which is on a gentle hill at the entrance of the mine, may have been the place to which the stone was drawn by windlass for working. At Totternhoe there is no mention of a smithy where tools could be made and kept in sharp condition; the grains of iron pyrites in the stone made frequent blade changes

⁷⁸ Howe (1910), 261.

⁷⁹ Dunno (pseud.), *Dunno's Originals* (Dunstable, 1855), 47. A sledge is, strictly speaking, a vehicle on runners; there is an agricultural vehicle of this construction known as a 'stone-boat.'

⁸⁰ T. W. Bagshawe, 'A Vanished Industry of Dunstable', *Dunstable Gazette* (28 December 1968), 3.

⁸¹ Kalm (1892), 294; Salzman (1967), pl. vii.

^{81a} In letter to me, dated 1 June 1970.

⁸² Kalm (1892), 299.

⁸³ Knoop and Jones (1967), 52.

necessary.⁸⁴ The evidence of a fire in the right hand building could indicate the presence of a forge.

The lodge was used also for the storing of tools. In the notice of an auction of the *Tatternole* or *Tattinghoe* quarry to take place in Dunstable on 13 January 1762 it is interesting to note that together with the quarry were to be sold "all the Machines and Implements used in getting and raising the Stone".⁸⁵ Kalm says that "as soon as it comes out of the mine or stone-pit, it is worked by the carls, while it is still soft".⁸⁶ Certainly the stone would now be rough-hewn, if only to reduce the weight before transport, and Kalm reports: "After they have got the stone to the place they wish, they hew it with the aforementioned picks [i.e., very sharp and of variable size and breadth] . . . With these the stone is hewn tolerably even and flat on the sides."⁸⁷ He describes this process carefully: a long saw used by one or two quarrymen cuts the blocks, then rulers, straight-edges or set squares were used to make the sides even and the corners square. Finally, an iron scraper or rimer was used to scrape and shave it flat.⁸⁸ J. Wyatt reported that several tools, different in form from those in use in 1871, had been found inside the quarry, in places where falls of stone of an earlier day had caused abandonment of workings.⁸⁹

"It is worked by the carls", Kalm continues, "while it is still soft, for any purpose they please and which it can be used for".⁹⁰ This is the nearest suggestion that the stones might have been not only rough-hewn at the site, but moulded and carved as well. The Cambridge colleges bought some ready-made material cut into mouldings at quarries from templates sent by their masons.⁹¹ For the repair of Rochester Castle finished stones were purchased from Boughton quarry.⁹² Salzman cites numerous references to templates being taken to quarries to be worked up,⁹³ but there is no such reference to Totternhoe. It is true that when the quarry was auctioned in 1762 "Chimney Pieces, ready finished", made presumably at the quarry, were to be sold.⁹⁴ A survey of Hertfordshire Perpendicular mouldings revealed numerous examples of common moulding types, but only one peculiar example of the reuse of templates. Nor does Kalm, so meticulous and probing in his descriptions, mention templates, moulded stones or carvings. It is more probable, therefore, that the rough-hewn blocks were delivered to the masons' yards, either to permanent ones in the towns, specializing in tombs, fonts and such objects, or to temporary ones set up at each building site. Totternhoe stone does not dry out for a very long time and therefore would remain workable for many weeks.

⁸⁴ Howe (1910), 261.

⁸⁵ F. A. Blaydes (ed.), *Bedfordshire Notes and Queries* (Bedford, 1886), 1, 46.

⁸⁶ Kalm (1892), 295.

⁸⁷ *Ibid.*, 297.

⁸⁸ Compare Salzman (1967), pl. v.

⁸⁹ Wyatt (1871-2), 150.

⁹⁰ Kalm (1892), 295.

⁹¹ Clunch was used extensively for the early colleges of Cambridge. Documentary references exist for its use at Peterhouse, Trinity Hall, Christ's and Caius, although most have been refaced subsequently: Watson (1911), 197-9. NE. of Cambridge were located the clunch quarries of Burwell, Reach and Isleham, to the S., Cherryhinton, and to the SW., Eversden, Haslingfield and Barrington: D. Purcell, *The Stones of Ely Cathedral* (2 ed., Ely, n.d.), 6.

⁹² Knoop and Jones (1967), 69 and n. 7.

⁹³ Salzman (1967), 123 f.

⁹⁴ *Op. cit.* in note 85, 46.

THE TRANSPORT OF THE STONE

In the middle ages transport of building stone over land was as costly as the material itself, so cheap water transport was used wherever possible.⁹⁵ Around Totternhoe, despite the water-holding character of the chalk and the prevalence of springs, there are no deep water courses. Indeed, the Chiltern Hills and East Anglian heights of N. Hertfordshire constitute a major watershed between the Great Ouse to the N. and the Thames to the S.⁹⁶ Rivers rising near the quarries, the Ousel and Lea in Bedfordshire, the Gade and Ver in Hertfordshire, do not achieve sufficient depth so near their sources for the shipment of stone. That destined for the Hertfordshire churches must have been carted, and surviving ancient records tend to confirm this. Twelve cartloads of *Egremont* stone were shipped from Dunstable to Windsor in 1356,⁹⁷ and carriage was impressed in Hertfordshire and Bedfordshire by Hugh of Kimpton in 1343 for the king's works at Windsor and Westminster.⁹⁸ If stone could be carted such distances, similar transport must have supplied Hertfordshire.

At Totternhoe a broad thoroughfare, Wheelbarrow Way, led from Rats Holes Pit, between Quarry Pits and Quarry Flat, across Hunger Hill (FIG. 22). It was 16 acres in area and was designated common land. Its great breadth, from 1 to 3 chains (1 chain = 66 ft.), indicates the scale of the quarrying output at its apogee. S. of it in 1829 lay a large unenclosed field of 21 acres called Long Cart House Furlong and, beyond, a small field of just over 2 acres, Short Cart House Furlong, suggesting the location here in earlier times for carters' vehicles. At Sandgate Castle in 1540, 110 different carts were used over a period of four weeks, and forty carts were used on average per day.⁹⁹

When the fourth duke of Bedford was rebuilding Woburn Abbey in the mid 18th century, stone was carted the 7 miles from Totternhoe. The duke sent from his own estate some farm carts, teams and men, ordinarily employed in the carriage of produce.¹⁰⁰ He also employed professional carriers whose carts were designed to take much heavier loads and whose activities, at least in that period, formed a network joining village to village, linking the whole of England. Cart House Furlong may have been the depot for medieval predecessors of such carters, whose speciality was the transport of stone. At Vale Royal, certain masons are known to have engaged in carting as a by-occupation of their craft.¹⁰¹

Wheelbarrow Way proceeded eastwards merging with Drovers Way at Jack

⁹⁵ Salzman (1967), 119; Knoop and Jones (1967), 45 f.; Purcell (1967), 98 ff.

⁹⁶ R. Lydekker, *Hertfordshire* (Cambridge, 1909), 17.

⁹⁷ Exchequer K. R. Accounts, bundle 471, doc. 15.

⁹⁸ Hope (1913), 1, 113. Although the Totternhoe quarries are located in S. Beds., it is less dependent on them than is Herts. At Luton, Eaton Bray and Totternhoe (Beds.) are outstanding churches using this stone. At Hockliffe, Tilsworth and Northill chalk dressings contrast with walls of ironstone, a more durable stone found in central Beds., obtained from the band of Gault and Greensand running NE. across the county (V.C.H., *Beds.*, 1, at 1). Although the headwaters of the Great Ouse system rise near Totternhoe, there was little motivation to cart the stone northwards: the fine oolites of Rutland and Northants. could be transported S. by boat along the Nene and Ouse systems to the wharf at Bedford. There is no evidence that Totternhoe stone went to Windsor circuitously, i.e. by boat along the Ousel then carted S. through the Vale of Aylesbury; it would have been uneconomic.

⁹⁹ Knoop and Jones (1967), 47.

¹⁰⁰ G. Scott Thomson, *Family Background* (London, 1949), 20-2.

¹⁰¹ Knoop and Jones (1967), 89 n. 2, and 47.

King's Pit to approach Dunstable (FIG. 19). Drovers Way continued SE. to join the Icknield Way, from which Watling Street, the Hitchin gap, Ermine Street and other routes gave access to the S.

Medieval quarries, such as Ham Hill (Somerset), often served remarkably restricted localities. Totternhoe stone, however, was used more widely, in S. Bedfordshire and Buckinghamshire as well as the whole of Hertfordshire. Considering the sticky nature of the chalk marl bordering the scarp on the N., and the equally impassable London clay on its S. boundary, such a wide distribution is truly remarkable. The 1829 map of Totternhoe shows a field opposite Quarry Pits called Causeway Acre, obviously a raised way over wet, boggy ground (FIG. 22). Carting a considerable weight of stone along rural trackways in wet seasons would have been virtually impossible; transport would have been easier in periods of drought, while in all seasons a firm road surface would have been invaluable. Such a hard surface may have been provided by the complex Roman road network that covered Hertfordshire, although its condition by the late middle ages cannot be known for certain; C. Morris suggested that many of the roads may have been in excellent condition still 1000 years ago,¹⁰² but I. D. Margary's picture of the system's gradual break-down is not encouraging.¹⁰³ It remains a possibility, however, that Totternhoe stone was able to reach the towns and villages of Hertfordshire at least in part along surviving Roman roads.

Berkhamsted was 9 miles from Totternhoe, St. Albans 14 and Watford 17 miles; Hertford and Barnet were 22 miles distant, Cheshunt and Royston 26, while Bishop's Stortford and Sawbridgeworth were 31 miles away—all measured as the crow flies. Some assessment of what these distances meant in terms of how far a cart loaded with stone could travel in a day is provided by comparison with Vale Royal, where in the late 13th century a cart could travel 20 miles per day, and work a six-day week.¹⁰⁴ The Masons' Ordinances for 1370 at York Minster show that the working day varied in length according to the season of the year, in summer being just over twelve hours, and in winter just under nine; one hour was given off for dinner, with one half hour for drinking and another for sleeping.¹⁰⁵ G. Scott Thomson notes in the 18th-century Woburn accounts that the old family coach went 3 miles per hour, and postulates that a cart laden with stone must have travelled even slower.¹⁰⁶

When the rough-hewn stone reached the building site, a masons' yard would be set up. The freemasons would set to work cutting the stones while still soft and workable to the master mason's templates. The moulded stone would stand in the masons' yard for about a year to dry out thoroughly before any minor defects were corrected and it could be placed in position in the building.

¹⁰² C. Morris, 'Roman Roads and Saxon Settlements in Hertfordshire', *Herts. Past and Present*, no. 6 (1966), 6; The Viatores, *Roman Roads in the South-east Midlands* (London, 1964), 12 f. and 34, 507 for diagram of road construction.

¹⁰³ I. D. Margary, *Roman Roads in Britain* (3 ed., London, 1973), 22 ff.

¹⁰⁴ Knoop and Jones (1967), 47.

¹⁰⁵ *Ibid.*, 104 f.

¹⁰⁶ *Op. cit.* in note 100, 26.

FLINT

Flint, the only building stone abundant in Hertfordshire itself, was used for the walls of most local churches (PL. XXIV, A-B). It is almost pure silica (silicon dioxide),¹⁰⁷ of the same family as obsidian and quartz, but it is uncertain whether it is organic or inorganic in origin.¹⁰⁸

Large lumps of flint are found occasionally in the lower chalk; in the middle chalk it is very rare indeed; but in the soft layers of the upper chalk flints occur in quantity, either in scattered nodules, or as lumps filling crevices, or in clearly defined strata. Flint nodules are usually egg-shaped, measuring 2 in. to 1 ft. in diameter. Outside they are covered by a thick white crust called the cortex; the inside is like solid glass, translucent and pleasant to the touch. It is a completely non-absorbent stone, found in a wide range of colours, even red and yellow, depending on the locality; greys and blacks are characteristic of Hertfordshire. Chemical action in the soil can cause colour change in the form of milky mottling. Flint is among the most durable natural materials, but its hardness prevents its being worked like other stones. When, in the process known as 'knapping', a nodule is struck at right angles to the surface, it splits, presenting one concave and one convex surface; when a slab is struck thus a cone falls out below, a property known as 'flaking'.¹⁰⁹ The knapping of flint, a ton or two at a time, in preparation for building, is a time-consuming task and skill can be acquired only by experience.

The quality of the flint varies according to its position in the chalk.¹¹⁰ In the hornbed, or chalk-with-clay, the nodules are of inferior quality, rough in shape and uneven in texture; these are used for hardcore or filling.¹¹¹ The two upper strata, the topflint and the wallbed, produce better nodules, but they too are uneven in form and texture. The smoothest nodules are found on the floorbed, and the texture of these is most easily worked.

BUILDING A FLINT WALL¹¹²

Foundations for thick medieval walls were normally of firmly-rammed hardcore, such as rubble or flint, topped by a skimming of lime. The depth of the traditional wall foundation would be on average 5 to 6 ft., and the width twice that of the intended wall.¹¹³ For the wall itself, when built with flint, the type of mortar was dictated by the nature of the material; since the nodules were small and rounded, with very poor bonding qualities, the mortar had to be plentiful. Baggallay suggested 16 bushels of dry mortar before the addition of water to set

¹⁰⁷ *Op. cit.* in note 18, 254.

¹⁰⁸ Oakley and Muir-Wood, *op. cit.* in note 3, pl. iii, 2, and p. 40; Sherlock (1960), 20.

¹⁰⁹ Watson (1911), 201 f., and 318 for general note on flint; *op. cit.* in note 18, 256, fig. 23.

¹¹⁰ R. R. Clarke, *Grimes Graves, Norfolk* (H.M.S.O., London, 1970), 10 f.; Baggallay (1885), 119 f.

¹¹¹ At St. Mary's, Reed, Herts., a section is revealed of the chalk rood stair showing how flint rubble was used for filling.

¹¹² This account of flint wall building describes the traditional practice of the Handy family of builders who have worked on the maintenance of flint and 'clunch' churches in Herts. for three generations. G. E. Evans (in *Where Beards Wag All: The Relevance of the Oral Tradition* (London, 1970), 18) wrote "the testimony of the craftsman is more accurate than the average printed source. He is . . . able to give a fuller account, with all the local variations, of his craft".

¹¹³ See also Salzman (1967), 82-4.

about 5 bushels of rough flint.¹¹⁴ Since the stones are non-absorbent the mortar mixture should be dryish, with only sufficient moisture to give adhesion; builders call this 'chaffy'. The usual medieval mortar consisted of one part lime to three parts sand;¹¹⁵ for use with flint, the mixture should be weaker, with a larger proportion of sand than usual to minimize the shrinkage. Occasionally a brick fragment was used in the wall to assist drying, as found during the recent restoration of the clockhouse at St. Albans. A flint wall must be thick; 2 ft. is the optimum, and it should never be less than 12 in., even in places where maximum weight reduction is required, as in the upper stage of a church tower.

To establish the line of the building, the chalk quoins are built up to a height of two or three blocks, plumbed into the correct position.¹¹⁶ A cord is then run from quoin to quoin to mark the line of the wall. A large trowel full of mortar is laid in the middle, and the better knapped flints placed in position, with the glassy face towards the front and back of the wall, and the inferior pieces and chip-pings in the middle.¹¹⁷ The flints are sorted as the laying proceeds. Longer pieces are laid across the wall for tying; there are no lacing courses as such because of the continual interlacing of the inner and outer faces. The mortar is then cut off at the surface. Shuttering is not normally used: to maintain a handsome surface, the glassy black face must be kept continuously clean. In Hertfordshire the flints were not usually coursed or laid in a regular pattern—St. Botolph, Shenley, is an exception;—they were placed randomly in a sweeping series of concentric semicircles. The 'improver' is considered a more suitable layer of flint rubble walls than the craftsman or brick-layer; once trained, he is kept on this work.

If the interior wall is to be plastered, the flints used on the inner face are of the unknapped variety, and the mortar on this face is not cleared off; it is left reasonably smooth, with no large lumps obtruding, but leaving a continuous key. Over this two or three coats of lime plaster are laid, adhering, not to the flints, but to the mortar in which they are embedded. The position of doors and windows is measured in from a gauge rod,¹¹⁸ and the wall built up around them. Floor joists are laid directly into the wall on a padstone; the joists are put in position first and the wall built up to them.

The building of the flint wall is a slow process which cannot be hurried. It is possible, but not desirable, to erect more than 15 in. per day. Beyond this the low absorption rate of the flint and the weight of the later work will compress the earlier parts and cause bulging. If a length of wall measuring 20 ft. is being constructed, or if the work is in the upper stage of a church tower, raising the wall by this height is indeed a day's work. Work must be discontinued in the rain and carefully covered to prevent damage.

As flint is extremely dense, the wall will last indefinitely, provided the dampness is deflected from the top to prevent frost damage. A carefully knapped

¹¹⁴ Baggallay (1885), 122.

¹¹⁵ Salzman (1967), 149.

¹¹⁶ Baggallay (1885), 122, makes the questionable statement that the upright stonework must be added after the flint has taken its bearings.

¹¹⁷ R. W. Brunskill, *Illustrated Handbook of Vernacular Architecture* (London, 1971), 45c.

¹¹⁸ This is a rod the exact height of the story, with positions of the windows marked on it.

surface is in itself superbly weather resistant and handsome; outstanding examples in Hertfordshire include the ancient churches at Aldbury, Great Hormead, South Mymms, Walkern and Watton. The surfaces were left unplastered externally; where they have been rendered it is a modern feature.

HERTFORDSHIRE CONGLOMERATE

Hertfordshire has one other extremely hard native stone: conglomerate or pudding-stone. It consists of stained flint pebbles cemented together with silica in pieces weighing from a few pounds up to more than a ton.¹¹⁹ It is a hardened portion of the Woolwich and Reading beds and was formed by the rolling motion on the beaches in Tertiary times. It occurs in its original bedding between Aldenham and Shenley and is also frequent at St. Albans and Great Gaddesden. When split it forms a clean surface cutting through pebbles and matrix alike; because of its extreme hardness, it will take a high polish. It is found from time to time built into the foundations of churches, as at Sarratt and Great Munden, probably because of its effectiveness as a damp-proof course.

THE INFLUENCE OF TOTTERNHOE STONE AND FLINT ON STYLE¹²⁰

Flint rubble walls must be thick, perhaps half as thick again as ashlar; simplicity of concept and good proportion must prevail in the building design (PL. XXIV, A). In the best Hertfordshire examples flints are laid at random to achieve a pleasant overall texture; coursed flints were less usual and patterned flushwork never attempted. Chequer-work of chalk and flint, requiring a broader scale to accommodate the larger module, was on the whole rejected. Well-coped battlements or parapets are as effective against moisture-penetration as overhanging roofs, but the former, demanding constant maintenance, are usually found only on more prosperous churches (PL. XXIV, B). Redbourn is an isolated example of ornamental brickwork combined with flints in battlements. Buttresses tend to be large and prominent for the size of church. They are essentially of cut stone, with flint introduced to link them visually to the building. Flint rubble towers are especially thick-walled, often stepped back at each stage for weight reduction. The 'Hertfordshire spike', a thin *flèche* of timber construction placed over the centre of a tower and covered with lead, follows logically from a desire for lightness.¹²¹

Thick walls make for deep windows. Set in frames of Totternhoe stone, the shallower jamb is usually the exterior one and the deeper, more complex moulding in the protected interior position. Flint rubble walls are strong and require less precision of construction than cut stone; they are therefore well-adapted to the insertion of large windows. Extensive E. windows, as at Anstey, Ashwell and

¹¹⁹ R. W. B., 'Hertfordshire Conglomerate or Puddingstone', *Manshead Magazine*, no. 2 (January 1959); *op. cit.* in note 96, 35.

¹²⁰ See the pioneer study by A. W. Anderson, 'Notes on the Churches of Hertfordshire', *Trans. St. Paul's Ecclesiological Soc.*, vi (1906-10), 73-80.

¹²¹ The spike at Flamstead is analysed by S. F. Clarkson 'Flamstead', *Trans. St. Albans and Herts. Archit. and Archaeol. Soc.*, 1884-94, 80-2.

Braughing, are not hard to find, although W. windows tend to be smaller, perhaps because the prevailing wind is from that direction. The ease of cutting tracery in Totternhoe stone had to be balanced against its lack of durability. Clerestory windows are usually small, a trend governed less by the potential of the building materials than by economics: flints were cheap and readily available, whereas stained glass and cut stone were costly by comparison.

Church furnishings benefit from the easy carving of the Totternhoe stone: the fonts at Ware, Hitchin, Newnham and Caldecote (PL. XXIII, c) are notable; fine tombs are found at Aldenham, Benington, Little Munden and South Mymms. Tower walls are thick and tower arch mouldings are deep and varied; those at Braughing, Watton, Ware and Bishop's Stortford may be singled out from many more. The profiles of the moulded stonework have much to tell those with the patience to study them, both about the churches' history and about the architects who designed them.

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LIST OF ABBREVIATIONS

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| Baggallay (1885) | F. T. Baggallay, 'The Use of Flint in Building, especially in the County of Suffolk', <i>Trans. Royal Inst. of British Architects</i> , 1, n.s. (1885), 105-124. |
| Bagshawe (1968), i | T. W. Bagshawe, 'The Totternhoe Caverns: The History of the Quarries', <i>Dunstable Gazette</i> (4 October 1968), 5. |
| Bagshawe (1968), ii | <i>Idem</i> , 'The Uses of the Stone', <i>ibid.</i> (11 October 1968), 5. |
| Colvin (1963) | H. M. Colvin (ed.), <i>The History of the King's Works. The Middle Ages</i> , 2 vols. (London, H.M.S.O., 1963). |
| <i>Gesta Abbatum</i> | Thomas of Walsingham, <i>Gesta Abbatum Monasterii Sancti Albani</i> , ed. H. T. Riley, 3 vols. (Rolls Series, xxviii, London, 1867). |
| Harvey (1954) | J. H. Harvey, <i>English Mediaeval Architects</i> (London, 1954). |
| Hope (1913) | W. H. St. J. Hope, <i>Windsor Castle, an Architectural History</i> , 2 vols. (London, 1913). |
| Howe (1910) | J. A. Howe, <i>The Geology of Building Stones</i> (London, 1910). |
| Kalm (1892) | <i>Kalm's Account of his Visit to England on his way to America in 1748</i> , trans. J. Lucas (London, 1892). |
| Knoop and Jones (1938) | D. Knoop and G. P. Jones, 'The English Medieval Quarry', <i>Econ. Hist. Rev.</i> , ix (1938-9), 17-37. |
| Knoop and Jones (1967) | <i>Idem</i> , <i>The Mediaeval Mason</i> (Manchester, 1967). |
| Matthews (1962) | C. L. Matthews, 'Archaeological Sites on the Totternhoe Ridge', <i>Manshead Magazine</i> , no. 8 (1962), 14. |

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| Purcell (1967) | D. Purcell, <i>Cambridge Stone</i> (London, 1967). |
| Salzman (1967) | L. F. Salzman, <i>Building in England down to 1540</i> (Oxford, 1967). |
| Sherlock (1960) | R. L. Sherlock, <i>British Regional Geology: London and Thames Valley</i> (London, H.M.S.O., 1960). |
| Warnes (1926) | A. R. Warnes, <i>Building Stones: their Properties, Decay and Preservation</i> (London, 1926). |
| Watson (1911) | J. Watson, <i>British and Foreign Building Stones</i> (Cambridge, 1911). |
| Wyatt (1871-2) | J. Wyatt, 'The Ancient Camps of Maiden Bower and Totternhoe', <i>Assoc. Arch. Soc. Rep.</i> , xi (1871-2), 141-50. |

ADDENDUM

Since this article went to press I have learned that the quarries were reopened in 1972 by the Totternhoe Lime and Stone Company to provide material for the restoration of Woburn Abbey being carried out by Donald W. Insall and Associates (A. J. Frost, architect in charge). The quarrymen are Stamford Stone Ltd.; the stonemasons Rattee and Kett of Cambridge.