NOTES

[34] This applies both to the form of the voussoirs and to the lugs with which they were keyed together.
[35] Some French cloisters of this type (e.g. Arles, Mont St Michel) have moulded eaves-level stringcourses internally but not externally.
[36] The first suggestion is illustrated by a base at Wenlock Priory (R. B. Lockett, 'A catalogue of Romanesque sculpture from the Cluniac houses of England', *Jnl. Brit. Archaeol. Assoc.*, 3rd ser. xxxiv (1971), pl. XI(4)); the second by part of a cloister probably from Fontainebleau (Victoria and Albert Museum A3–1911).
[37] Listed G. Webb, *Architecture in Britain: the middle ages* (2nd ed., Harmondsworth, 1965), 56–58.
[38] As on the W. front of Llandaff cathedral.
[39] R. Gilyard-Beer, *Haughmond Abbey* (HMSO, forthcoming) will be the best account.

THE USE OF QUARR STONE IN LONDON AND EAST KENT

In a useful appendix to an article by Professor Jope on the Saxon building-stone industry,[40] Dr F. W. Anderson and the late R. N. Quirk discussed the geology and use of Quarr stone, a Tertiary limestone from near Binstead in the Isle of Wight. They showed how this stone, long worked out in the quarries, was at the same stratigraphical horizon in the Bembridge limestone as Binstead stone but was in appearance quite different. Quarr stone is, in fact, a creamy-yellow limestone (but greyer than Caen), composed of comminuted shells which occurred only in a shell-bank W. of Binstead. Quarrymen know it as 'Featherbed stone'. In the latter part of their note Anderson and Quirk say that: 'Quarr stone was not used extensively outside the Isle of Wight, except in the Hampshire Basin and Sussex, where a good building stone was not readily available'. They go on to point out that there is no record of its use in Dorset where other good local stones could be used. In his book *The Pattern of English Building*, Mr A. Clifton-Taylor also discusses the use of Quarr stone[41] and although admitting its widespread use in the Hampshire Basin and Sussex, says that Lewes Priory in East Sussex is the most distant building at which it had been identified.

Recent work in East Kent has shown that Quarr stone was used there extensively in the early Norman period alongside Caen stone,[42] and a recent visit to the White Tower at the Tower of London showed that it was also used in this famous late 11th-century royal keep built by Bishop Gundulf of Rochester. The quarries in the Isle of Wight (the name Quarr is synonymous with quarry) were always in royal ownership from the Norman Conquest,[43] and it seems clear that in the late 11th century and perhaps the beginning of the 12th, it was exported widely by sea up the English Channel for royal building work (e.g. the Keep of Canterbury Castle as well as the White Tower) and for building work at major ecclesiastical houses (such as Christchurch Priory and St Augustine's Abbey in Canterbury, and St Martin-le-Grand, Dover). It is also found in quite a large number of churches in East Kent. This is mostly as reused material (e.g. Monkton, Eastry, St Nicholas-at-Wade and All Saints, Shuart)[44] but the unique parish church of St Mary's Brook, near Ashford has Quarr used for the chancel arch and all its eastern quoins. Only in the great western tower, built last but in direct sequence, is Quarr stone gradually superceded by Caen.[45] It is of significance that all these churches were owned by Christchurch Priory Canterbury or the Archbishop, and that many of them may have been rebuilt or built for the first time in the late 11th century after Archbishop Lanfranc had in the 1070s and 1080s divided the Christchurch property between himself and the monks. Archbishop Lanfranc had also regained for Canterbury many manors which had been taken by Odo, Bishop of Bayeux and others.[46] One of the most notable of those returned to the monks was Brook, where the architectural decoration of the church is very similar to that in Ernulf's crypt and choir (1096–1107) at Canterbury Cathedral, but the Archbishop had also recovered Reculver for himself and it is possible that the chapels-at-ease attached to Reculver (All Saints, Shuart and St Nicholas-at-Wade in Thanet) were also built in the late 11th century.

In Canterbury itself, three great buildings, the Royal Keep, Christchurch Cathedral Priory and St Augustine's Abbey, all contain Quarr stone used in initial Norman

campaigns, and it is these buildings with the wealth of documentary material attached to them which provide the closest dates for the use of Quarr stone in East Kent. At St Augustine's Abbey, Quarr stone is found in the eastern crypt, transepts and nave mixed with Caen stone. Although it is mostly used for column drums, string courses, capitals and bases, it is often found in ordinary ashlar work, while Caen, a softer stone, is also used in string courses, etc., but proportionally less than Quarr. All this work at St Augustine's dates from the time of the first two Norman abbots Scotland (1070–87) and Wido (1087–99)[47] and was probably complete by 1091 when Gundulf, Bishop of Rochester translated the bodies of the early Archbishops to the new church. However, the superstructure of the NW. ('Ethelbert's') tower was not built until the mid 12th century, and it is significant that the surviving base of this tower contains only Caen stone. At Canterbury Cathedral, a little Quarr stone has been found in the surviving fragments of Lanfranc's Cathedral (1070–77) but it is found extensively in Ernulf's great choir and crypt of 1096–1107. It is used here mostly on the outside of the building (very little Quarr is visible in the crypt), and though 19th- and 20th-century restoration work has replaced many of the architectural details (string courses, etc.), with Portland stone, Quarr stone can still be seen as ordinary ashlar, in a few string courses, abaci, and even occasionally used for carved ornamentation in blind-arcading.[48] No Quarr stone has yet been found in any later Norman work at the Cathedral, that is in the work of Prior Wibert (1151–67) or in the great reconstructions after the 1174 fire. Quarr stone, however, can be found in Lanfranc's great dormitory for the Priory (particularly in the projecting string-courses) and in the Infirmary hall and chapel (also probably Prior Ernulf's work) though the square E. end of the Infirmary chapel, with the chevron-decorated N. and S. windows, contains no Quarr and probably replaced the original apse in the later 12th century.

At Canterbury Castle a very detailed analysis of the surviving fabric of the Keep[49] was made in 1978 by the Canterbury Archaeological Trust. This disclosed that Quarr stone was used extensively in the plinth, particularly for the chamfered and moulded courses and as broken fragments in the infill, but above this it dies out and all the higher quoins, mouldings and ashlar work, where they survive, are only in Caen.[50] There is therefore clear evidence here, as at Brook church, of the supply of Quarr running out. Unfortunately a close date for this at the Castle is not possible, but a date before 1120 at the latest and possibly around 1100 is very likely. The building of the great Keep at Canterbury and Ernulf's small 'keep' at Brook are most likely to date from the unsettled years of Anselm's exile in the latter part of William Rufus's reign or possibly the first few years of Henry I's.

One other major building in East Kent where Quarr stone is used is St Martin-le Grand, Dover.[51] This very large church with its unfinished W. end (work stopped here for political reasons before 1130 at the latest) was built largely in the later 11th century and much Quarr stone is now visible in the area of the crossing.

It seems very likely therefore that Quarr stone was used in East Kent only for about thirty years, fifty years at most (*c.* 1070–1120) and that its use was sanctioned by the King (William I and William II and perhaps Henry I) for the building work of many great religious houses,[52] as well as for his own royal keeps in Canterbury and London. Quarr stone, which can be seen best in St John's chapel or in internal quoins on the second floor of the Tower of London, may help to unravel the complex building history of the Tower.[53] Unfortunately virtually all of the outside is 17th-century Portland stone. After about 1100 the stone, which was already becoming scarce, was probably only used in the Hampshire Basin. It is found for example, in the eastern parts of the new abbey church of Romsey (early 12th century or even a little earlier?), but as work progressed on the nave of this church Quarr is replaced by much poorer quality Binstead stone and later by Chilmark stone. The stone used for Quarr Abbey in 1293[54] was almost certainly more Binstead stone than Quarr, as was some of the stone requisitioned by William of Wykeham in the 14th century.[55] The heyday of Quarr stone was therefore over by the end of the 11th century and in major Norman buildings of before this date we may perhaps expect to find it being

used all over SE. England[56] (even possibly in northern France). Certainly it may have been used elsewhere in London other than just the White Tower.

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NOTES

[40] *Medieval Archaeol.*, VIII (1964), 115–17.
[41] Pages 60–61. His account is largely based on Anderson and Quirk, see note 40.
[42] My interest in the stone was sparked off by a remark by Mr S. E. Rigold, and I am grateful to him, Derek Renn, Dom. Frederick Hockey, Margaret Sparks, F. W. Anderson, John Harvey and Richard Morris for commenting on an earlier draft of this article.
[43] See V. H. Galbraith, 'Royal Charters to Winchester', *English Historical Review*, 35 (1920), 382–400 — Charter IX for Bishop Walkelin's permission from William Rufus to use it (*c.*1087–98) at Winchester; and S. F. Hockey, *Quarr Abbey and its Lands* (1970), 2 and 118.
[44] Found in 1978 in the excavation of this now demolished church.
[45] See *Archaeol. Jnl.*, CXXVI (1970), 270–72. Mr Rigold suggests, in correspondence, that the church may be pre-Ernulf and the tower Ernulf.
[46] See F. R. H. Du Boulay, *The Lordship of Canterbury* (1966), 36–47.
[47] See the detailed contemporary accounts by the monk Goscelin: Migne, *Patrologia Latina*, CLV cols 15–62.
[48] A large piece of Quarr has even been found very recently (Nov. 1979) at the bottom of a hole for a scaffold post erected for the work on Ernulf's choir either in *c.*1100 or possibly in the 19th century (as yet unpublished excavations by the Canterbury Archaeological Trust).
[49] *Excavations at Canterbury Castle* (forthcoming, 1980). See sections by D. F. Renn and the present writer.
[50] Martyn Owen of the Geological Museum has kindly confirmed the Quarr stone finds in Canterbury, but has not yet examined the other finds in Kent.
[51] I am indebted to Brian Philp for allowing me to inspect the remaining portions of this great unfinished church in his excavations.
[52] Only William Rufus's Winchester Charter, see note 43, survives as documentary evidence for this, but other royal charters for Canterbury, Lewes, Chichester, Romsey, etc., must have once existed.
[53] See D. Sturdy, 'Nine Hundred Years of the Tower', *The London Archaeologist*, 3, no. 10 (1979), 270–73.
[54] See Hockey, op. cit. note 43, 59.
[55] Ibid., 118.
[56] As stone mortars, Quarr was exported to Sussex, Kent, Essex, Middlesex, Cambridgeshire, and Kings Lynn. See Dr Gerald Dunning's note in H. Clarke and A. Carter, *Excavations in King's Lynn, 1963–70* (1977), 327–29.

TREE-RING DATING: A REPLY TO D. J. SCHOVE

Many dendrochronologists consider a reply essential to correct some of the erroneous and misleading statements made by D. J. Schove in the last volume of this journal.[57] Archaeologists must not be left with the impression that dendrochronological dating is such a haphazard process ('dating . . . appeared to be the only possible one'; 'agreement . . . is only fair, but there seems to be no alternative') or is less reliable than radiocarbon dating. Schove's methods of dating on floating chronologies, particularly when this involves other people's data, are unacceptable.

From the start, Schove lists his failures and abandoned attempts at dating in an unpromising way. He uses phrases which are anathema to the dendrochronologist, such as 'visual agreement was not good'. The success of tree-ring dating is entirely dependent on the visual correspondence of the annual ring-width variations over 50 years or more, and if such matching cannot be found then accurate dating is not possible. A match is or is not correct — there are no alternatives. It is true that occasionally a tentative date is quoted which is subsequently proved incorrect; but further checks invariably indicate the correct match where there is a choice.

He quotes a previous warning that 'various methods of dating must often be used before certainty is attained' (p. 219). This is completely untrue. Dendrochronological dating is the most accurate method of all, and results override any possibly conflicting archaeological or other evidence. Archaeological and radiocarbon dating can only give a very rough guide as to the likely tree-ring date. A timber is often much earlier than the stratigraphic deposit in which it lies. Radiocarbon dating usually has such a high standard deviation, of more than $\pm$ 60 years, that its value is limited.

It is interesting that the computer programs we use to evaluate the quality of ring-width matches are unlikely to succeed in locating matches between places as far apart as