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SYNOPSIS

About 200 honestones, the majority of which are from Anglo-Saxon or medieval sites in Eastern, Midland and Southern England, have been studied in order to determine their provenance. They are petrographically described and classified as numbered types, and their provenance is discussed. The first and most numerous type, with 87 examples (over 100 including closely related types) is that of the " schist hones " common on medieval sites; they are shown to be mullions in a mica-quartz-schist of distinctive mineralogy, for which radiometric age data (about 1000 m.y.) and petrographic evidence point to a source in the pre-Cambrian of central southern Norway from which they must have been imported as trade articles. About a third of the remaining hones are greywackés and allied types characteristic of ancient geosynclinal areas such as southern Scotland, Wales and Brittany, and of the drift derived from them; most of these also must have been brought considerable distances, although less than in the case of the " schist hones ". The remainder are quartzose and micaceous sandstones and siltstones, and sandy limestones, most of which are of relatively local origin. An analysis of the data in terms of grain size and mineral composition shows a nearly normal distribution with the " schist hones " and greywackés occupying a central position presumed to coincide with optimum honing qualities. An analysis in terms of site and (historical) age distribution shows that prior to the Viking invasions the pattern of provenance ranged from local to semi-remote (less than 250 miles) and was similar to that of Romano-British times. The " schist hones " were introduced by Viking settlers at about A.D. 900, and ousted most other types until about A.D. 1300, after which there was a gradual return to the old pattern of provenance although the trade in " schist hones " continued until the 17th century.

INTRODUCTION

THE familiar role of polished stone artefacts in working out the patterns of migration and trade in the Neolithic and Bronze ages is taken over by honestones in the Iron Age and its sequels in Roman, Dark Age and medieval times. Between 1956 and 1967 the author had occasion to study about 150 hones from sites in eastern and southern England, mainly of Saxon to medieval date, with a view to determining their provenance. The first and most important collection examined was from the late Saxon, later Anglo-Danish town of Thetford, excavated by the Ancient Monuments Department of the Ministry of Public Buildings and Works. The last publication on the subject was the description by Morey & Dunham (1953) of 30 late Saxon and medieval hones from Yorkshire (mainly from York), without which this study would have been much more difficult and to which the author acknowledges his debt. These Yorkshire hones have been re-examined in the light of the study of additional material, and the results are incorporated in the present work. In view of the importance of the " schisthones " so familiar from medieval sites, it has also been necessary to check as many as possible of those listed in an earlier review by G. C. Dunning (1938). Most of these have been studied and listed by the present author, together with further material, some of which proved to be of critical importance. The total number of hones petrographically studied and listed has thus been brought up to 201, 164 of which have definite Saxon or medieval dating, and 13 of which are believed but not proved to be of this period. The rest are outside our terms of reference as to either locality or date, but have been included for comparative purposes; they comprise nine pre-Saxon and nine post-medieval hones from England, three Viking hones from Norway, one medieval hone from Scotland, and two 9th century hones from Holland.

Morey & Dunham divided the Yorkshire hones into four major groups, defining the last three as " Lower Palaeozoic ", " Millstone Grit " and " Cretaceous " types respectively. This use of stratigraphical terms seems to beg the question of provenance, especially in the absence of fossil evidence. We have used virtually the same groupings, defined as follows in terms of lithological facies; I Metamorphic Rocks; II Greywackés, mudstones and other siliceous sediments of geosynclinal facies; III Sandstones and siltstones of marginal and freshwater facies; and IV Sandy and silty limestones. The hones investigated have been listed as numbered types within the subdivisions of these major groups, to facilitate the addition of further types if necessary as a result of future work. Individual hones are referred to in the text by their archaeological sites and an identifying number, but the British Museum (Natural History) registration numbers are quoted for thin sections excepting for hones represented by " enquiry " slides in the Geological Survey Collection which are indicated by their ENQ numbers. A few hones not represented by thin sections have been investigated microscopically by other methods. Most of the specimens and slides used for comparative purposes are in the Geological Survey Museum and British Museum (Natural History) collections; the latter include material collected by the author in the course of field work for this purpose.

I. METAMORPHIC ROCKS

Excepting for two hornfelses (sub-group D) all the honestones of this group are quartz-rich metasediments of low to medium metamorphic grade. The majority fall into three closely-related sub-groups; A: mica-quartz-schists and highly micaceous quartzites; B: metasiltstones or silty phyllites and C: quartzites with little or no mica. Each of these may be divided into textural types based on their foliation:—(a) with linear foliation due to the intersection of two or more s-planes; (b) with tabular foliation; and (c) without true foliation or schistosity. Not all these textural types are found as hones but all occur among rocks with which the hones have been compared. Because sub-groups A, B and C are closely related, their provenance will be discussed only after all three have been described.

A. Mica-quartz-schists and micaceous quartzites

Almost all the hones described under this heading are probably mullions. They display a linear schistosity which, it is reasonable to assume, has been imposed on rocks which would otherwise be tabular-schistose in structure.

(1) Grey, lineated psammitic mica-quartz-schists (mullions) of fine sand to coarse silt grade.

All but three of the artefacts referred to as " schist hones " belong to this, which is Type (1) of Morey & Dunham (1953) and described by them as " grey, fine-grained quartz-mica-granulites, showing distinct lamination in the hand-specimen and a measure of metamorphic sheen, but not schistose ". The following is a complete list (87 hones).

Details of Hones	Slide No.	Collection
Yorkshire		
York, unspecified site	ENQ 1054	York Museum
York, unspecified site	ENQ 1055	York Museum
York, Goodramgate	ENQ 1047	York Museum
York, Goodramgate	ENQ 1048	York Museum
York, Dove's Pavement	ENQ 1049	York Museum
York, Rawcliffe Lane	ENQ 1050	York Museum
York, Skelton	ENQ 1052	York Museum
York, Coppergate	ENQ 1057	York Museum
York, Coppergate	ENQ 1058	York Museum
York, Coppergate	ENQ 1059	York Museum
Almondbury, Castle Hill	ENQ 1067	York Museum
Almondbury, Castle Hill	ENQ 1068	York Museum
*?Huddersfield, (site unspecified)	ENQ 1065	Huddersfield Museum
*?Huddersfield, (site unspecified) [*longitudinal section*]	ENQ 1069	Huddersfield Museum
*Rishworth	ENQ 1071	Huddersfield Museum
Knaresborough	ENQ 1072	Huddersfield Museum
Lincolnshire		
Riseholme, No. 3	B.M. 1964, 732(3)	Chester Museum
Norfolk		
Thetford 1048C	B.M. 1959, 210(1)	Norwich Castle Museum
Thetford 474	B.M. 1959, 210(2)	Norwich Castle Museum
Thetford 1048A	B.M. 1059, 210(4)	Norwich Castle Museum
Thetford 1123	B.M. 1959, 210(5)	Norwich Castle Museum
Thetford 704	B.M. 1959, 210(6)	Norwich Castle Museum
Thetford 464	B.M. 1959, 210(7)	Norwich Castle Museum
Thetford 242	B.M. 1959, 210(8)	Norwich Castle Museum
Thetford 6	B.M. 1959, 210(9)	Norwich Castle Museum
Thetford 1196	B.M. 1959, 210(3)	Norwich Castle Museum
Thetford 905	B.M. 1966, P22(2)	Norwich Castle Museum
Thetford 400	B.M. 1966, P22(3)	Norwich Castle Museum
*Wortham	(no section)	Ipswich Museum

Suffolk		
*Bealings (*one transverse, two longitudinal sections*)	B.M. 1964, 723	Brit. Mus. (Nat. Hist.)
*Snape, R962–110	B.M. 1963, 22	Ipswich Museum
Ipswich, * Sugar Factory	B.M. 1963, 755(1)	Ipswich Museum
Ipswich, *Buttermarket	B.M. 1963, 755(2)	Ipswich Museum
Essex		
Rayleigh Castle	B.M. 1966, P21	Southend Museum
*Mucking, 200S × 330E, N/S	B.M. 1967, P53(2)	Colchester Museum
Cambridgeshire		
Barton, Black Ash Ditch, nos 1 to 7 inclusive.	B.M. 1966, P15(1–7)	Camb. Univ. Mus. of Arch. and Ethnogr.
Huntingdonshire		
St. Neots	B.M. 1964, 725	C. F. Tebbutt Collection
Thorpe Farm, Ellington, (2)	B.M. 1966, P13(2)	C. F. Tebbutt Collection
Thorpe Farm, Ellington (3)	B.M. 1966, P13(3)	C. F. Tebbutt Collection
Northamptonshire		
‡Lyveden, no. 3	B.M. 1967, P62(2)	Westfield Museum, Kettering
Sulgrave, no. 3	(no slide)	Ancient Monuments Department, M.P.B.W.
Sulgrave, no. 4	B.M. 1966, P20(11)	Ancient Monuments Department, M.P.B.W.
Buckinghamshire		
Aylesbury, Walton Rd. 55/63(1)	B.M. 1966, P14(1)	Bucks County Museum
Aylesbury, Walton Rd. 55/63(2)	B.M. 1966, P14(2)	Bucks County Museum
Emberton	B.M. 1966, P14(3)	Bucks County Museum
Caldecote, 36	B.M. 1966, P58	Bucks County Museum
London		
Moorfields G.M. 10937	B.M. 1966, P17(10)	Guildhall Museum
Moorfields G.M. 11055	B.M. 1966, P17(5)	Guildhall Museum
Moorfields G.M. 11056	B.M. 1966, P17(6)	Guildhall Museum
Moorfields G.M. 11057	B.M. 1966, P17(7)	Guildhall Museum
Moorfields G.M. 11058	B.M. 1966, P17(8)	Guildhall Museum
Moorfields G.M. 11059	B.M. 1966, P17(9)	Guildhall Museum
Public Cleansing Dept., Upper Thames St. G.M. 22016	(No section)	Guildhall Museum
Salters' Hall, Walbrook G.M. 18760	B.M. 1966, P17(4)	Guildhall Museum
Salters' Hall, Walbrook G.M. 18787	B.M. 1966, P17(1)	Guildhall Museum
Salters' Hall, Walbrook G.M. 18788	B.M. 1966, P17(2)	Guildhall Museum

‡ Since going to to press 6 further hones of this type have been found at Lyveden.

Details of Hones	Slide No.	Collection
Salters' Hall, Walbrook G.M. 18789	B.M. 1966, P17(3)	Guildhall Museum
Cheapside G.M. 21318	B.M. 1966, P17(11)	Guildhall Museum
†Southwark, Lant St. (17th C.)	ENQ 2085	London Museum
†Southwark, Lant St. (17th C.) L.M. 17216	B.M. 1965, P42(1)	London Museum
†Southwark, Lant St. (17th C.) L.M. 18241	B.M. 1965, P42(2)	London Museum
†Southwark, Lant St. (17th C.) L.M. 19201	B.M. 1965, P42(3)	London Museum
Kent		
Faversham 1883; 1909, 150	B.M. 1959, 213(4)	Ashmolean Museum
Stonar, Sandwich X (*Transverse and longitudinal sections*)	B.M. 1945, 17	Brit. Mus. (Nat. Hist.)
Stonar, Sandwich A to I inclusive	B.M. 1966, P19 (1 to 9 inclusive)	Deal Museum
Surrey		
Guildford, Mount St., G.6993	(No section)	Guildford Museum
Guildford, Mount St., G.6994	B.M. 1966, P16(3)	Guildford Museum
Dorset		
Sherborne, Bedwill Copse (B1)	B.M. 1959, 211(1)	C. E. Bean Collection
Sherborne, Old Castle (B2) (*longitudinal section*)	B.M. 1959, 211(2)	C. E. Bean Collection
Sherborne, Schoolroom (B3) (*longitudinal section*)	B.M. 1959, 211(3)	C. E. Bean Collection
Sherborne, Old Castle (B6)	B.M. 1959, 211(6)	C. E. Bean Collection
[*Holland*]		
[Dorestad 69.4.5.3 (*longitudinal section*)	B.M. 1966, P25(2)	British Museum]
[*Norway*]		
[Rokleiv, Hommedal, Aust-Agder, 13957A.	B.M.1967, P51(2)	Oslo University Archaeological Museum]

N.B. The following symbols denote hones outside the terms of reference of the title of this paper:—

* Hones believed but not proved to be of Saxon or medieval date.

† Hones of pre-Saxon or post-medieval date.

[—] Hones from sites outside England.

Almost all the above hones are represented by thin sections interpreted as being transverse to a marked lineation. For the Bealings and Stonar X hones there are also thin sections parallel to the lineation (longitudinal) and a few other sections are interpreted in this sense, as indicated above. The sections show little variation in essentials, hence a detailed description of a single typical hone will serve for all. Noteworthy departures from it in particular characters will be mentioned in passing.

As seen in transverse section, hone No. 1123 from Thetford (B.M. 1959,210,5) consists, to the extent of about half its volume, of angular equant quartz grains ranging from 30–300 μ diameter, mainly rather below 100 μ, the mean maximum diameter of 100 grains being 88 μ. The quartz grains are more often than not separated by mica; when in contact their junctions are straight or nearly so (tessellate texture of A. G. Macgregor, 1952, p. 245; 1951, p. 266). They rarely show strain shadows and are usually clear, although sagenitic quartz has been noted in one case (Aylesbury (1)). No feldspar has been observed in Thetford 1123, which is atypical in this respect; in most cases there are occasional grains, similar in size to the quartz grains, of an optically negative oligoclase or oligoclase-andesine, while in some (Moorfields 11055, Stonar E and H, Ellington (3), Barton (4), ENQ 1050 and 1056) scarce microcline is also present. In ENQ 1056 the microcline forms scanty polycrystalline grains with (and replacing) quartz, indicating detrital derivation from an area of potash-metasomatism. The feldspars so far named are fresh, but ENQ 1050 and 1052 also contain grains of a sericitic aggregate after feldspar.

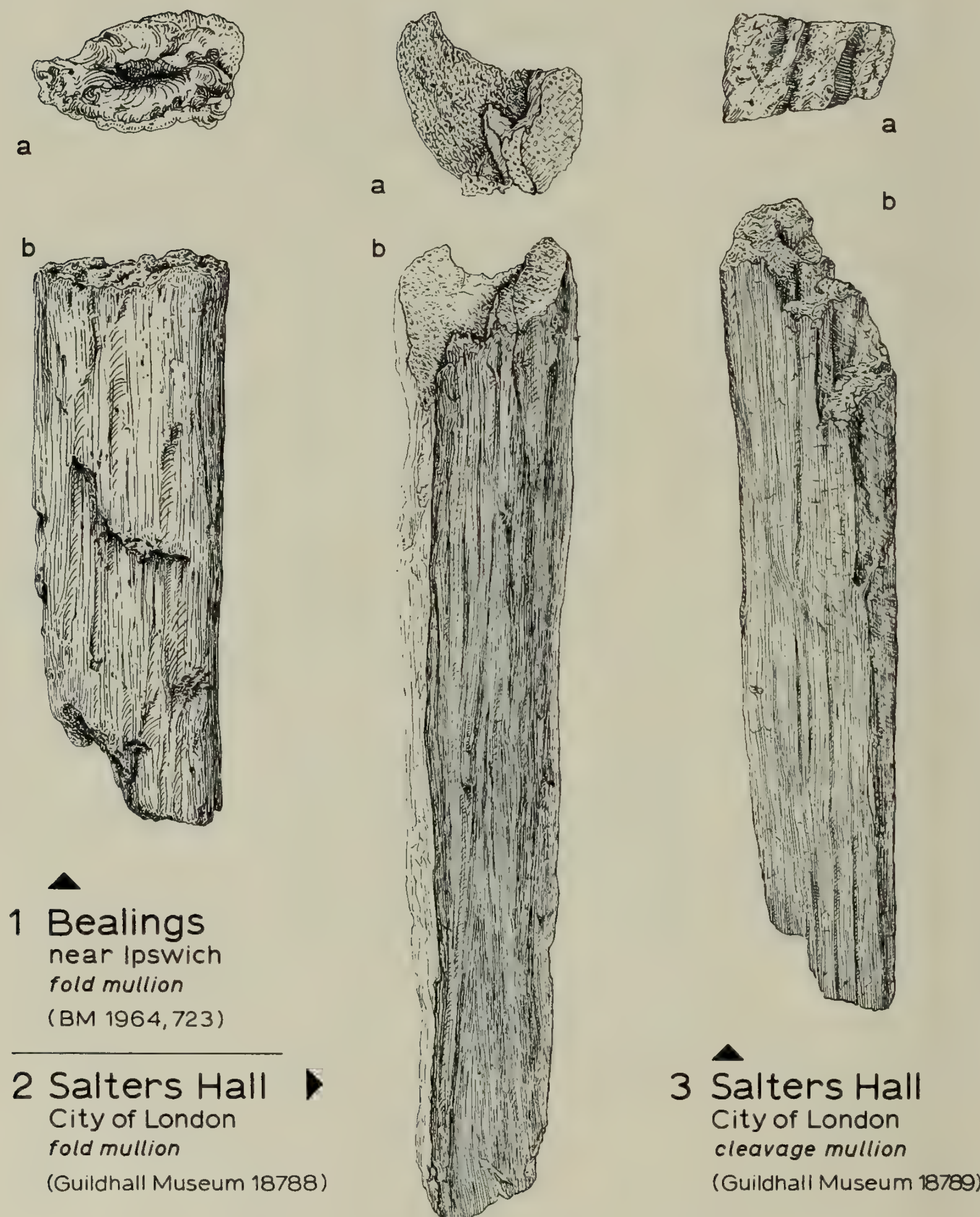
Next to quartz, muscovite is the most abundant mineral, in thin plates ranging from about 25–75 μ in diameter, mainly about 50 μ. It is irregularly distributed between the quartz grains and groups of grains, partly as sheaves which are disoriented in relation to each other and in places comminuted, and which resemble brecciated pure mica-schist. Isolated muscovite flakes often penetrate quartz-grains. Muscovite tends to show the same interference colours over wide areas of the section, indicating that the c-axes are normal to the lineation; it never appears as basal sections in transverse slices. In contrast to this, sporadic brown biotite, mainly in larger flakes (up to 100 × 20 μ) is oriented at random. Among the hones of this type biotite varies somewhat in colour, from reddish to greenish brown; in some cases (as in ENQ 1057, 1059, 1071, 1072, Thetford 1048 (1), Moorfields 11055) it resembles muscovite in grain-size and is very scanty, and in a few cases (ENQ 1049, 1058, 1067, 1068; Thetford 474, 1329; Stonar X; Aylesbury (2); Ellington (3)) it is absent.

Resembling the biotite in habit, grain-size and orientation is a pale green chlorite, uniaxial or pseudo-uniaxial positive, with straight extinction, negative elongation and a birefringence just below that of quartz (ca. 0·008). Its refractive index (β) has been determined in only two cases: Wortham (1·594) and Bealings (1·599); both values, in conjunction with the other observed characters, fall within prochlorite (Winchell, 1936, p. 649). Though rarely abundant, this chlorite is present in almost all the hones of this type, and is generally optically identical with that of Thetford 1123. Occasionally the chlorite is biaxial, and in four cases (Stonar C, Moorfields 11057, Barton (1) and Caldecote) it is uniaxial negative; in only five cases (Aylesbury (1) and (2), Ellington (2), Sherborne Old Castle (B2) and Mucking) is it absent. Calcite, in angular, anhedral monocrystalline grains of a size comparable with the quartz, tends to be associated with the chlorite. It is mainly untwinned, and is sparse and irregularly distributed in Thetford 1123 and most other cases; sometimes it is abundant, forming large monocrystalline grains, which in one case (Stonar F) enclose quartz poikilitically. It is absent from only four hones of this type (Barton (2), Sherborne Old Castle (B2) and Schoolroom (B3) and Mucking). The absence of calcite and chlorite in the cases cited may be due simply to the small area of the thin sections, since these minerals are the most constant and characteristic of the minor constituents of the "schist hones". There is no calcite in the thin section of Rokleiv 13957A, but it can be detected on a cut surface.

The most abundant accessory minerals of Thetford 1123 are the ores, apparently a mixture of magnetite and ilmenite, the latter accompanied by abundant irregular grains of leucoxene. Also present are one or two euhedral crystals of green tourmaline, rounded tiny zircons, and one grain of a highly refracting and birefringent optically positive mineral with extinction slightly oblique to a cleavage, probably monazite. All but the last named are generally distributed among the "schist hones". The ore content varies greatly in quantity and in species composition; in some hones (e.g. Sherborne Old Castle (B6) and Faversham) magnetite in great abundance is exclusive, while others (e.g. ENQ 1055, Ipswich Buttermarket) contain only ilmenite passing into leucoxene. Zircon is sometimes euhedral, sometimes anhedral and polycrystalline. Other noteworthy accessories are rutile in ENQ 1049 and 1050 and Faversham; actinolite occurs only in the Bealings hone. Many of the hones, particularly among those found at sites of late date, are rich in epidote, often in large anhedral grains (e.g. Salters Hall 18787 and 18788, Moorfields 11059, Southwark (ENQ 2085), Emberton, Stonar E, Ellington (2) and (3), Barton (4) and (7), Thetford 474, Sherborne Old Castle (B2)). No. 19201 from Southwark (Lant St.) has clinozoisite of similar form.

No detailed micrometric analysis has been made, but the " hard " constituents (quartz + accessories) of Thetford 1123 were estimated by the Rosiwal method at 51·8% by volume. In most of the other hones of this type which have been measured, the corresponding value ranges between 50% and 60% but in a small minority (e.g. Aylesbury (2), Barton (4)) it is much higher, so much so that many of the quartz grains are in contact with quartz and the rocks are transitional to the quartzites of sub-group IC. By contrast, in a few cases (e.g. Aylesbury (1), Moorfields 11056, Stonar D) muscovite is exceedingly abundant and most of the quartz-grains are isolated by it. Some hones (e.g. Moorfields 11058, Stonar F and G, Ellington (2)) show a rough alternation of more quartzitic and more micaceous bands; the latter appear to be zones of shearing in which the comminuted micas envelop isolated minute quartz-grains. In ENQ 1067 this banding shows a definite parallelism, and there is an approach to this in Thetford 704. One hone (Thetford 6) contains large irregular patches of tessellate quartzite completely devoid of micas (cf. IC, below).

The foregoing description relates to the transverse sections on which Morey & Dunham based their type (1), although some longitudinal sections have incidentally been referred to. The true nature of these schist hones is not clear from transverse sections alone, and did not become so to the writer until, in 1962, the Bealings hone was sent for determination to the British Museum (Natural History) by Mr. H. E. P. Spencer of the Ipswich Museum. As this specimen (Text-fig. 1*a*, *b*) was ploughed



FIGS. 1, 2, 3. Mica-quartz-schist mullions used as hones: (a) end and (b) side view.

up in a field on Jolly's Farm, Bealings, Suffolk, its archaeological date is uncertain. It is a fold-mullion in mica-quartz-schist, like those described by Dr. Gilbert Wilson (1953) from the Moine Series at Oykell Bridge, Sutherlandshire. It shows all the characteristics of such mullions, including two intersecting series of s-planes and a micaceous skin, and retains enough of the surrounding material to show its structural relationships. Wear on one exposed surface indicates use as a hone. In transverse section (Pl. 1, fig. 1) it is of the type described above, but longitudinal sections (Pl. 1, fig. 2) cut normal to each of the two s-directions show a very different texture, with granulitic layers and thin lenticles of quartz crystals lying parallel with the lineation and separated by thin layers or lenticles of very elongated muscovite flakes. The parallelism is interrupted by larger quartz augen, irregular calcite crystals, and occasional non-oriented biotite and uniaxial positive chlorite. The relative elongation of the quartz crystals differs appreciably in the two longitudinal sections, which resemble the two already referred to from Sherborne (Old Castle B2, Schoolroom 133) and also ENQ 1069, listed by Morey & Dunham as a " fine-grained quartz-muscovite-chlorite-schist " and constituting their type (2) (Morey & Dunham, Pl. 11, fig. 3). It is obvious from the Bealings hone that the " schist hones " are mullions cut transversely to their elongation to give the sections constituting Morey & Dunham's type (1), and parallel with it to give their type (2). The two Sherborne specimens of which longitudinal sections were taken are tabular fragments in which the direction of lineation is not apparent, and the same is probably true of ENQ 1069. This inference as to the relationship of Morey & Dunham's types (1) and (2) was confirmed by cutting transverse and longitudinal sections of the only "schist hone" (Stonar X) then in the B.M. (N.H.) collection; these also correspond to Morey & Dunham's types (1) and (2) respectively. Further confirmation is provided by specimens of the raw material, scarcely used as hones, in a level dated at about A.D. 1500 at Salters' Hall, Walbrook (Guildhall Museum 18787–9). These have been compared directly with Wilson's (1953) material from Oykell Bridge, which they closely resemble as hand specimens although they do not match it in thin sections. No. 18787 (Pl. 1, figs. 3 and 4) is, in Wilson's terminology, a (curved) irregular mullion; no. 18788 (text-fig. 2*a*, *b*) a fold mullion, in section a 60° segment of a circle; and No. 18789 (text-fig. 3*a*, *b*) a cleavage mullion of quadrangular section. There are specimens from other sites which closely resemble these; e.g. Stonar I, a cleavage mullion of rhombic section. Most of the Moorfields (15th century) specimens are also easily seen to be mullions, although much worn.

(2) Grey micaceous quartz-schist of heterogeneous grain-size.

Norfolk. Thetford 73; B.M. 1959, 210(27). Norwich Castle Museum.

This is probably a mullion like those of type (1) but differs from them in important respects. It is finer-grained and its quartz, which often shows strain polarization and a tendency to sutured junctions, tends to occur as islands of coarser-grained material (ca. 30–60 μ) separated by tracts of finer grain (ca. 10–30 μ) approaching type IB(1) (below) in character. Feldspars (microcline and plagioclase) occur sporadically and show optical distortion. The muscovite occurs both as small intergranular flakes (ca. 10–25 μ diameter) like those of type (1), and as large ragged tables up to 300 μ across and 100 μ thick. There is also a little pale biotite. Chlorite is absent but calcite, epidote, apatite and magnetite are abundant. A little sphene (rounded) and tremolite (euhedral) are also present.

(3) Grey banded quartz-mica-schist.

Essex. East Tilbury; B.M. 1968, P. 22. Tilbury Museum.

This hone has much in common with the last; it is treated as a distinct type because it completely lacks the biotite, calcite and, visibly twinned feldspar of Thetford 73 and is also much richer in mica. It is lineated but not a mullion. Its quartz, like that of type (2) is often strain-polarized; it shows a more marked differentiation between coarser and finer grained material, the former tending to form distinct lenticles separated by sheets of the latter, and wrapped around by large curved flakes or sheaves of muscovite. The latter grade down to small intergranular flakes, and the larger muscovites also form continuous bands visible in the hand specimen. Epidote is especially abundant both in large crystals and in streaks of small ones, and there are abundant small euhedral crystals of sphene mostly enclosed in micaceous aggregates. Apatite and magnetite are accessory.

B. Quartz-mica-metasiltstones or silty quartz-phyllites

Dark aphanitic rocks with an indistinct schistosity, generally linear, contrasting markedly with those of sub-group A (the " schist hones ") despite a similar mineral composition.

(1) Quartz-muscovite-metasiltstones of medium grade, with little or no biotite (lineated muscovite-quartz-phyllites).

Details of Hones	Slide oN.	Collection
Yorkshire		
York Assembly Rooms	ENQ 1051	York Museum
York, Coppergate	ENQ 1060	York Museum
York, Clifford St.	ENQ 1062	York Museum
	ENQ 1063 (*oblique section*)	York Museum
	ENQ 1064	York Museum
Norfolk		
Thetford 10	B.M. 1959, 210(11)	Norwich Castle Museum
Thetford 10	B.M. 1959, 210(12)	Norwich Castle Museum
Thetford 622 (Site 2)	B.M. 1959, 210(13)	Norwich Castle Museum
Thetford 769	B.M. 1959, 210(14)	Norwich Castle Museum
Thetford 969	B.M. 1959, 210(15)	Norwich Castle Museum
Thetford 278(1)	B.M. 1959, 210(16)	Norwich Castle Museum
Thetford 278(2)	B.M. 1959, 210(17)	Norwich Castle Museum
Thetford 120(1)	B.M. 1959, 210(18)	Norwich Castle Museum
Thetford 120(2)	B.M. 1959, 210(19)	Norwich Castle Museum
Thetford 554	B.M. 1959, 210(20)	Norwich Castle Museum

Thetford 31	B.M. 1959, 210(21)	Norwich Castle Museum
Thetford 1195	B.M. 1959, 210(22)	Norwich Castle Museum
Thetford 1361	B.M. 1959, 210(23)	Norwich Castle Museum
Thetford 745	B.M. 1959, 210(25)	Norwich Castle Museum
Thetford (Site 1)	B.M. 1959, 210(26)	Norwich Castle Museum
Thetford 1054	B.M. 1966, P 22(1)	Norwich Castle Museum
Huntingdonshire		
Ellington (1)	B.M. 1966, P13(1)	C. F. Tebbutt Collection
Northamptonshire		
Sulgrave (170)	B.M. 1966, P20(2)	Ancient Monuments Department, M.P.B.W.
Surrey		
Guildown S.2384	B.M. 1966, P16(1)	Guildford Museum
[*Norway*]:—		
[Rokleiv, Hommedal, Aust-Agder, 13957B	B.M. 1967, P51(3)	Oslo University Archaeological Museum]

Most of the above hones are represented by thin sections showing a tessellate arrangement of the quartz grains. Thetford 622 (site 2), B.M. 1959, 210(13) is typical (Pl. 2, fig. 1). Its polygonal quartz grains, 20–30 μ in diameter, are notably devoid of strain shadows. They are rarely in actual contact, being separated by colourless mica-flakes of slightly lesser diameter. The micas are more evenly distributed than in type IA(1), but show the same feature of more or less uniform polarization colours, indicating that the section is perpendicular to a lineation. There are also smaller micas which penetrate the quartz grains. The only other conspicuous constituents are abundant ore grains, apparently mainly magnetite but also some hematite.

Similar sections of two York hones (ENQ 1060, 1062) were the basis for Morey & Dunham's type (3). Some others, finer-grained and richer in mica, were erroneously placed by Morey & Dunham among the " sediments of lower Paleozoic type "; e.g. ENQ 1051 and 1064 which constitute their types (7) and (8) respectively. This error is probably due to the greater thickness of these thin sections; allowing for this they are similar in essentials to the Thetford 622 (site 2) hone described above.

Calcite is sporadically present in many hones of this type. One (Thetford 969) contains a rounded calcite grain enclosing a kernel of quartz, suggesting a recrystallized oolith. In most cases however the calcite occurs not in the quartz-mica aggregate forming the mass of the rock, but in patches and veins of quartzite resembling that in Thetford 6 (type IA(1) above), and very like the quartzite of type IC(1) below. These quartzite inclusions are generally in the form of irregular streaks and veins of coarser grain than the quartz-mica aggregate. Associated with the calcite, they often, as in Thetford 969, contain a chlorite resembling that found in type IA(1) in its colour and birefringence and (where this can be demonstrated) in its uniaxial positive character. In Thetford 278(2) the quartzite patches are rounded and about 150 μ in diameter, suggesting polycrystalline sand grains with constituent individuals up to 50μ in diameter. In B.M. 1959, 210(26) (Thetford site 1), there are relatively coarse quartzite patches containing euhedral sphene in addition to calcite and chlorite. In Thetford 745, some of the crystals in the quartzite patches show strain polarization.

Many of these hones, particularly those with quartzite inclusions, contain patches and streaks of material of sub-parallel orientation (granulitic texture), though without much elongation of the mica-flakes or quartz-grains. These are interpreted as sections oblique to the lineation and as due to local distortions of the latter (Pl. 2, fig. 1). One such patch in Thetford 278(2) (Pl. 2, fig. 2) contains larger mica-flakes than the surrounding material, accompanied by calcite and optically positive chlorite; it is transitional in character to type IA(1). Thetford 554 is heterogeneous: the section is crossed by a broad band of quartzite very rich in calcite, resembling Thetford 447 (type IC(1), below) but finer-grained and containing clots of the quartz-mica aggregate seen in the main part of the slice; this latter is very fine-grained and transversed by " granulitic " bands with very perfect parallelism and considerable elongation of the micas. A texture like that of these bands characterizes the entire area of the sections of Thetford 10 and Thetford 36, in which the quartz grains show a consistent parallel elongation amounting to about one and a half times their breadth (which averages about 20 μ), and the micas show perfect parallelism and extreme lengthening, forming exceedingly thin folia. It is on account of the similarity of these sections to occasional patches in the more typical sections of hones of this group, and the analogy between this similarity and the relationship between longitudinal and transverse sections in the " mullion " hones of subgroup IA, that this type (IIB(1)) is regarded as having a linear schistosity, typical sections as in the case of type IA(1) being transverse to the lineation. One of the York hones, ENQ 1063, shows a uniform parallel texture without much elongation of the quartz-grains and with some micas oblique to the general orientation; it is clearly like the patches referred to above as oblique to the lineation and represents a fragment of this type cut obliquely. It was incorrectly classed by Morey & Dunham as a siltstone of lower Paleozoic type (their type (9)).

(2) (Quartz-muscovite-biotite-metasiltstone (lineated muscovite-biotite-quartz-phyllite).

Norfolk. Thetford 1062; B.M. 1959, 210(24). Norwich Castle Museum.

This type differs sufficiently from the last to be separately described, although closely related. It is a micaceous quartz-siltstone of the same grain-size (20 μ) as type IB(1), but differs in its irregular texture resembling the " swirling " pattern of type IA(1), in the relatively thick stubby habit of its pale greenish muscovite plates (also about 20 μ diameter), and in the presence of irregular flakes of brown biotite up to 300 μ in diameter and 100 μ thick. There is no chlorite, but an iron-stained carbonate is present in occasional rounded grains. Ore-grains of square outline, probably magnetite, are abundant, as are minute rounded zircons. Inclusions of tessellate quartzite, of grain-size 50 to 200 μ, are so abundant that the stone is almost a mélange of quartzite and micaceous siltstone; the inclusions form several irregular incomplete bands across the section. None of the quartz shows strain polarization.

(3) Lineated blue-black muscovite-biotite-chlorite-quartz-phyllite.

Kent. Sarre 510B; B.M. 1959, 212(2). Maidstone Museum.

This stone differs from the last in its much finer and less even grain (quartz-grains 5–15 μ, muscovite flakes 5–20 μ diameter) and in the abundance of finely-divided chlorite of low birefringence. The nearly uniform polarization colours of the muscovite flakes, which are apparently orientated at random, shows that their vertical axes lie in the plane of the section, hence that this section like the preceding is normal to a lineation. There are sporadic larger tables, up to 50 μ diameter and 40 μ thick, of reddish-brown biotite, irregularly distributed ore-grains and some larger (up to 100 μ diameter) agglomerations of opaque matter, but no carbonate. This rock may not be related to the others in this sub-group; it differs markedly from them in composition and texture.

C. Quartzites (Metamorphic)

These differ from the mica-quartz-schists of sub-group A in that micas are present, if at all, only as isolated flakes sporadically distributed.

(1) Calcite-bearing quartzite (mullion).

Norfolk. Thetford 447; B.M. 1959,210(10). Norwich Castle Museum.

Inequigranular tessellate quartzite with grains of silt grade (diameter 10–100 μ) irregularly distributed in patches of varying coarseness. The coarser-grained patches are devoid of mica but contain abundant irregular calcite crystals similar to those of the " schist hones " (type IA(1)); the quartz crystals are often elongated and some show strain polarization. The finer-grained patches show a fine granulitic texture like the longitudinal sections of the lineated phyllites (type IB(1) above), but with only occasional thin elongated mica-flakes in parallel orientation. One such patch, in the form of a small overfold, contains abundant rounded grains and hexagonal plates of hematite. Biotite and chlorite are absent.

(2) Slightly micaceous bedded quartzite.

[*Norway.* Rokleiv 13956; B.M. 1967, P51(1). Oslo University Archaeological Museum.]

This is one of three hones from Rokleiv, Hommedal, Aust-Agder, S.W. Norway, lent as part of a sample for comparative purposes (see p. 150 below). It is a tessellate quartzite without strain polarization, of grain-size from 50–120 μ (almost all less than 100 μ), with sporadic grains of soda-microcline and fewer of oligoclase-andesine, and scattered thick tables of muscovite mainly between 40 μ and 50 μ diameter (range 20–100 μ). The only accessories are minute grains of rutile and magnetite.

(3) Grey fine-grained quartzite, muscovite- and biotite-bearing.

Hampshire. Hamwih, Site C, P.103; B.M.1964,730(1). Southampton Museum.

This is another tessellate quartzite, with grains varying from 50–300 μ in diameter and rarely showing strain polarization. It closely resembles the more quartzitic " schist hones ", but differs from them in containing only scattered mica flakes with biotite in excess of muscovite, and in lacking calcite and chlorite. The micas are somewhat smaller than the quartz grains, the rather thick biotite tables being oriented at random while the thinner muscovites tend to parallel orientation and often penetrate quartz. Accessories are schorl, apatite, zircon, and monazite. The stone may be a mullion.

(4) Buff-grey flaggy sutured quartzite with scanty mica.

Hampshire. Hamwih P.56①, Hone B. B.M.1964, 730(2). Southampton Museum.

An inequigranular quartzite of grain-size 80–250 μ, mainly about 150 μ, with a tendency to parallel-oriented tabular habit of the quartz grains, which show sutured junctions, frequent strain polarization and abundant minute red inclusions, probably rutile. There are numerous curved shear-planes marked by thin mica-plates (muscovite and hydrobiotite up to 100 μ in diameter) and by lenticles of finely divided quartz (grain-size 5–10 μ); the latter is also present in irregular interstitial patches (incipient mortar structure). These structures collectively give rise to a rough parting. There are sporadic larger muscovite flakes with chlorite after biotite in parallel growth, and abundant minute wisps of sericite and clots of limonite. Accessories include tourmaline, zircon, rutile, anatase, hornblende, unidentified ore, and clusters of tiny siderite rhombs.

(5) Grey quartzitic phyllite ("novaculite").

[*Holland.* Dorestad 69–4–5–1; B.M. 1966, P25(1). British Museum].

This hone, although outside our geographical terms of reference, has been included because of its association with the earliest dated "schist hone" (before A.D. 860; see p. 154 below). The thin section, cut parallel with the foliation, shows a fine-grained sutured quartzite of grain size mainly 5–25 μ, with abundant scattered flakes of muscovite and some of chlorite, of diameter 5–50 μ; many smaller micas, also tiny needles of rutile, pierce the quartz-grains. There are scattered grains of ore.

PROVENANCE OF HONESTONES OF SUB GROUPS IA, IB, & IC

Type IA(1), which is identical with type (1) of Morey & Dunham but includes also their type (2), accounts for most of the metamorphic honestones. Most of the remainder belong to type IB(1) which is the same as Morey & Dunham's type (3) but also includes their types (7), (8) and (9). Most of the types in these three sub-groups can be shown to be closely related by their mineralogy, by transitional examples, or by inclusions of material of one type in another. The most important common mineralogical features are the quartz grains with rectilinear boundaries and without strain polarization, the irregular monocrystalline calcite grains and the chlorite which is nearly always uniaxial positive. There is a broad similarity, with some variation, in the assemblages of accessory minerals. Types IA(2) and (3) contain material transitional in character to IB(1), while one hone of the latter type, viz. Thetford 278(1), contains material transitional to IA(1). The most important inclusions are of quartzite, occurring in one hone of type IA(1) and in several of type IB(1). The quartzite hone Thetford 447, type IC(1), contains calcite grains like those of type IA(1) and metasiltstone patches resembling type IB(1). Most of the thin sections show the confused structure characteristic of transverse sections of mullions, while a few have the strict granulitic parallelism and frequent microscopic augen-structure found in longitudinal sections of mullions. Four hones (Bealings and the three " raw material " hones from Salters' Hall) are demonstrably mullions and are represented by both these kinds of section, and another (Stonar X), a typical " schist hone " not obviously a mullion is also represented by both kinds of section. The metasiltstones of type IB(1) are also represented by two kinds of thin section which can be interpreted in this way. It is clear that type IB(1) represents fine semi-pelitic bands in the psammitic series of which subgroups IA and IC are more typical, the inclusions of one type in another being due to the peculiar microbrecciation or mutual infolding occurring in mullion formation. Archaeological evidence bears this out; this type is (in England) always associated with " schist hones " but has a narrower site distribution. IB(2) is clearly a variant of IB(1), and IB(3) may be another.

The inference is drawn that the " schist hone " series (i.e. the whole group of types of which the schist hones, IA(1) are the most important) come from a region (or regions) of fine-grained psammitic with some semipelitic mica-quartz-schists in which mullion structure is extensively developed. This feature probably made them especially useful as hones since it ensures even distribution of the honing properties parallel to length, and also obviates the necessity for shaping them. It is significant that very few of these mullion hones show any trace of artificial shaping, although some have been pierced. The source area must be one of metamorphic rocks and is unlikely to be outside northern or western Britain, or northern or western Europe. Within this general region, the possibilities of provenance can be limited to some extent by geochronological data. Unfortunately these must necessarily be few owing to the limitation in quantity of available material which is inherent in research on artefacts; in fact, we have only one radiometric date for a hone, obtained by the Age Determination Unit at Oxford under Dr. N. J. Snelling by the potassium-argon method on muscovite from one of the raw material mullions (Guildhall Museum 18787) from Salters' Hall, Walbrook, City of London. The age of 950 $\pm$ 30 million years* lies outside the range of any British metamorphic area, being too low for the Scourian or Laxfordian and too high for the Moinian or Caledonian episodes. It corresponds to the earlier phase of the Ryphean metamorphism represented, in north-western Europe, only in extreme southern and south-eastern Norway and south-western Sweden, excepting for remote areas in central Finland and the Kola peninsula (see Kulp & Neumann, 1961, pp. 470–1; Polkanov & Gerling, 1961, pp. 493, 495–7).

As indicated below (pp. 180–2), the appearance of "schist hones" in England immediately follows the first considerable Viking invasions and settlements, and it is to be expected, if some or all of them have a Norwegian provenance, that they must also be widely distributed in Norway itself. According to Petersen (1951, English summary) Norwegian honestones of the first millennium and the Viking period are of two principal kinds: quartzites ranging from the younger Iron Age to earlier

* Reference, I.G.S. KA67.115. %K 5·23; radiogenic ^{40}Ar 2·575 $\times$ 10^{-4} scc/gram (N. J. Snelling, priv. comm.).

Viking times and " bluish slates " (*sic*) which became dominant during the " real Viking period " (*sic*). Hones exemplifying these types from a site bridging both periods at Rokleiv, Hommedal, Aust Agder, were kindly lent by Universitets Oldsaksamling, Oslo. One of these (13956) is a micaceous quartzite of a common type (IC(2), above) not yet found as hones in England but texturally like type IC(3) from Hamwih. The other two (13957A and B), described as " blue slates ", are respectively a calcite-poor " schist hone " of type IA(1) and a metasiltstone of type IB(1). Thus the "bluish slates " of Petersen include the two main types of our " schist hone " series, and the theory of a Norwegian provenance which would be preferred on general principles is reinforced by the only radiometric date we have from an English site. At least one source locality for Viking honestones is well known: that of Eidsborg, Telemark, central southern Norway. Nine samples of lineated mica-quartz-schist from the Eidsborg quarries (collected by Dr. J. A. Dons; B.M. 1967, P50 (1–9) prove to be petrographically identical both in transverse and longitudinal section with our type IA(1) and especially resemble the City of London (Salter's Hall and Moorfields) material (Pl. 1, figs. 3–6). Potassium-argon age determinations on muscovite from two specimens (Nos. 8 and 9) gave ages of 991 ± 37 and 989 ± 31 million years respectively.* Although the mean of these (990 m.y.) is 40 m.y. higher than the apparent age of the Salters Hall hone (18787), the latter may have lost argon in the five centuries since it was quarried, and in any case its margin of error overlaps that of the Eidsborg material. Eidsborg is therefore a possible source for the City of London hones, perhaps also for most or all of the " schist hone " series, despite the lack so far of actual specimens from there of our other main metamorphic type, the phyllite IB(1). There may of course be further source localities within the same general region.

As the demonstration of a Norwegian source for " schist hones " depends, so far, on a single age determination on an archaeological find, possible sources outside Scandinavia must also be considered. At least one theory of such a provenance, that of Morey & Dunham (1953) has been advanced on petrographic grounds, namely the resemblance of the " schist hones " from Yorkshire to thin sections (S.8523, S.8523A, and S.8523B), in the Geological Survey Museum, of schists from the Honestone or Parallel Banded Series of the Lower Dalradian in Allt Bhronn, a tributary of the Bynack Burn in uppermost Deeside S.W. of Braemar, Aberdeenshire (Morey & Dunham, pl. 11, figs. 1, 2); and between their type (2), which as we now know is simply a longitudinal section of a " schist hone " (Morey & Dunham, pl. 11, fig. 3), with a thin section (S.3839) of a rock from Sròn Dias crags, Glen Loch, a tributary of Glen Fernate, north Perthshire (Barrow, 1904, pl. 31, fig. 2). The Honestone Series was first described and named by Barrow (1904), who considered it a lateral facies of the Moine psammites; the name is based on an exposure in the Fealar area, S.E. of Upper Glen Tilt, " often visited in former years by farmers and shepherds, who came from considerable distances to procure a certain portion of the parallel banded material to be used as honestones " (Barrow, 1904, p. 433). The series outcrops along a narrow band to the E. and S.E. of the Dee and Tilt

* References: (8): KA68.16: %K, 5.36; radiogenic ^{40}Ar 0·496 p.p.m.; %rg. ^{40}Ar 98·6. (9)KA68.17: %K, 6·12; rg^{40}Ar 0·565 p.p.m.; %rg. ^{40}Ar, 98·6. (N. J. Snelling, priv. comm.).

valleys, and in a few localities farther S.E., of which Glen Loch is one. It was redescribed by Barrow, Hinxman & Cunningham Craig (1913, pp. 17–21); see also Barrow & Cunningham Craig (1912, pp. 31, 38) who grouped it with the Perthshire or Central Highland Series, since named the Dalradian.

The thin sections of rocks from the Honestone Series in Allt Bhronn are not identical with the " schist hones " with which they were compared by Morey & Dunham. They resemble the " schist hones " in the habit of their quartz and mica and in the absence of strain polarization, but differ from them in having more biotite than muscovite and in lacking the characteristic calcite and uniaxial positive chlorite. They display well the marked banding which gives the Honestone Series its alternative name, and which is due to the alternation of less micaceous quartzitic material containing scattered bioties (resembling a quartzite hone from Hamwih, type IC(3) above) with richly micaceous bands in which the micas approach parallel orientation. An approximation to this banding is seen in a few " schist hones " (e.g. Thetford 704, ENQ 1067, noted on p. 141 above); in one case (Guildford G6994), it is clearly seen in the hand specimen, folded on an axis parallel to the lineation. As already noted, however, these hones differ in their detailed mineralogy from the Allt Bhronn rock, which is typical of the main part of the Honestone Series, as examplified by numerous specimens collected from the middle of the outcrops in Glen Ey, Allt Bhronn and Glen Tilt and by a section (S.9797) in the Geological Survey Museum of an example from the Fealar area, described by Barrow (1904, p. 434; 1913, p. 18). The honestones close to the Central Highland Quartzite, however, are much more siliceous than this (Barrow, *loc cit.*), and mullions in a rock of this composition and texture, with the addition of the chlorite and calcite characteristic of the " schist hones ", would match the latter. An example of such a rock from this level in the Honestone Series (see Barrow's manuscript entry in the Geological Survey Register) is that from Sròn Dias crags, Glen Loch, the thin section of which has already been mentioned as Morey & Dunham's match for their type (2). This thin section differs from oblique sections of the " schist hones " only in two points of detail: it contains much more alkali-feldspar and its chlorite is uniaxial negative with a deeper body-colour and higher refractive index than that found in any of the " schist hones ", presumably due to a lower MgO : FeO ratio (it is probably a thuringite—see Winchell, 1936, p. 649). A uniaxial positive chlorite close to that of the " schist hones " is however found elsewhere in the Honestone Series, e.g. in association with calcite in a rock from the left bank of the Glen Ey Burn about a quarter of a mile above Altanour Lodge (B.M. 1963, 969(6)); this differs from the " schist hones " in its mica (biotite only) and in its tabular foliation. Hence although the " schist hones " have not been exactly matched in the Honestone Series, all their characters can be found in different rocks of this series, and it is highly probable that all, including mullion structure which is common in this region, occur in combination at some point or points along the outcrop which would therefore be a potential source. Such a source may well be difficult of access or be buried under landslips. It may be noted that our nearest match, that from Sròn Dias Crags, is in that part of the outcrop lying south of the watershed between Glen Tilt and the glens leading south-east to the fertile valley of Strathmore, an area of settlement since prehistoric times.

The above discussion refers directly to the " schist hones " proper (type IA(1)). The second most abundant type in the " schist hone " series, the lineated phyllite or metasiltstone, IB(1), has not yet been matched in this region. It was compared by Morey & Dunham (1953) with a thin section of a rock (Geological Survey Museum, S.2807) from Upper Nochty (incorrectly referred to by them as Upper Mochty), Upper Strathdon, N.W. Aberdeenshire; this however is an error as the Upper Nochty rock is an amphibole-hornfels with only a textural resemblance to the phyllites of type IB(1). There is however a rough comparison between the latter and a rock from the Honestone Series three-quarters of a mile above Altanour Lodge, Glen Ey, S.W. of Braemar (B.M. 1963, 969(11)) which differs from type IB(1) in being inequigranular and somewhat coarser-grained, and in containing biotite to the exclusion of muscovite; it contains calcite but no chlorite. Clearly a close match with type IB(1) could occur in the Honestone Series.

The Honestone Series in S.W. Aberdeenshire and N. Perthshire is not the only possible alternative source of " schist hones " in the Highlands, in which mica-quartz-schist mullions occur at other horizons and localities. In N. Aberdeenshire and the adjacent part of Inverness-shire, there are inliers of Dalradian type in the Moine outcrop (the Grantown and Cromdale Series) in which mullion structures are frequently developed (McIntyre, 1951, pp. 7–8). Many occurrences in the Braemar area are noted by King & Rast (1956). On the western side of Portsoy harbour, Banffshire, at the northern limit of the Dalradian outcrop, a small inlier of mica-quartz-schist which forms a promontory is faulted into the serpentinite intrusion. It consists chiefly of mullions indistinguishable in hand-specimen from the " schist hones ", although differing from them in thin section in having sutured quartz-grains with strain polarization and in lacking calcite and chlorite; the mica is sometime biotite (B.M. 1965, P40(1)), sometimes muscovite (B.M. 1965, P40(2)). There are also rocks closely similar to the Honestone Series among the Moine schists (Barrow *et al.*, 1913, p.18); Barrow compares the figured section of the rock already referred to from Sròn Dias Crags (S.3839) with a " fine Moine gneiss " (1904, caption to pl. 37, fig. 2). The Struan Flags, the Moine psammites exposed in the Glen Garry section N.W. of Blair Atholl, have one lithological phase (" highly micaceous gneisses ") rich in quartz and mica and frequently showing " rodding " (here used as synonymous with mullion structure: Barrow, 1904, p. 408). North of the Great Glen, at Oykell Bridge, there is an area in the Moines over which mullion structure predominates (Wilson, 1953) and in which many examples megascopically resembling the " schist hones " can be found, some of which also match the latter in grain-size and in the absence of strain polarization; they differ in that the mica is mainly brown biotite, in the presence of a moderate amount of alkali-feldspar, and in the absence of calcite. They contain chlorites varying from uniaxial positive (B.M. 1965, P1(3)) to biaxial negative after biotite (B.M. 1965, P41 (2)). If true matches for the " schist hones " occur here, the district is a particularly likely provenance in view of its proximity to the sea and to areas of Viking settlement. Finally, if the normal schist hones (IA(1)) are comparable with the " normal Moines " of Read (1931) in their comparative evenness of grain, tessellate texture and absence of strain polarization, one aberrant type (IA(2)) approaches Read's " granulated Moines ", the "abnormal" Moines of A. G. Macgregor (1952, pp. 244–5, also pls. vi and vii; the " abnormal " Moines are those modified by the Moine thrust movements). Macgregor (*loc cit.*) further observes that chlorite and calcite are found in veinlets, probably of hydrothermal origin, in both " normal " and " abnormal " Moines in Central Sutherland. References to " mullions ", " rodding " and linear foliation in the literature of the thrust-belt, especially in the work of Peach & Horne (1907) are too numerous to cite. One description by J. J. H. Teall on pp. 75–76 of this work of the textures revealed by thin sections respectively parallel and normal to the lineation of a fine-grained quartz-mica-schist of Lewisian age (Geological Survey Museum, S. 3751) could serve as a textural description of the " schist hones ".

It is therefore probable that potential sources for " schist hones " exist in the Scottish Highland Caledonides despite the fact that identical rocks have not yet been located in the field. Even granted that their original and main source is in S. Norway, it is likely that Viking invaders or settlers who chanced to discover outcrops of rocks like their native honestones would use them for that purpose. This possibility may be extended to structurally and mineralogically similar areas in the Caledonides such as Donegal, Shetland and West Central Norway; the last of these in particular (as distinct from the older southern region unaffected by the Caledonian movements) is a mirror image of the Scottish Highlands as regards both rock types and structures (A. Kvale, 1953, pp. 61–64).

Pre-Cambrian schists of similar composition, grain-size and metamorphic age also outcrop over small areas in Anglesey and south Devon (Start Point). Morey & Dunham (1953, p. 143) mention that mica-quartz-schists from Anglesey differ from the " schist hones " in showing strain-polarization (e.g. Geological Survey Museum E.10068 from Cerig Duon, a muscovite-bearing quartz-schist). It should be added that they are texturally unlike the " schist hones " and lack their characteristic calcite and chlorite, and that this also applies to the Start schists. One of the quartzite types, however, IC(4) from Hamwih, might easily have come from one of these sources, particularly the Start area which is at no great distance by sea.

Another and very different provenance is that suggested by Dunning (1938) who argues from the distribution of the few continental " schist hone " finds in his list in favour of a multiple provenance in the various Hercynian massifs (Brittany, Ardennes-Rhineland, the Massif Central of France) near or within which they occur. He suggests the neighbourhood of Angers as a particularly likely source for the " schist hones " of English sites, which are mainly of Norman or later date, as being central both to the Angevin empire and to a region of " schistes ". Although the " schistes d'Angers " are not schists in the English sense but Ordovician and Devonian roofing slates, true metasedimentary schists do occur in the area in an extension of the narrow belt of metamorphic rocks south of the great east-west dislocation of southern Brittany. One such rock collected by Dunning from the banks of the Loire near Angers (B.M. 1966, P23) has a superficial resemblance to some " schist hones ", but a thin section shows it to be a composite cataclastic schist made up of sheets and lenticles of quartzite resembling type IC(4) (above), and mica-rich bands rather like those of the banded "schist hones", but in both cases without their calcite and chlorite; all the quartz is strain-polarized. Reference to French petrographers as to the possible Armorican origin of the " schist hones " has elicited divergent but non-committal replies based on absence of known matching types; thus while Michel-Lévy (quoted by Dunning, 1938, p. 694) considers that " there is no evidence against the Armorican origin of the fine mica-schists submitted for examination ", J. Cogné of the Institute of Geology, Rennes (quoted by Morey & Dunham, 1953, p. 143) emphasizes that he knows of no rocks in Brittany like them, especially in the distinctive presence of calcite; this opinion was repeated verbally to the writer by Professor P. R. Giot, also of Rennes (1959). While nothing closely resembling the typical " schist hones " has been found in Brittany, the thin section of one of the quartzite types (IC(3)) is similar to that (F.1809) of a " schist " from Tanté, Brittany, in the Geological Survey Museum. Both the quartzite types mentioned in this paragraph (IC(3) and (4)) are from Hamwih (Southampton), a site nearer to Brittany and much older than most of those at which " schist hones " have been found, so they may well be of Armorican origin, especially as they are associated with greywacké hones (IIC (6–9) below), also probably from Brittany.

The Rhineland-Ardennes area has also been suggested as a possible source for some late Saxon " schist hones " on account of the association of these, as at Northampton, with pottery of Eifel type (Dunning, 1938, p. 695) and probably also because of their frequent association with millstones of Niedermendig-Mayen lava from the Eifel. Moreover, " schist hones " are associated at some sites with honestones of other types for which an Ardennes-Rhineland source is probable; e.g. at Thetford, with the cataclastic greywackés of sub-group IIA and the silty greywacké of type IIC(3) (below); and at Dorestad (Holland) where one of the earliest " schist hones " is associated with an Ardennes-type " novaculite " hone (type IC(5), above; cf. B.M. 45070 from Salm-Chateau, Luxembourg, Belgium). However, since these sites are noted for evidence of widespread trading contacts, this is no evidence in favour of an Ardennes-Rhineland provenance for " schist hones "; rather the contrary, since this region has long been known as a source of honestones both of types already mentioned and, more typically, of porphyroids and leptynites derived from acid igneous rocks. These are all common in rock collections and their source localities are well known, whereas it has not been possible to match the " schist hones " with rocks from this area. The closest comparison we have been able to make is with some micaceous quartzites of similar grain-size and without strain-polarization in the Bastogne area (B.M. 1921, 532, 26–28) but these are unlike the " schist hones " texturally, and lack both calcite and chlorite.

One further possible source for the " schist hones " remains to be considered: the drifts of Eastern England, which contain abundant far-travelled erratics from Scotland and Scandinavia, some of which must have been used as hones. Dalradian " Honestones " must occur in the drifts, but in view of the narrow outcrop of this formation and its great distance one would not expect them to be common. This is also likely to be true of the Norwegian honestones. This has been borne out by prolonged search by the writer in the coastal drifts of Norfolk and a more cursory examination of those of Holderness, which have failed to yield a single specimen. Of 400 far-travelled erratics from the Yorkshire coast recorded in a study by J. Phemister (1926, p. 437) only two, to judge by the description, could be of any of the types here considered, but these (" Metamorphic grits, probably Highland ") are likely to be schistose grits coarser than the " schist hones ". One or two of the schist fragments classified as hones from Thetford, and the Bealings hone, may have been derived from the drift in view of their crude untrimmed state, but this alone does not constitute proof of a drift origin.

To summarize our conclusions as to the provenance of the hones of these three sub-groups: some, perhaps all, of the " schist hones " (type IA(1)) and those shown to be closely related to them (types IA(2–3), IB(1–2) and IC(1–2) were certainly brought from southern Norway, but some may be of Scottish Highland origin. Of the remaining quartzites, types IC(3) and (4) are probably from Brittany, the nearest possible source area to Hamwih (Southampton) within which comparable rocks are found. Alternatively, IC(3) may be a quartzite associate or precursor of the " schist hones " from Norway, and a source in the S.E. Highlands of Scotland is also possible. The " novaculite " IC(5) is almost certainly from the Ardennes. The lineated phyllite from Sarre, type IB(3), may have come from any fold-mountain area of low metamorphic grade. Its association at an early Saxon cemetery in Thanet with a deltaic siltstone hone of Carboniferous type (IIIB(4), below) suggests a provenance in the Ardennes-Rhineland area, or one much nearer in the Boulonnais.

D. Rocks characteristic of metamorphic aureoles

This is a small heterogeneous group of fine-grained metasediments.

(1) Quartz-schorl hornfels (altered phyllite), blue-black fragment.

Suffolk. West Stow (120), M13(408); B.M. 1964, 724(1). Bury St. Edmunds Museum

A fine-grained, roughly banded rock composed chiefly of schorl in prisms averaging about $10 \times 2\ \mu$ with interstitial quartz. The banding is mainly due to minor variations in grain-size but there are also coarser-grained bands of quartz up to $\frac{1}{2}$ mm. thick, the quartz grains (up to $150\ \mu$ diameter) enclosing slender schorl prisms.

(2) Quartz-biotite-hornfels (altered phyllite): dark brown hone of rectangular section.

* *Kent.* Wye; B.M. 1966, P18 (longitudinal section). Maidstone Museum.

A quartz-mica rock in which thick, ragged red-brown biotite tables of diameter 5–50 μ, and less abundant muscovite plates of diameter 5–25 μ, show a rough orientation with c-axes tending to be normal to the length of the hone, but randomly oriented in transverse section. The anhedral quartz is accompanied by a little alkali-feldspar and abundant tiny plates of hematite. The rock resembles type IB(3) above but differs in lacking perfect parallelism on the part of the micas so that it has no true lineation; also in its abundant biotite and in being without calcite and chlorite.

(3) Banded garnet-hornfels (altered calcareous phyllite): hone with stylized head at one end.

**Essex.* Mersea; B.M. 1967, P2.

This regularly grey-brown and buff banded rock is composed largely of colourless mica not fully oriented, ca. 15 μ diameter $\times$ 3 μ, with abundant quartz and some calcite, enclosing numerous tiny rounded garnets (ca. 2–5 μ). The dark bands are distinct from the light ones only in containing a much higher proportion of garnets.

PROVENANCE OF HONES OF SUB-GROUP ID

Type (1) is not particularly efficient as a hone, and is associated at West Stow, an early Saxon site, with sarsens of Group IIIA which must be regarded as makeshift hones of local origin. It seems unlikely to have come from Devon or Cornwall, the most typical British source of such rocks; it may be from Aberdeenshire by way of the local drift.

Type (2) could be a hornfelsed phyllite or slate in which directed pressure at the time of recrystallization has imposed a partial orientation of the micas; it could belong to the fine-grained associates of the "schist hones" (IB(1)) modified by proximity to a major intrusion, but could equally well (and more probably) come from the aureole of any high-level granite intruded into somewhat ferruginous pelites.

Type (3) also shows signs of cataclasis as well as thermal metamorphism. It resembles some of the "novaculites" used as hones in the Ardennes-Rhineland area: e.g. B.M. 67886 from Salm-Chateau, prov. Luxembourg, Belgium. This seems the most probable source.

II. ANCIENT ARENACEOUS AND ARGILLACEOUS ROCKS OF GEOSYNCLINAL ("FLYSCH") FACIES (LITHIC ARENITES, GREYWACKÉS AND MUDSTONES)

These are sedimentary rocks of types characteristic of geosynclinal areas. All are probably of pre-Mesozoic age. Being sediments of rapid accumulation, they are ill-sorted; grains of hard stable minerals such as quartz, with others of less stable minerals and fine-grained rocks, are embedded in a matrix derived partly from mud, partly from the breakdown of unstable grains of feldspars and ferromagnesian minerals. The matrix has undergone some recrystallization and consists of chlorite, sericite and secondary quartz with varying quantities of calcite, limonite and indeterminate opaque matter. Local fine-grained concentrations of particular constituents indicate derivation from former unstable grains (e.g. sericite from feldspar, chlorite from pyroxene), the original form of which can often be seen in ordinary light. These rocks range from semi-metamorphic types, transitional to group I, to others in which the matrix is reduced to interstitial proportions and unstable mineral and rock fragments are few, and which are transitional to group III. They have been divided into four sub-groups.

A. Greywackés and sub-greywackés partially recrystallized and modified by cataclasis.

The hones of this sub-group are considered here, rather than with the metamorphic rocks, because of their obvious character as flysch sediments, but their affinities are with schistose grits and semi-schists. The matrix has been more coarsely recrystallized than that of the following sub-groups, and the larger grains are sometimes broken or rounded by movement. They are arranged in broadly descending order of metamorphic grade.

Norfolk

(1) Chloritic, semi-schistose silty greywacké.
Thetford 916; B.M. 1959, 210(28). Norwich Castle Museum.

(2) Chloritic and sericitic semi-schistose silty greywacké.
Thetford 789; B.M. 1959, 210(29). Norwich Castle Museum.

(3) Chloritic and sericitic semi-schistose silty greywacké with abundant biotite.
Thetford 594; B.M. 1959, 210(30). Norwich Castle Museum.

Surrey

(4) Semi-schistose sericite-quartz-grit.
Guildown, S.2385; B.M. 1966, P16(2). Guildford Museum.

Dorset

(5) Semi-schistose sericite-quartz greywacké-grit.
†Hod Hill [Romano-British]; B.M. 1964, 493(5). British Museum.

Type (1) is unusual in that its matrix is composed largely of a uniaxial negative chlorite of high birefringence, probably iron-rich; it may originally have been a chamosite-quartz-siltstone. The matrix also contains much sericite and abundant tiny angular quartz grains, apparently due to crushing. The larger quartz-grains, which range in diameter from 50–100 μ, show strain polarization and are mainly rounded or lenticular, and the chlorite tends to wrap around them so as to approach the texture of a schistose-grit. There are scattered larger flakes of the same chlorite, and rather more numerous ones of muscovite, both ranging up to 250 μ diameter and showing a rough orientation. The only accessory is tourmaline. Type (2) resembles type (1) but its matrix contains abundant chalcedonic quartz and sericite. Type (3) is again similar but much of the chlorite of the matrix is replaced by fine-grained, deep-brown biotite and there is much opaque matter; the same chlorite as in (1) and (2) is, however, present. All these rocks are closely similar in their proportion of hard minerals (chiefly quartz), which is 55·6% in (1), 52·7% in (2) and 53·3% in (3) (by the Rosiwal method).

Types (4) and (5) are a contrast to the preceding three both in this respect and in mineral composition, consisting almost entirely of strain-polarizing quartz grains of various sizes, wrapped about with subordinate fine sericite and crushed quartz as in schistose grits. The Guildown hone is of fine sand grade (grains 10–600 μ, mainly 150–400 μ in diameter; sericite flakes 10–30 μ); the Hod Hill hone is on the borderline of the sand and silt grades (grains 10–400 μ, mainly ca. 100 μ). Other minerals are few and scanty. Both hones contain a few scattered larger micas, and the Guildown hone has small grains of fresh albite. A little chlorite can be detected in the ground mass of both hones, with sparse limonite spangles in the case of Guildown and a little graphite (?) in that of Hod Hill. Many of the quartz grains show evidence of crushing and rounding.

PROVENANCE OF HONES OF SUB-GROUP IIA

All these types can be matched more or less closely among the cataclastically metamorphosed sediments of the Bastogne area in the Ardennes, represented in the British Museum (Natural History) by a large collection presented by Dr. Catherine Raisin, B.M. 1921, 532. None of the Bastogne rocks is quite as simple in its mineralogy as types (1) and (4), and most of them contain biotite, but five (Nos. 109, 111, 116, 125 and 144) closely resemble type (1) in texture and in the properties of their chlorite. At least ten others differ only in detail, such as the presence of larger biotite flakes and a uniaxial positive chlorite, from types (2) and (3).

While all the Bastogne rocks are richer in mica and chlorite than types (4) and (5), several (particularly No. 107, also Nos. 105 and 102) resemble the latter in their inequigranular character and in their matrix chiefly of sericite with crushed quartz. Both these types may therefore be from the Ardennes, but their archaeological locations suggest alternative sources in Brittany, where rocks of broadly similar character occur in thrust belts: e.g. a Carboniferous schistose grit from Carhaix, Finistere, B.M. 1960, 566(80). The Hod Hill hone (type 5) may be an elongated pebble from the Chesil Beach, being associated with sling-stones certainly from there, and if so, it may be from an Armorican source by way of the Bunter Pebble Bed of S.E. Devon; or it may be from the Devonian or Carboniferous of Devon itself. The Guildown hone (type 4) may be connected with a mass burial following a massacre of Norman raiders in 1036 (Dunning, p. 684).

No comparable matching has been found in other areas of cataclastically deformed rocks such as the schistose-grit belt in the Scottish Dalradian, although there is a very broad resemblance of all these hones to rocks of this age and type near the Highland boundary and in Shetland. Type (4) is the one most nearly matched in this area; cf. a pebbly schistose grit, B.M. 1964, 739 from near Crieff, Perthshire, but this latter contains biotite, calcite and uniaxial negative chlorite. The Ardennes, or possibly Brittany, remain the most likely source.

B. Sand-silt greywackés (or greywacké-grits)

These terms are used here to include greywacké honestones showing a seriate variation in grain-size from mud up to sand grade, the coarser material being mainly angular quartz with subordinate lithic grains and generally some feldspar. They are here considered under two headings: types with and without volcanic rock fragments respectively. The ratio of hard grains to soft matrix is very variable.

(a) Greywacké-grits with grains of volcanic rocks:

(1) Highly calcareous greywacké-grit with abundant and varied volcanic fragments.
Yorkshire. Uncleby, 330.47; B.M.1959, 212(7). Yorkshire Museum.

(2) Calcareous and micaceous greywacké-grit with abundant volcanic fragments.
Lincolnshire. Hough-on-the-Hill. B.M. 1959, 213(1). British Museum.

(3) Chloritic greywacké-grit with abundant volcanic and other lithic fragments.
Bedfordshire. Harrold [Slide in Birkbeck College, London]. Bedford Museum.

(4) Micaceous and chloritic greywacké-grits with some volcanic fragments.
Lincolnshire. Fonaby, GR.24; B.M.1964,731. Scunthorpe Museum.
**Essex.* Mucking, 313, GHS; B.M.1967,P53(8).

Type (2) from Hough is central in character to this series. Its angular to sub-angular grains average less than 100 μ in diameter but range up to 300 μ; they are mainly of quartz most of which is of metamorphic or igneous origin, much of it showing the bands rich in bubbles and minute inclusions which characterize the quartz of many granitoids. Sporadic feldspar grains include fresh oligoclase-andesine, albite, microcline, orthoclase and indeterminable sericitized material. Chert is absent but lithic grains include lavas of andesitic, dacitic, keratophyric and rhyolitic types, and mudstones. There are also a few chloritic aggregates, probably representing altered pyroxene. Abundant flakes of muscovite, oriented parallel to the bedding, range from 25–300 μ in diameter; there are also smaller and fewer flakes of biotite and occasionally of chlorite. The matrix of finely divided quartz with some sericite and chlorite is largely the result of the breakdown of unstable particles; it also contains scattered calcite grains some of which can be seen to corrode quartz and feldspar. Scanty tourmaline and fairly abundant ore are the only accessories. Hard minerals form 40·6 % of the total volume.

Type (1), a large well-shaped greenish-grey hone from Uncleby, possibly of ceremonial character, differs from type (2) in its coarser grain, most grains exceeding 100 μ and ranging up to 1 mm. diameter; in its larger and more varied content of lithic grains, including basalts, spilites, cherts and phyllites in addition to those of the Hough hone; and in the abundant calcite forming the sole matrix in places and corroding many large quartz grains. Elsewhere in the matrix, chlorite is abundant. Larger grains of orthoclase and oligoclase-andesine are present, but large mica and chlorite flakes are absent and there is no trace of bedding. The hard minerals form 48·6 % by volume.

The hones of types (3) and (4) differ from types (1) and (2) in the absence of calcite and in the presence of chequer-albite as the sole alkali-feldspar. The Harrold hone (type 3) resembles that from Uncleby (type 1) in most other respects, apart from its oriented flakes of chlorite after biotite. The two hones of type (4) contain fewer lithic fragments than the preceding, most of them being of chert or phyllite; the scanty volcanic grains are only of andesitic, dacitic and rhyolitic types. They have large oriented flakes of muscovite and fewer of biotite and chlorite; chlorite also occurs as thick tables and aggregates. The Fonaby hone has 60·9 % by volume of hard constituents and its grain size is similar to that of the Hough hone; that from Mucking is slightly finer-grained (maximum diameter ca. 150 μ). The quartz of this type is largely of metamorphic origin, and some large polycrystalline grains are present in the Fonaby hone. The matrix of type (4) is richly chloritic with abundant sericite.

(b) Greywacké-grits without grains of volcanic rocks:

(i) Types with abundant feldspar:

(5) Arkosic and micaceous greywacké-grit.
Yorkshire. York, Goodramgate 551.1.48; ENQ 1046. York Museum.

This is the original of Morey & Dunham's type (4), described by them as "greenish-grey chloritic and micaceous silty sandstone" (Morey & Dunham, pl. 11, fig. 5). It is composed mainly of angular quartz-grains ranging from 10–600 μ in diameter, accompanied by a variety of fresh feldspars including anorthoclase, microcline, chequer-albite, oligoclase-andesine, and indeterminate sericitized feldspar, in a mainly chloritic matrix with some sericite, quartz, ores and apatite. Micas (muscovite and hydrobiotite) and chlorite after biotite are sporadically distributed as flakes up to 300 μ across. Like most of the following types it contains few lithic grains apart from abundant chert. Apart from the absence of lava grains and the variety of feldspars it resembles the Fonaby hone (type 4, above).

(ii) Types with abundant biotite:

(6) *Devon.* †Blackbury Camp (Iron Age); B.M. 1959,213(2). Exeter Museum.

(7) *Dorset.* †Studland 110 (Romano-British); B.M. 1964, 728(1).
†Studland 125 (Romano-British); B.M. 1964, 728(2).

Hampshire. †Hurstbourne Tarrant, Rag Copse 19 (Romano-British); B.M. 1964, 729(2).

London. †London Wall 5043 (Tudor); B.M. 1966, P17(3). Guildhall Museum.

These hones are all pre-Saxon, excepting for the last which is post-medieval; they are included to demonstrate possible differences in provenance from those of Saxon and medieval times. They are very similar, differing mainly in freshness and in their accessory and minor constituents. Their quartz grains range from 40–150 μ, averaging about 100 μ, in diameter, and many show strain polarization or the striation characteristic of much quartz of granitoid origin. All contain oligoclase and the Hurstbourne Tarrant hone also has albite and weathered orthoclase. The only lithic grains are of chert and quartzite. Muscovite is subordinate to biotite, which in type (6) occurs in thin flakes oriented parallel to the bedding, some being altered to chlorite. In type (7) the biotite has been leached and is represented by nearly colourless hydrobiotite associated with limonite; the London Wall hone has much less hydrobiotite and much more limonite than the others. Accessories are tourmaline in type (6) and zircon in type (7); the Studland hones also contain hornblende. The proportion of hard grains is just over one half by volume: 52·2 % in the Blackbury hone, 53·2 % in that from Hurstbourne Tarrant.

(iii) Types with abundant calcite:

(8) *Hampshire.* Hamwih, P.53, L3 and 4, G.S. "B"; B.M. 1964, 730(3). Southampton Museum.

London. Public Cleansing Dept., Upper Thames Street, G.M. 22017; B.M. 1966, P17(12). Guildhall Museum.

(9) *Cambridgeshire.* Great Chesterford, Grave 115; B.M. 1964, 726. British Museum.

[*Dumfriesshire.* Lochar Moss; B.M. 1966, P24. Dumfries Museum]

The abundant calcite of both these types is mainly of detrital origin but has been increased diagenetically, often at the expense of quartz and feldspar. The quartz grains range from 30–350 μ (very occasionally larger). The feldspar is oligoclase-andesine, somewhat altered; the larger fragments also include chert and quartzite, and sericite and chlorite aggregates. The matrix is rich in chlorite as well as in calcite.

Type (8) is rich in quartz of granitoid origin and the feldspars are those characteristic of granodioritic or tonalitic rocks. It contains both muscovite and biotite, in flakes of similar diameter to the quartz grains. The calcite is disseminated through the matrix, but does not predominate over the other constituents. In general, type (8) resembles type (2) (Hough) excepting for the absence of alkali-feldspars and volcanic rock grains. By contrast, type (9) contains metamorphic and vein quartz to the virtual exclusion of that of granitoid origin, some of it being in polycrystalline grains. The only mica is muscovite, biotite being replaced by a bright green chlorite. Calcite is so abundant that the rocks are almost limestones, the Lochar Moss hone having as little as 22·5% of hard constituents. The two hones of type (9) differ slightly in lithic and minor constituents, the Lochar Moss hone having grains of phyllite, that from Chesterford grains of schist and quartzite and a little chequer-albite.

PROVENANCE OF HONES OF SUB-GROUP IIB

Sandy greywackés are widely distributed in all Palaeozoic and some pre-Cambrian geosynclinal areas and few data are available as to the distribution of particular types. In the writer's experience (uncorroborated by statistical evidence) those with volcanic rock-grains are more abundant in Caledonian (especially Ordovician and Silurian) areas and those with weathered biotite and scanty lithic grains in Hercynian (especially Carboniferous) outcrops. Taken in conjunction with the principle that the nearest possible provenance of an artefact is, *ceteris paribus*, the most probable, this generalization accords well with the site distribution of the hones of this sub-group. Types (1), (2) and (4), with volcanic grains, are all from northern and eastern sites and are most likely to be of Scottish Southern Upland or Lakeland origin. Type (3), from Harrold, resembles the Denbighshire Grits in its alkali-feldspar, but contains a greater variety of rock fragments (Cummins, 1957); it could be from the Welsh Ordovician or from the pre-Cambrian of the Longmynd in Shropshire. Type (5), ENQ. 1046, differs from the Hough hone mainly in its lack of volcanic grains; it also is from a northern site (York) and was compared by Morey & Dunham (1953) with three sections of rocks from southern Scotland in the Geological Survey Museum. One of these, from Berwickshire, cannot be traced; a second, a Silurian greywacké from Morrinton Quarry, 7 miles W.N.W. of Dumfries (S.13399), resembles type (5) in its great variety of feldspars (orthoclase, some enclosing tourmaline; microperthite; anorthoclase; albite; and oligoclase-andesine) and is like type (2) in its variety of lava fragments. The third section, from Chilcarroch, 4 miles N. by E. of Port William, Wigtownshire (S.22202) contains granodiorite-tonalite debris but no volcanic fragments (cf. type 8).

Types (6) and (7) are rather lacking in distinctive characters; they agree in a comparative lack of unstable grains and in their richness in leached biotite. The fact that all but one (London, Tudor) are from southern pre-Saxon sites suggests nearby Hercynian sources, probably in Devon-Cornwall or Brittany where similar rocks are plentiful, especially in the Carboniferous.

Type 8 has already been compared with a Wigtownshire rock. It also, especially in its richness in granitoid quartz, resembles the Mam Tor Sandstone, a sub-greywacké from the flysch facies of the Millstone Grit in Derbyshire (B.M. 1963, 256), excepting that the latter has less matrix and no calcite. It has not been matched with rocks from Hercynian areas farther south, but one would not be justified in assuming such a provenance unlikely.

Type (9) differs from all the preceding in its lack of granitoid quartz, in its metamorphic rock fragments and in containing so much calcite as to be almost a limestone. It has not been matched but the site of one of the hones (medieval, with a stylized head) in the Southern Uplands suggests a local origin. The other, from Chesterford (early Saxon), probably came by way of glacial drift.

To sum up: a northerly origin, probably south Scottish, seems likely for types (1) to (5), (8) and (9); types (3) and (8), however, may well be from fatther south. A southerly origin, probably Devon-Cornwall or Brittany, is likely for types (6) and (7), none of which are Saxon or medieval.

C. Silty greywackés (greywacké-siltstones)

These hones are distinguished from those of the preceding sub-group (B) only by the absence or scarcity of grains exceeding 100 μ in diameter (adopted here as the lower limit of the sand grade) but they are actually a much more homogeneous set on account of their poverty in feldspathic and lithic fragments and the much more even grain-size of their silt components. The latter are chiefly of angular quartz usually showing strain polarization and in most cases ranging from about 20–80 μ in diameter with a mode near 50 μ. All but one contain a little oligoclase-andesine and a variable quantity of sericitized feldspar and of relatively large plates of muscovite, biotite, and chlorite; the chief lithic component is chert. The matrix is basically of sericite, chlorite and quartz (both chalcedonic and mud-grade detrital). They fall into three clearly distinguishable although not easily defined sets:

(a) Types with abundant pelitic ground-mass and lithic fragments. All contain chlorite in lenticular-tabular crystals, generally in parallel growth with muscovite, biotite being scarce or absent. There are no alkali-feldspars or calcite. The size of the larger grains varies from coarse to medium silt grade.

(1) Coarse-medium grained micaceous greywacké-siltstones with abundant detrital mudstone grains.

Norfolk. Thetford, D. 1287; B.M. 1967, P.54(1). Norwich Castle Museum.
Suffolk. Ipswich, Cox Lane 57/10; B.M. 1959, 212(6). Ipswich Museum.

The grains of these hones, both lithic and mineral, are mainly 50–70 μ in diameter. They include mudstones, cherts, chloritic aggregates perhaps representing basalt mesostasis, and sericitic aggregates after feldspar. The muscovite flakes range up to 200 μ in the Ipswich and 100 μ in the Thetford hone, and there is also a little biotite in both. In addition to the green chlorite flakes characteristic of both hones a colourless chlorite is also present in the Ipswich hone: both chlorites contain colourless mica in parallel growth. There is abundant limonite, patchily distributed. The hard constituents of the Cox Lane hone total only 21 % by volume, owing to the abundance of mudstone grains.

(2) Fine-medium grained greywacké-siltstones with abundant lithic grains.

Yorkshire. Ripponden (J. W. Barrett Collection); ENQ 1070. Halifax Museum.

London. †Gateway House, Cannon Street (1610–40). G.M. 21833; B.M. 1966, P17(14). Guildhall Museum.

†65–66 Coleman Street (mid-17th Century). G.M.21465; B.M. 1966, P17(15). Guildhall Museum.

Morey & Dunham describe ENQ 1070 as " greenish-grey chloritic siltstone containing " nests " of chlorite up to 150 μ in diameter and quartz grains up to 50 μ across " [mainly 20–30 μ] " in a matrix of finely divided micaceous material with scattered opaque grains ". The matrix averages about 5 μ in grain-size and contains much chlorite and quartz, and careful examination shows that it is largely composed of mudstone pellets of similar size to the quartz grains. There are unoriented muscovite and scarce hydrobiotite flakes up to 100 μ across and most of the large chlorites are actually distorted single crystals, some with parallel inclusions of mica. The two 17th century London hones are essentially similar.

(3) Slightly cataclastic siliceous greywacké-siltstone.

Norfolk. Thetford 1041; B.M. 1959, 210(31). Norwich Castle Museum.

This is a coarser-grained rock than the above, the quartz-grains ranging up to 100 μ in diameter but mostly around 60–70 μ. Grains of chert and of chloritic and sericitic aggregates are abundant, but only a few traces of mudstone grains are to be seen; if originally present they have been broken down into a structureless matrix by a mild cataclasis. There is much finely-divided quartz in the matrix. Sporadic small flakes of muscovite and green and colourless chlorites with mica in parallel growth average about 50 μ diameter. The hard grains amount to 40·6% by volume.

(4) Siliceous and micaceous greywacké-siltstone.

Hampshire. Hamwih, P.51 ⊕, GS"A"; B.M.1964,730(4). Southampton Museum.

This is very similar to type (3) but distinguished from it by the lack of lithic grains and the abundance of larger muscovites and some biotite, ca. 10–30 μ diameter, in the groundmass, in addition to very sporadic larger flakes. There is no trace of cataclasis. The hard constituents form 39·8 % by volume (see pl. 2, fig. 3).

(b) Sub-greywacké-siltstones, consisting of abundant angular quartz grains of medium silt grade, with chloritic and sericitic aggregates and mica and chlorite flakes, in a pelitic matrix containing calcite which is corroding quartz.

(5) Sub-greywacké-siltstone with fresh orthoclase but almost without lithic grains.

Hampshire. Hamwih, P43; B.M. 1964, 730(5). Southampton Museum.

A beautifully fashioned unused hone, six inches long, with rectangular cross section and semi-cylindrical ends, in light grey siltstone. The mica and chlorite flakes range up to 100 μ diameter, and calcite is abundant. Hard constituents total 44·4%.

(6) Sub-greywacké siltstone with chert grains but no fresh orthoclase.

Hampshire. Hamwih, P.108c, site C; B.M.1964,730(6). Southampton Museum.

This hone differs from type (5) also in containing mush less calcite and much fewer and smaller mica and chlorite flakes.

(7) Sub-greywacké-siltstone with fresh orthoclase, and abundant mica and chlorite flakes, chert grains and calcite.

Hampshire. Hamwih, P.29(5)B; B.M. 1964, 730(7). Southampton Museum.

This differs from type (5) also in the presence of larger quartz-grains, ranging up to 100 μ diameter.

(c) Micaceous greywacké-siltstones with much biotite, much of it converted to hydrobiotite. Limonite is common as platy pseudomorphs and in the groundmass. Quartz-grains range up to medium silt grade (50–60 μ). Calcite, which tends to corrode quartz, is present in the groundmass.

(8) Micaceous greywacké-siltstone with abundant oriented muscovite, brown biotite, and hydrobiotite.

Hampshire. Hamwih, P.54, GS"A", L2; B.M.1964,730(8). Southampton Museum.

The affinities of this hone are with the preceding types, (5), (6) and (7). Like most of them it contains fresh orthoclase and abundant calcite. The mica-flakes range up to 150 μ diameter.

(9) Micaceous limonitic greywacké-siltstone with abundant oriented muscovite, green biotite and chlorite.

Yorkshire. York, Dove's Pavement; ENQ 1053. York Museum.
*Rishworth, B. ENQ 1066. Huddersfield Museum.

The muscovite flakes of these hones range up to 250 μ diameter. Biotite is mainly represented by limonite pseudomorphs up to 100 μ across, flat in ENQ 1053 and curved around the quartz grains in ENQ 1066. The flakes of chlorite are optically positive in the former, negative in the latter. There is no fresh feldspar, but abundant sericitic aggregates, sporadic calcite, and accessory tourmaline.

PROVENANCE OF HONESTONES OF SUB-GROUP IIC

The general remarks as to the provenance of the hones of sub-group IIB apply even more strongly to these, any of which could occur in any geosynclinal terrain of relatively unmetamorphosed flysch sediments. Some close comparisons and matches with rocks from *in situ* have however been made and may be significant when considered in conjunction with associated material and archaeological siting.

(a) *Types* (1) *to* (3) *inclusive*

Silty greywackés with abundant detrital mudstone grains and lenticular tables of chlorite are especially common in the Upper Ordovician and Silurian of north central Wales and the southern Lake District. Thus type (1) resembles a Caradocian rock from Cynwyd, Montgomeryshire (B.M. 1962, 257) which contains tables of a similar chlorite although in much greater abundance. Type (2) is like a Ludlow silty greywacké from one mile south of Llangollen, Denbighshire, except that the latter (B.M. 1962,258) has more and larger micas. All the hones of these types are from eastern English or London sites and could be from nearby drift which contains greywacké erratics from Wales and the Lake District. Type (3), also an eastern English (Thetford) hone, could be from the same source; on the other hand, it has features in common with the cataclastically deformed greywackés of sub-group IIA and can be compared with rocks from the same area of the Ardennes, e.g. finer-grained patches in the Villeroulx Grit (B.M. 1921, 532(146)). Similar silty greywackés also occur in the Dalradian of Shetland.

(b) *Types* (4) *to* (8).

All these hones are from the Saxon site of Hamwih (Southampton), and have so much in common that a single source area seems most probable. In most of its characters, type (4) closely resembles a silty greywacké of Brioverian (pre-Cambrian) age from Erquy, Côtes-du-Nord, Brittany (B.M.1960,566,(36); Pl. 2, fig. 4); the latter, however, contains fresh orthoclase and calcite in its matrix, in which it resembles type (5) from which it is indistinguishable in hand specimen.

The Erquy rock contains all the minerals and kinds of lithic fragment found in types (5) to (7), which differ from it in their scantier matrix. Type (8) could be simply a mica-rich rock from the same series. As northern Brittany and western Normandy constitute one of the nearest and most accessible possible source areas to Hamwih, this (or the associated Palaeozoic in which similar rocks occur) must be considered the most probable provenance.

(c) *Type* (9)

The two hones of this type, Morey & Dunham's types (11) and (12), were classed by them among "sediments of Millstone Grit type". They compare type (12), ENQ 1066, (Morey & Dunham, pl. 11, fig. 4) with a Millstone Grit "shale" (G.S.M. No. E.22045) from Oxenhope, Yorks, but this latter is a well-sorted and poorly compacted micaceous siltstone. Both hones resemble, without closely matching, a rock quarried for honestones at Tynehead, Cumberland (B.M. 1909, 552) which differs from them in showing traces of thermal alteration (due perhaps to the proximity of the Whin Sill) and in being devoid of calcite. The north Pennine area is also the nearest possible source to the Yorkshire sites, and seems the most probable one.

D. Silty mudstones

This subgroup is distinguished from the last by the relative paucity of silt-grade hard components; while no formal limit has been laid down for the proportion of these, in no case does it exceed 10%. The hones consist essentially of fine-grained sericite, chlorite and quartz of mud grade ($< 10\ \mu$ diameter), with variable quantities of other minerals.

(1) Fine-grained quartz-sericite mudstone.
Yorkshire. York, 654.3.48; ENQ 1056. York Museum.

Morey & Dunham describe this as " grey indurated mudstone, composed of closely-interlocked fine mica flakes not over 5 μ across, with widely spaced angular quartz grains up to 40 μ in diameter, and tiny opaque minerals ". The matrix also contains much quartz of grain-size 1–3 μ.

(2) Highly chloritic mudstone (slate) with scattered grains of quartz silt.
Suffolk. West Stow 201; B.M. 1959, 212(19). Bury St. Edmunds Museum.

This stone resembles those of type IIC(2) above, differing in the paucity of the silt grains and in being richer in fine-grained chlorite (in flakes 2–5 μ diameter). It originally consisted largely of flattened mudstone particles oriented parallel to the bedding but these have mostly disintegrated although some traces of their outlines are still visible.

(3) Fine-grained black mudstone or indurated shale.
Norfolk. †Caister-by-Norwich (Romano-British) Grave 10, 77, 939; B.M. 1959, 213(3). Norwich Castle Museum.

This is finer-grained and probably younger than any of the preceding. In addition to chlorite, sericite, quartz and opaque grains mainly about 1 μ or 2 μ in size, it contains much nearly isotropic matter of low refractive index, possibly a clay mineral; also scattered quartz grains up to 10 μ in diameter, and calcite in the form of minute tests. The latter have been submitted to Dr. C. G. Adams of the British Museum (Natural History), who agrees that they are foraminifera, indeterminable but certainly not older than Lower Carboniferous. As a rock of this degree of compaction from any probable source area is unlikely to be younger than Carboniferous, this appears to fix its age.

PROVENANCE OF HONES OF SUB-GROUP IID

Type (1) was matched by Morey & Dunham with a " compact ash " (G.S.M. slide E. 1465) from Watley Gill, Westmorland, a rather coarser rock with some feldspar, larger quartz grains, and scattered groups of tiny carbonate rhombs. A very close match is given by a pre-Cambrian rock formerly quarried for hones (" Charley Hill honestone ") from Whittle Hill quarry, Charnwood Forest, Leicestershire (B.M. 80099) also supposed to be of acid pyroclastic origin. Type (2) resembles a siltstone from Lankrigg, Cumberland (G.S.M., E.13004) which was compared by Morey & Dunham with ENQ 1070, type IIC(2) above, and which is actually transitional between these two types. Such highly chloritic slates and mudstones are abundant in the Lake District. Type (3) is a marine Carboniferous mudstone, probably from the Pendleside Series. All the hones of these three types could have come by way of local drift.

III. SANDSTONES AND SILTSTONES OF FRESHWATER AND MARGINAL FACIES

In contrast to those of group II, the honestones of group III are well-sorted and even-grained, with finer material, if present, reduced to the role of pore-filling and cement. They are listed in three sub-groups, the first two composed of sandstones but differing in their cement, and the last of siltstones.

A. Sandstones with siliceous, more or less micaceous cement (sedimentary quartzites)

(1) Impure flaggy sandstone with thin siliceous and micaceous cement and compacted sub-angular grains.

Hampshire. Hamwih, P.19(2); B.M. 1964, 730(9). Southampton Museum.

This stone has some characters in common with the silty greywackés of sub-group IIC, but the matrix, in this case mainly chalcedonic quartz with sericite and some chlorite, is reduced to thin intergranular films and pore fillings. The quartz grains average about 100 μ diameter, mainly angular to sub-angular and deeply compacted, and often slightly elongated with sub-parallel orientation. Many have the characters of granitoid quartz and most show strain polarization. There is also abundant sericitized feldspar and chert, sporadic oligoclase-andesine and accessory schorl. The flaggy character of the stone is due to oriented scattered flakes of muscovite, hydrobiotite and chlorite up to 150 μ across. The rock approximates to a partially sorted sub-greywacké (protoquartzite of Krynine; Pettijohn, 1957, p. 300). The hard constituents total 68·5 %, excluding sericite aggregates after feldspar.

(2) Fine-grained pure sandstones with quartz cement in optical continuity with rounded grains.

Berkshire. Sutton Courtenay, 1923, 825a; B.M. 1959, 212(9). British Museum.
Suffolk. West Stow 151; B.M.1959, 212(18). Bury St. Edmunds Museum.

The quartz cement of these stones is marked off from the original well-rounded grains by its lack of bubbles and absence of strain polarization, and in places by a thin and impersistent film of iron oxide. Most of the quartz grains are between 100 μ and 150 μ in diameter. The other constituents are chert, occasional orthoclase, a few flakes of hydrobiotite, a little interstitial sericite, occasional clots of limonite and accessory tourmaline. The hard constituents of West Stow 151 amount to 90·6 % by volume.

(3) Impure micaceous sandstone with quartz cement, partly in optical continuity with sand grains but partly chalcedonic.

†*Hampshire.* Hurstbourne Tarrant, Rag Copse 17 (Romano-British); B.M. 1964, 729(1).

The diameter of the subangular to rounded quartz grains of this stone ranges from 100–300 μ. Scanty microcline is the only fresh feldspar but sericitic aggregates are abundant. Chert is also abundant and there are fragments of metamorphic quartzites and phyllites. Scattered through the rock are flakes of muscovite and hydrobiotite, unoriented and bent by compaction, and scanty grains of glauconite and tourmaline. Limonite and chalcedonic silica occupy some pore-spaces.

PROVENANCE OF HONES OF SUB-GROUP IIIA

The degree of compaction and partial recrystallization of type (1) suggests a Palaeozoic age. In texture and composition it approximates to an impure ganister and it may well be from one of the southern English coalfields, e.g. north Somerset or Gloucestershire. A provenance in older rocks of marginal facies (e.g. the Devonian of north Devon or west Somerset) is also possible.

Type (2) (Pl. 2, fig. 5) can be readily matched with " sarsens ", concretionary siliceous sandstones occurring as masses in the Reading Beds of the London and Hampshire basins and as relict surface stones and in gravels derived from them: e.g. B.M. 1955, 66 (Pl. 2, fig. 6) from gravel at Watford, Hertfordshire and B.M. 1939, 62 from a solution hollow in chalk at Walter's Ash, Buckinghamshire (figured in Davies & Baines, 1953, Pl. I). Over wide areas of south-eastern England these sarsens are the only local hard rocks which can be used as hones and they were worked for this purpose although not particularly efficient, a fact evidenced in place names such as Whetstone, Middlesex and Honor End, Buckinghamshire (Davies & Baines, 1953, p. 7). Although there is no need to look farther for the source of these hones it should be noted that a closely similar stone of the same age is quarried at Houdain, fifteen miles north of Arras, Pas-de-Calais, France (G.S.M. slide F.828) and that generally similar rocks can be found in older formations as far back as the Lower Palaeozoic.

Type (3) contains more weathered feldspar and biotite than type (2) but it also resembles some rocks presumed to be sarsens, viz. some of those used to build Stonehenge and presumed to be relict Tertiary surface stones: e.g. B.M. 1911, 349(1) described by Maskelyne (1878); see also Prestwich (1854). This is a local and eminently probable source.

B. Sandstones cemented mainly by limonite, aided by compaction; secondary quartz, if present, is not the main cementing agent.

(1) Micaceous, feldspathic, fine to medium-grained flaggy sandstones.

Yorkshire. York, Clifford Street, C. 659A; ENQ 1061. York Museum (22).
Norfolk. Thetford 238; B.M. 1959, 210(34). Norwich Castle Museum.
Suffolk. West Stow 65; B.M. 1959, 212(16). Bury St. Edmunds Museum.
West Stow 97; B.M. 1959, 212(17). Bury St. Edmunds Museum.
Northamptonshire. Lyveden, No. 2; B.M.1967, P 62(1). Kettering: Westfield Museum.
†*London.* Southwark, Lant Street, 19202 [17th century]; B.M. 1965, P42(4). Guildhall Museum.

This type is central in character to the stones of this sub-group. Quartz is the predominant constituent, in grains mainly over 100 μ diameter and ranging up to 150–200 μ in most cases (up to 250 μ in Lyveden No. 2 and up to 500 μ in West Stow 65 and 97), generally subangular, with much of granitoid origin and much showing strain-polarization. Feldspars are generally abundant, and chequer-albite and plagioclase (basic oligoclase to acid andesine) are present in all cases excepting Lant St. 19202 where their place is taken by orthoclase, microcline and untwinned albite; the latter two are also found in ENQ 1061 and the two West Stow hones. Sericite aggregates are abundant and chloritic " nests " are present to a varying extent, as are flakes of muscovite and hydrobiotite (deep brown fresh biotite in ENQ 1061) and a limonitic cement. Tourmaline and zircon are minor accessories.

(2) Fine-grained flaggy limonitic sandstone with abundant and varied lithic grains.

Essex. Linford, TR12Xm, L2; B.M. 1959, 212(5). London Museum.

This is obviously a fragment of building or paving stone which has been used as a hone. It resembles type (1) excepting in the greater abundance and variety of non-quartzose grains, which include phyllites, andesitic and dacitic lavas and tuffs as well as the usual cherts, and abundant sericitized feldspar grains which outnumber those of fresh feldspars (orthoclase, microcline and oligoclase). The flaggy character is due to flakes of muscovite and chlorite; limonite is abundant but the stone is poorly cemented. Accessory garnet is present in addition to tourmaline.

(3) Fine to medium-grained flaggy limonitic sandstones with abundant lithic fragments and some calcite and micas.

Northamptonshire. Lyveden, No. 1; B.M. 1965, P43. Kettering: Westfield Museum.

†*London.* Southwark, Lant Street 19203 [17th century]; B.M. 1965, P42(5). Guildhall Museum.

The presence of calcite in interstitial anhedral monocrystalline grains is the main point distinguishing these hones from types 2 and 4. Sericitized feldspar grains and chloritic " nests " are abundant, but chert is the only lithic component apart from some micaceous aggregates, which may be phyllites, in Lyveden No. 1. Some green aggregates may be glauconite. The alkali feldspars differ (chequer-albite in Lyveden No. 1, orthoclase and microcline in Lant Street 19203) but they are not abundant. The sporadic large muscovite flakes are often bent or crushed by compaction, and pore spaces are occupied by a sericite-chlorite matrix.

(4) Fine to medium-grained limonitic sandstone with abundant chert.

Lincolnshire. Riseholme, No. 2; B.M.1964,732(2). Chester Museum.

This is a fragment of square cross-section, perhaps a building stone, but it has been used as a hone. The rounded to subangular quartz-grains range from 100–400 μ diameter and are accompanied by microcline, sodic oligoclase, and oligoclase-andesine. Non-quartzose grains are as abundant as in types 2 and 3 but are limited to chert and sericitized feldspar. Tourmaline is the only accessory, and micas are absent excepting for a little sericite.

(5) Nearly pure limonitic quartz sandstone with much secondary quartz.

Norfolk. Thetford 929; B.M.1959, 210(32). Norwich Castle Museum.

This stone is of about the same grain-size as the last three (ca. 200 μ). Much of the quartz shows secondary growth, often reconstituting crystal faces, in optical continuity with sub-angular to rounded grains, but this does not cement the grains which are almost always separated by thin but dense limonite films. Most of the quartz is without strain-shadows. Rare untwinned albite is the only feldspar, and there are no lithic grains or mica-flakes; zircon is the only accessory. Quartz and feldspar total 88 % by volume.

(6) Fine-grained sandstone with accessory gypsum.

Essex. †Mucking RBI(3) [Romano-British], B.M. 1967, P53(10).

This is a quartz-sandstone almost as pure as type (5), but finer-grained (mainly just over 100 μ) and with some unusual mineralogical features. The only feldspar is scanty microcline; lithic grains are restricted to coarse chert, and mineral aggregates to scanty sericitized feldspar. Cementation is mainly by compaction, the limonite being patchily distributed. Some rounded limonitic aggregates embodying very fine-grained micaceous matter may represent glauconite grains. There are a few small flakes of muscovite and hydrobiotite. The gypsum is in anhedral crystals, apparently detrital or penecontemporaneous.

(7) Medium-grained highly limonitic sandstone.

Dorset. Sherborne, Pinford Lane; B.M. 1959, 211(5). C. E. Bean collection.

This hone is coarser-grained than any of the preceding. The subangular to rounded quartz grains, many of which are of granitoid origin or of vein-quartz, average about 500 μ diameter. Many show strain shadows. No feldspar, mica or accessory minerals are to be seen, but fine cherts are abundant, and a thick limonitic cement envelops all the grains.

PROVENANCE OF HONES OF SUB-GROUP IIIB

Types (1) to (3) are probably Upper Carboniferous rocks from the Pennine area. Type (1) is Morey & Dunham's type (10), based on ENQ 1061 and compared by them with a slide of a fine-grained sandstone from the Marchup Grit, a component of the Millstone Grit, from Crag Plantation, N.W. of *Haddock Stones, 2 miles N. of Otley, West Riding of Yorkshire (G.S.M. No. E.22030). It also closely resembles a grindstone (D.1177, B.M. 1959, 210, 38) from the Thetford site; stone has long been exported from the West Riding coalfield area for this purpose. Type (2) from Linford is essentially similar, differing only in the abundance of lithic fragments resembling Scottish Old Red Sandstone lavas and fine-grained metasediments; it may well be a Carboniferous sandstone from Northumberland or south-eastern Scotland. Type (3) differs from the preceding two in being transitional to the flysch type of

* "Maddock Stones" in Morey & Dunham's paper.

Millstone Grit: e.g. the Mam Tor Sandstone (B.M. 1962, 256) already quoted in comparison with some hones of sub-group IIB; there is no reason to doubt its Carboniferous origin.

The remaining honestones of this sub-group are probably of different ages. Type (4) is peculiar in the absence of micas combined with a variety and abundance of mineral aggregates and lithic fragments; its poor consolidation suggests an origin largely from resorted Upper Carboniferous material, possibly one of the Jurassic Estuarine sandstones of the Yorkshire coast or Lincolnshire. This is also a possible source for the rather different type (5), the salient characters of which are also to be found in parts of the Old Red Sandstone of south-eastern Scotland. The gypsum of type (6) suggests a Triassic sandstone from the Midlands, and its general characters can be broadly matched among rocks of this age and area. Type (7) is a " carstone " of a kind abundant in the Lower Greensand from Folkestone westward to Dorset, and outcropping quite close to Sherborne where it was found.

All the above types, excepting No. 7, may have come by way of the glacial drift of the eastern counties in which sandstones of ages from Devonian to Eocene, and particularly Carboniferous, are common. Most of them are also potentially serviceable for building or paving or as grindstones and some must have been quarried and transported for these purposes and only incidentally adapted as hones. Thus type (2) (Linford) and type (4) (Riseholme) are clearly building stones, while type (1) matches grindstones found on one of its sites (Thetford). The ruins of Roman towns and villas were also a ready source of material. Hence none of these stones need have been brought far for use as hones. They are not particularly suitable for this purpose and must be regarded as makeshifts for better and less accessible material.

C. Siltstones cemented by limonite or by compaction

These hones differ from those of sub-group B in their finer grain (average diameter less than 100 μ).

(1) Coarse-grained micaceous and feldspathic quartz-siltstone.

Norfolk. Thetford 242; B.M. 1959,210(33). Norwich Castle Museum.

This hone resembles those of type IIIB(1) excepting in grain-size (mainly 50–70 μ) and in its alkali-feldspar, an orthoclase-cryptoperthite (in addition to chequer-albite and oligoclase-andesine). Chloritic aggregates are especially abundant and the principal mica is hydrobiotite with only sporadic muscovite. Cementation is largely by compaction, the limonite cement being patchily distributed.

(2) Massive purplish-grey coarse-grained limonitic quartz-siltstone.

Hampshire. Hamwih, P29(5)C; B.M. 1964, 730(10). Southampton Museum.

This differs from type (1) mainly in the evenness of its limonitic cement which coats all grains and fills all pores. Its quartz is largely free from bubbles and strain polarization although some is of granitoid origin. Feldspars include microcline, chequer-albite, albite-oligoclase and oligoclase-andesine. Only occasional muscovite and hydrobiotite flakes are present, and chlorite is rare. Chert and sericitized feldspar are abundant, and tourmaline and zircon are the only accessories.

(3) Dark brown medium-grained limonitic quartz-mica-siltstone, near sub-greywacké.

Kent. Sarre 520B; B.M. 1959, 212(3). Maidstone Museum.

The angular to sub-angular quartz grains of this stone range from 40–60 μ in diameter and are accompanied by a little oligoclase-andesine, possibly also orthoclase, and sporadic chert. Abundant reddish-brown biotite in ragged flakes, bundles and " nests " is irregularly distributed between the grains, flakes being often bent by compaction. The only other constituents are scattered muscovite flakes up to 150 μ diameter, accessory tourmaline, and limonite clots and films.

PROVENANCE OF HONESTONES OF SUB-GROUP IIIC

Type (1) is close enough to type IIIB(1), despite its somewhat unusual alkali-feldspar, to be attributed to a similar source: i.e. the Upper Carboniferous of northern or north midland England. Type (2) is similar in essentials though it differs from all the stones of sub-groups B and C in its body-colour; it resembles some finer-grained grey beds in the Pennant Sandstones of the South Wales, Gloucestershire and Somerset coalfields, and may well have come from the last-named, although in view of the situation of Hamwih and its associations there with honestones probably from Brittany, a continental source cannot be ruled out. Somewhat similar stones also occur in the Wealden of Sussex (Hastings Sandstones). The mineralogy of type (3) is like that of many silty shales from the Coal Measures: e.g. that from Oxenhope (G.S.M. slide E.22045) already cited in comparison with type IID(2) above. It differs in being almost wholly of silt-grade quartz and biotite. A Carboniferous source seems most probable, perhaps by way of drift but perhaps from Belgium or the Rhineland. The red-brown biotite and absence of chlorite may indicate slight heat-alteration.

IV. SANDY AND SILTY LIMESTONES

Logically, this group of hones should be treated as a further subdivision of group III, since they have mostly originated as mature well-sorted sands and silts which have been cemented with calcite before compaction. In view of their number and variety, however, and as the calcite matrix amounts in most cases to more than 50% of the rock which also contains calcite sand-grains and fossil fragments, it seems better to treat them separately as limestones. Most show lustre-mottling due to the calcite forming interlocking plates, considerably larger than the average grain-size of the quartz; some, in which the calcite occurs in grains of the same size as the quartz, may be impure calcarenites. In most cases cementation has been accompanied, perhps followed, by a partial replacement of quartz by calcite, leading to a reduction in the amount and grain-size of the quartz; there is indeed a rough inverse correlation between these two quantities. Finally, almost all contain glauconite, although this varies greatly in abundance.

Most of these limestone hones fall into a very few well-defined groups. The primary division adopted is on the basis of the fossil content.

A. Silty ostracod-limestones without echinoderm plates or spines

All these hones show lustre-mottling.

(1) Silty ostracod-limestone with scattered flakes of hydrobiotite.
Yorkshire. Uncleby, 343.47; B.M. 1959, 212(8). Yorkshire Museum.

(2) Silty ostracod-limestone with scattered flakes of hydrobiotite and muscovite.
Suffolk. West Stow 148; B.M. 1964, 724(2). Bury St. Edmunds Museum.

(3) Silty ostracod-limestone with scanty wisps of muscovite.
Kent. Dover 643.B; B.M. 1964, 727(1). British Museum.

(4) Silty ostracod-limestone with flakes of muscovite and of chlorite after biotite, and *Cypridea propunctata* Sylvester-Bradley.
Hampshire. Hamwih, P.120A, 41; B.M. 1964, 730(11). Southampton Museum.

(5) Silty ostracod-limestone without micas.
Hampshire. Hamwih, P.29(5)A; B.M. 1964, 730(12). Southampton Museum.

(6) Silty ostracod-limestone with abundant hydrobiotite and *Platella jurassica* Bate.
Hampshire. Hamwih KL, P.6, L.3; B.M. 1964, 730(13). Southampton Museum.

These hones are all very much alike save for their micas, the large number of types being rendered necessary by the possibility that their ostracods may prove to belong to different species, as is the case with the only two of which these have been determined. The flaggy character of all these hones, which probably accounts for their popularity for this purpose, is due to the orientation of ostracod valves and fragments—and micas if present—parallel to the bedding. They vary little in mineralogy and texture. The quartz-grains, which in most cases are in process of replacement by calcite, average about 30 μ excepting in types (3) and (5) in which they are 40–50 μ. The calcite plates are also small, in general about three times the diameter of the quartz grains, so that lustre-mottling is visible only on a minute scale. The quartz grains form from 25—40% of the total volume. Other minerals are few and scanty. Glauconite is present in all but type (2); collophane in all but types (3) and (6), as bone fragments in type (1) (Uncleby) and as grains in the rest. Type (2) (West Stow 148) contains oligoclase-andesine and chert, which are absent from the others. Tourmaline is accessory in all but types (1) and (6). In type (4) the tests of *Cypridea* are associated with abundant tiny (ca. 15 μ) siderite rhombs, partially oxidized to limonite and sometimes filling complete tests.

PROVENANCE OF THE HONES OF SUB-GROUP IVA

The ostracods of types (4) and (6) from Hamwih, determined by Dr. R. H. Bate of the British Museum (Natural History), indicate probable derivation from two distinct areas in which flaggy ostracod-limestones are common, namely the Purbeck-Portland coast of Dorset (Purbeck Beds) and the Oolitic belt from the north-east Midlands to east Yorkshire. To begin with the latter: *Platella jurassica* Bate (Bate, 1963), identified in type (6), is recorded from the *Acanthothyris crossi* horizon (Kirton

Beds) at the base of the Lincolnshire Limestone north of Lincoln. The same horizon occurs at the base of the Upper Lincolnshire Limestone in south Lincolnshire, Rutland and Northamptonshire, where it contains lustre-mottled sandy limestones; at Corby, where the Upper Lincolnshire Limestone is used as a blast-furnace flux, the lowest beds are useless for this purpose on account of their high content of quartz. Beds of the same age also occur in the Howardian Hills and on the coast near Scarborough. On the other hand, this horizon is absent from Bedfordshire to Oxfordshire, and represented farther south (where present) by thin and inconstant beds of different facies from which *P. jurassica* is not recorded. Type (6) mineralogically resembles types (1) from Uncleby and (2) from West Stow; all three contain hydrobiotite as the principal or only mica, whereas it is absent from the other hones of this sub-group. In particular, types (1) and (6) are mineralogically identical, and on this evidence alone could easily have come from adjacent beds in the same formation, although unfortunately it has not been possible to check this by determining the ostracods of type (1). As Uncleby is less than fifteen miles from the Howardian Hills and less than thirty from Scarborough, this suggests a possible connection between Uncleby and Hamwih which could account for the occurrence of a Yorkshire hone at the latter site. Type (2) from West Stow differs in its accessory minerals from Nos. (1) and (6), and is probably from the East Anglian drift which is very rich in flaggy ostracod-limestones derived from the north-eastern area.

On the other hand, *Cypridea propunctata* Sylvester-Bradley (id., 1949), identified in type (4), occurs in the Upper Purbeck Beds of Durlston Bay, Dorset, less than fifty miles by sea from Hamwih, and the nearest source of good honestones. The same fossil probably occurs in the Purbeck Beds inland (e.g. at Swindon and Aylesbury) but these are much less likely sources than the coast. The latter (Purbeck to Portland) is also the most probable source for types (3) and (5) which have more in common mineralogically with type (4) than with type (6).

B. Sandy, with some silty, limestones and calcareous sandstones with echinoderm spines and plates, with or without other fossils (lamellibranchs, bryozoa etc.)

All these hones show lustre-mottling.

(1) Sandy limestones and calcareous sandstones with ostracod tests and fragments in addition to echinoderm plates and other fossils.

Yorkshire. York, Assembly Rooms; ENQ 1073. L. R. A. Grove Colln.
Suffolk. West Stow 49; B.M. 1959, 212(12). Bury St. Edmunds Museum.
Suffolk. West Stow 76; B.M. 1959, 212(13). Bury St. Edmunds Museum.
West Stow 77; B.M. 1959, 212(14). Bury St. Edmunds Museum.
West Stow 84; B.M. 1959, 212(15). Bury St. Edmunds Museum.
Kent. †Canterbury, near Riding Gate (Roman); ENQ 1044. F. Jenkins Collection.
Canterbury, Watling Street, 13th century pit: ENQ. 1045. F. Jenkins Collection.
Dorset. Sherborne, Pinford Lane; B.M. 1959, 211(4). C. E. Bean Colln.

The three Geological Survey sections (ENQ. 1044, 1045 and 1073) are described by Morey & Dunham (p. 146) as follows: " Pale buff glauconitic sandstone containing angular quartz grains ranging up to 250 microns across, with calcite and phosphate fossil fragments and scattered globules of glauconite. Accessory minerals include kyanite, zircon and magnetite. The matrix is coarse calcite, imparting a lustre-mottled appearance to the rock ". It should be added that the coarseness of the matrix varies somewhat in this type, the diameter of the calcite grains ranging up to 1 mm. in ENQ 1044 and 1045 and West Stow 49, up to 5 mm. in West Stow 76, 77 and 84, and up to 12 × 2 mm. in ENQ 1073 in which they are elongated or tabular. The matrix calcite constitutes from 60–67 % of the total volume and shows little or no tendency to increase at the expense of quartz; indeed, that of ENQ 1044, 1045 and 1073 contains patches of chalcedony indicating that it is beginning to silicify. All these hones contain abundant chert grains and occasional alkali-feldspars (orthoclase, microcline and lamellar-twinned albite). There is little collophane but much glauconite. In ENQ 1044, 1045 and 1073 there are grains of iron-stained carbonate; these may be worn echinoderm ossicles, as brown specimens of these also occur. The most abundant fossils are echinoid spines; there are also phosphatic (fish?) spines and fragments of lamellibranch shells. The ostracod remains are present mainly as fragments of a large species.

(2) Sandy limestones and calcareous sandstones with echinoderm and molluscan fossil fragments, but without ostracod remains.

Berkshire. Sutton Courtenay, 1923, 825b; B.M. 1959, 212(10). British Museum.

Kent. Horton Kirby, K.A.S.507; B.M. 1959, 212(1). Maidstone Museum.

These two hones resemble those of type (1) excepting for the absence of ostracods and the identity of the alkali-feldspar which is exclusively chequer-albite. The quartz of the Sutton Courtenay hone forms 50·3 % of the total volume.

(3) Silty limestone with echinoderm and molluscan fossil fragments, but without ostracod remains.

Berkshire. Sutton Courtenay 1923, 825c; B.M. 1959, 212(11). British Museum.

Resembles type (2) in all respects excepting grain-size; all the quartz grains are less than 100 μ diameter. The quartz constitutes only 42 % of the volume.

PROVENANCE OF HONESTONES OF SUB-GROUP IVB

Money & Dunham diagnosed the three ENQ slides of type (1) as " probably from the Kentish Rag in the Hythe Beds, a rock well-known from Roman times onwards ". They go on to match them with a thin section of Kentish Rag (E.19181) from Chilmington Quarry, Ashford, Kent. This latter, although very similar to type (1), does not exactly match it; it does however closely match type (2). The diagnosis of Kentish Rag provenance for most or all of the hones of type (1) and all those of types (2) and (3) is almost certainly correct. The group from West Stow which we have assigned to type (1), however, may come from the East Anglian drift in which similar rocks occur, such as lustre-mottled calcareous sandstones from the Spilsby Sandstone, not easily distinguished in small specimens and thin sections from the Kentish Rag; or the Calcareous Grits from the Jurassic of East Yorkshire. Such a source is also possible for ENQ 1073 from York. The Kentish Rag was, however, exported from Kent from Roman times onward (Morey & Dunham, 1953, p. 146) and remains the most probable source of all the hones of this subgroup.

C. Sandy and silty limestones without recognizable fossils.

(a) with lustre mottling:

(1) Arenaceous and micaceous silty limestone.

Norfolk. Thetford DRC1296; B.M. 1967, P54(2). Norwich Castle Museum.

This fragment of square cross-section resembles the " hearth-stones " of the Upper Greensand of Surrey, but despite its friability it has certainly been used as a hone. The quartz grains range up to 50 μ diameter and show signs of replacement by calcite; the latter is also present as rounded polycrystalline grains and indeterminate angular organic fragments. The mica is muscovite in thin plates up to 120 μ diameter. All are embedded in calcite plates up to 300 μ across.

(2) Silty limestone with recrystallized indeterminable organic fragments but no micas.

Hampshire. Hamwih, P.120A, 23; B.M. 1964, 730(16). Southampton Museum.

The calcite of this honestone occurs partly as fine-grained polycrystalline fragments the shape of which suggests that they are partially rolled fragments of tests which have been recrystallized, partly as plates approximately three times the diameter of the quartz-grains. Apart from these details and the complete absence of micas and other accessory minerals it resembles Hamwih P120A, 41, type IVA(4) above.

(b) Without lustre mottling:

(3) Silty limestones with abundant angular quartz.

Hampshire. Hamwih, P.56; B.M. 1964, 730(14). Southampton Museum.
Hamwih, P.8(8); B.M. 1964, 730(17). Southampton Museum.

These are poorly compacted calcite-siltstones of grain-size 20–30 μ, with quartz grains of the same size amounting to less than 20% of the total volume. The only accessory minerals, all of them scanty, are glauconite, collophane, and muscovite. Some of the calcite grains may be derived from ostracod tests.

(4) Silty limestone with sporadic quartz and incipient silicification.

Hampshire. Hamwih, P.19(1); B.M. 1964, 730(15). Southampton Museum.

This is an almost pure limestone (calcite-siltstone) of about the same grain size as type (3), but with the detrital quartz reduced to accessory proportions. It contains spherulitic or fibrous chalcedonic grains, larger than those of detrital origin. and probably authigenous. No other minerals have been observed.

(5) Calcareous sandstone without micas but with abundant metamorphic accessory minerals.

Kent. Dover 644B; B.M. 1964, 727(2). British Museum.

This contains rather less quartz than calcite, in rounded grains ranging from 50–150 μ in diameter, mostly over 100 μ. The quartz is often of the striated, strain polarized type characteristic of gneissose granites, and it is accompanied by similar-sized grains of microcline and microperthite. Chert and glauconite are abundant, and collophane frequent. Epidote, clinozoisite and zircon are accessory. Presumably all fossil fragments have been dissolved and recrystallized to form some of the clear monocrystalline calcite grains of the same size as the quartz grains and filling the spaces between them.

PROVENANCE OF HONESTONES OF SUB-GROUP IVC

The stones of this sub-group are not necessarily unfossiliferous. They are clearly rocks which would belong to one or other of the types in sub-groups A or B but of which the fossil content chances not to appear in the inadequate thin section, or has actually been dissolved and redeposited as calcite.

Type (1) is the only limestone hone from Thetford, and seems to be of a makeshift character. It may have come from the possible source already indicated (Upper Greensand of the North Downs) but the Spilsby Sandstone, probably by way of the East Anglian Drift, seems more likely.

Apart from its lack of recognizable ostracod fragments and micas, type (2) resembles Hamwih P.120A, 41, type IVA(4), already traced to the Purbeck Beds. Type (3) is very similar, differing mainly in the absence of lustre mottling. Again, a Purbeck source seems most likely. No match has been found for type (4), but in view of its scanty quartz content it can only be a makeshift hone, unlikely to have come from anywhere farther from Hamwih than Purbeck.

By contrast, type (5) resembles the typical Kentish Rag, which is generally characterized by microcline and metamorphic minerals such as kyanite. The substitution of epidote and clinozoisite for the latter may simply indicate an origin in some part of the Hythe Beds other than that from which the hones and matching specimens of sub-group IVB (above) were derived. The absence of the usual Kentish Rag fossil fragments is probably due to solution and redeposition.

CONCLUSIONS

(1) Correlation of petrographic character of hones with distance of site from source.

The relative distances of the archaeological sites of English hones from their probable geological sources vary, statistically speaking, with their broad petrographic character. This is shown in qualitative terms in Table I. The distances used as a basis for definition of " local ", " remote ", etc. are those which give the closest correlation with petrographic groups. Table I shows that the order of increasing proximity to source is, in terms of main petrographic groups, I, II, IV, III. It can be demonstrated that it is also the order of decreasing utility as hone-stones, assuming that this is related to measurable factors of texture and composition.

TABLE I

Distance relation of probable provenance to site	Approximate distance (miles)	Petrographic group			
		I	II	III	IV
(a) Local	<30	o	x	X	X
(b) Semi-local	30–80	o	x	x	X
(c) Semi-remote	80–250	x	X	x	x
(d) Remote	>250	X	x	o	o

X Dominant probable sources (for group IV, (a) and (b) are of sub-equal importance).
x Subordinate probable sources.
o Improbable as sources.

All honestones consist of angular or subangular grains of minerals harder than the relevant metal, in this case iron or steel (hardness usually exceeding 6 on Moh's scale, generally quartz, H = 7) embedded in a matrix of minerals softer than steel (H = 2 to 4: micas, chlorites, calcite, limonite, etc.). They vary as to the grain-size and the content of the hard components, both of which can be easily estimated. To study this variation, all the honestones of which thin sections of adequate size were available (about one in three of the total number) were measured. Grain-size was estimated in all cases, on the basis of the maximum apparent diameter of 100 grains selected by a randomizing procedure; in cases of a tendency to general tabular elongation, the measurement was made normal to this, but such cases are few. The proportion of hard components was measured by the Rosiwal method, using a Leitz integrating micrometer stage; in this case the number of hones measured was smaller, as very fine-grained rocks (grain-size below 30 μ or so) were omitted as being unsuited to the Rosiwal method. The results, in terms of petrographic groupings, are shown

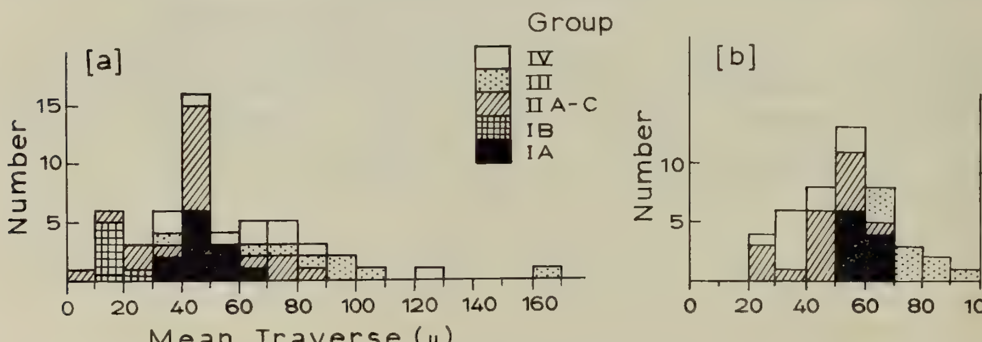


FIG. 4(a). Mean grain-size of hard components in 55 hones. (b) Percentage of hard components in 45 hones.

in text-figs. 4(*a*) and (*b*), and Tables II(a) and (b) respectively; see also the "site" and " source " maps, Text-figs. 5 and 6.

Text-fig. 4(*a*) shows a nearly unimodal frequency distribution in terms of grain-size, a secondary mode being due entirely to one sub-group (IB) which is for this reason shown separately. The major mode is in the sub-range 40–50 μ; as this is based on a series of random sections of grains, it corresponds to nearly double this value in terms of maximum diameter, i.e. to rather less than 100 μ, which we have chosen (after Milner, 1962) as our boundary between the sand and silt grades. The distribution is slightly skewed, the mean value of the apparent diameter being 56 μ. The well marked mode is presumably the result of empirical selection for honing qualities, in respect to which it is therefore assumed to be an optimum value. The distribution of the groups is shown (note that subgroups IC and D, and IID are unrepresented). The modal sub-range, 40–50 μ, is composed almost entirely of " schist hones " (IA) and flysch sediments (IIA–C); groups III and IV are distributed mainly between the centre and the upper end of the range. Table II(a) shows a comparison of the grain sizes of the groups in terms of statistical parameters. It shows that the order of increasing approximation to the general mean, which is near the mode, is also that of increasing remoteness from probable sources (excepting that in this respect subgroup IA and group II are equal), and that there is a decrease in the standard deviation of the grain-size in the same order (III, IV, II, IA). This implies that the " schist hones " and flysch sediments were found to be sufficiently superior as honestones to warrant acquisition through channels of remote trade. Subgroup IIB, the metasiltstones, are an apparent exception to this, since they form

TABLE II

Geological Provenance in relation to Archaeological Site

	A	B	C	D		
Predominantly	local	semi-local	semi-remote	remote		All
Group	III	IV	II	IA	IB	All
(a) Grain-size (μ), number	(8)	(11)	(17)	(12)	(6)	(54)
Median	90	67	46	48	16	49
Mode	90–100	65–75	40–50	40–50	10–20	40–50
Mean	104	69	49	49	17	56
Difference of mean from mean of total:	48	13	−7	−7	−39	—
Standard deviation	37	25	18	8	3	29
(b) Hard components (%) by volume:						
number	(9)	(9)	(16)	(11)	—	(45)
Median	79·0	36·6	46·6	59·1	—	53·0
Mode	75–80	35–40	50–55	55–60	—	55–60
Mean	76·8	37·1	44·2	59·8	—	53·1
Difference of mean from mean of total:	23·7	−16	−8·9	6·7	—	—
Standard deviation	9·3	6·9	11·3	4·2	—	16·7

a minor peak within the main distribution at 10–20 μ; but we have given reason to believe (pp. 148–9) that they come from a localized occurrence linked, probably by interbedding, with subgroup IA, the " schist hones ". It is possible that their very even texture, perhaps also their quantitative mineral composition, give them special properties which compensate for their fineness of grain; certainly they resemble the fine-grained stones used more recently for honing razors.

Fig. 4(*b*) shows that the frequency distribution of the ratio of hard to soft components, in terms of percentage by volume, is unimodal and nearly symmetrical with a well marked mode at 50–60 % and a mean of 53·1 %. The modal and the two adjacent sub-ranges consist mainly of the " schist hones " (IA) and the " flysch " hones (II), the former being slightly biased towards a higher and the latter towards a lower value. The sandstones of Group III are distributed mainly over the upper and the limestones (group IV) over the lower part of the range. Here again it is presumed that the well-marked mode with hard just in excess of soft components represents an optimum value for honing purposes. The statistical parameters given in Table II(b) show that once again the order III, IV, II, IA, that of increasing remoteness of source from site, is also that of increasing approximation to optimum composition. In this case, the order of decreasing standard deviation is upset by the high variance of the flysch sediments, the order here being II, III, IV, IA.

Summing up, we conclude that the order of increasing distance of source from site is also, in general, an order of transition from types mainly of makeshift character obtained casually to types specially selected by remote producers for manufacture into hones as trade commodities. No practical attempt has been made to check the reasonable assumption that the modal values for grain-size and content of hard components are also optimum values for honing qualities; this is suggested as an exercise in experimental archaeology.

(2) Correlation of provenance with sites and dating (see maps, figs. 5 and 6)

The sources of the " schist hones " and associated types, as shown above, are farther from the English sites at which they were found than is the case with hones of any other type. Their connection with Scandinavian settlement, which has been established by geochronological and by Norwegian archaeological data, is borne out by their archaeological distribution. They are in a large majority in northern and eastern England and in a minority in the south and west, these fields being conveniently delimited by the Thames estuary, and by Watling Street north-west of London; i.e. roughly the boundary of the Danelaw: see map, text-fig. 5). Further analysis shows that this correlation has a chronological rather than a geographical basis. Most hones dating from before the early tenth century are from sites in the south and west; most after that date from the north and east. This applies particularly to the three larger groups from the towns; the York hones belong mainly to the Viking and early medieval period, as do those from Thetford although the chronological range of the latter is wider; on the other hand the Hamwih hones range from the sixth to the early tenth century, coinciding with the history of Wessex as a separate kingdom. There is little overlap in time range between sites dating from before and after 900–925, and at sites bridging this gap (e.g. Thetford) " schist hones " are found only in deposits of the later period. The only exception (outside Scandinavia) to this restriction of the " schist hone " series to the tenth century and after is Dorestad on the Lek, a distributary of the Rhine. This wealthy trading centre was raided and temporarily occupied by Vikings as early as 834 (Arbman, 1961, p. 78), and was destroyed in 860 by a natural catastrophe (Dunning, 1938, p. 695).

This correlation of the introduction of the schist hones with the early tenth century is shown in Table III. Its significance almost certainly lies in the fact that the tenth century was the great age of Viking settlement, development and trade, as distinct from the earlier period of piracy, raiding and military conquest. Its early years mark the beginning of the absorption of the Danelaw into a unified English

TABLE III

Correlation of Petrographic Types with Archaeological Sites and Dates

Groups	I A-B	I C-D	I	II	III	IV	II-IV	Total
Northern and eastern sites (England)								
pre-450	0	0	0	1	1	0	2	2
Saxon and Medieval: 450–900	0	1	1	7	4	6	17	18
Saxon and Medieval: pre or post-900 (uncertain)	7	1	8	4	0	0	4	12
Saxon and Medieval: 900–1500	78	1	79	8	7	2	17	96
post-1500	0	0	0	3	2	0	5	5
	85	3	88	23	14	8	45	133
Southern and western sites (*England*)								
pre-450	0	0	0	5	1	1	7	7
Saxon and Medieval: 450–900	0	2	2	6	4	10	20	22
Saxon and Medieval: pre or post-900 (uncertain)	0	1	1	0	0	0	0	1
Saxon and Medieval: 900–1500	24	0	24	1	1	2	4	28
post-1500	4	0	4	0	0	0	0	4
	28	3	31	12	6	13	31	62
All sites (*England*)								
pre-450	0	0	0	6	2	1	9	9
Saxon and Medieval: 450–900	0	3	3	13	8	16	37	40
Saxon and Medieval: pre or post-900 (uncertain)	7	2	9	4	0	0	4	13
Saxon and Medieval: 900–1500	102	1	103	9	8	4	21	124
post–1500	4	0	4	3	2	0	5	9
	113	6	119	35	20	21	76	195
Sites outside England:								
pre-900	1	0	1	0	0	0	0	1
post-900	2	2	4	1	0	0	1	5
	3	2	5	1	0	0	1	6
Total	116	8	124	36	20	21	77	201

kingdom (Arbman, 1961, pp. 62–4). At this period Scandinavian traders maintained wide contacts, some individuals wandering from Greenland to Byzantium, and the North Sea became as busy a commercial highway as the Mediterranean had been under the Roman Empire. Up to this time, the pattern of the provenance of hones on English sites is essentially the same as that which, one may assume, prevailed in Roman times, excepting that sources were more local and makeshifts more frequent, an additional source being available from the ruins of Roman settlements. There is some evidence, as at Hamwih, for the continuation of trade connections with Brittany (p. 165 above), and possibly also with the Humber hinterland (pp. 173–4 above) and, curiously, of an absence of connection between Hamwih and such a relatively close source as Kent, since Kentish Rag is not found among the Hamwih hones although it was exported as honestones and seven out of seventeen of the Hamwih hones are sandy limestones. In general, however, the sources of honestones were local or semi-local; the most important types in the south are sandy and silty limestones, while " flysch " hones are important in both north and south. It seems clear that after 900–925 the " schist hones " and associated types became abundant enough as commodities to drive out of use most of the more local, presumably inferior, honestones. Once established, this trade in " schist hones " must have continued for some centuries. They are abundant, far outnumbering other types even on some southern sites, up to about 1300, after which time (so far as the evidence of our list is concerned) they appear only at long intervals, only in London and only as rough unfinished material. This may be due to the decline of Norse power and trade after the rout of the last Viking invasion by the Scots at the battle of Largs in 1263. After 1300, the next latest " schist hones " in our lists are the rough much-worn fragments found at Moorfields, London (after 1411, perhaps much later in the fifteenth century: see Dunning, 1938, p. 684) and the latest which one can call medieval are the three unworn mullions from Salters' Hall, Walbrook (ca. 1500), one of which yielded our geochronological data; these occurrences may represent temporary revivals of the trade, as may the latest, the four " schist hones " found at Lant Street, Southwark, associated with two of Millstone Grit type (IIIB(1), above). Apart from these, the post-medieval period is characterized by hones of flysch type (London Wall, Tudor, IIB(8); Gateway House, Cannon Street, 1610–40, IIB(2); Coleman Street, mid-seventeenth century, IID(3)); all probably from the north Pennine or Welsh areas. More recently, the emphasis is on rather finer-grained flysch sediments (e.g. Moughton Whetstone, B.M. 1924, 531), often hornfelsed (e.g. Tynehead, B.M. 1909, 552; Water of Ayr Stone, B.M. 51285) and on the " novaculites " and porphyroids of the Ardennes-Rhineland area. If the Dalradian (or Moine) series contributed to the " schist hones " of English sites, it was probably in Viking times; in later times, the Dalradian honestones of certain localities were well known and sought after in eastern Scotland (Barrow, 1904, p. 433), but they do not seem to have been used in England.

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Fig. 5. Sites of described hones in England. (See text. p. 180) Key to site localities:—

Al	Almondsbury	Li	Linford
Ay	Aylesbury	Lc	London (City)
Ba	Barton	Ly	Lyveden
Be	Bealings	Rc	Rayleigh Castle
Bl	Blackbury	Rp	Ripponden
Ca	Caister-by-Norwich	Rh	Riseholme
Ch	Chesterford	Rw	Rishworth
Cl	Caldecote	Sc	Sutton Courtenay
D	Dover	Sh	Sherborne
El	Ellington	Sl	Studland
Em	Emberton	Sn	St Neots
Fa	Faversham	So	Southwark
Fo	Fonaby	Sp	Snape
Gu	Guildford	Sr	Sarre
Hw	Hamwih	St	Stonar
Hr	Harrold	Su	Sulgrave
Hk	Horton Kirby	T	Thetford
Hg	Hough-on-the-Hill	U	Uncleby
Hu	Huddersfield	Ws	West Stow
Ht	Hurstbourne Tarrant	Wo	Wortham
Ip	Ipswich	Wy	Wye
K	Knaresborough	Y	York

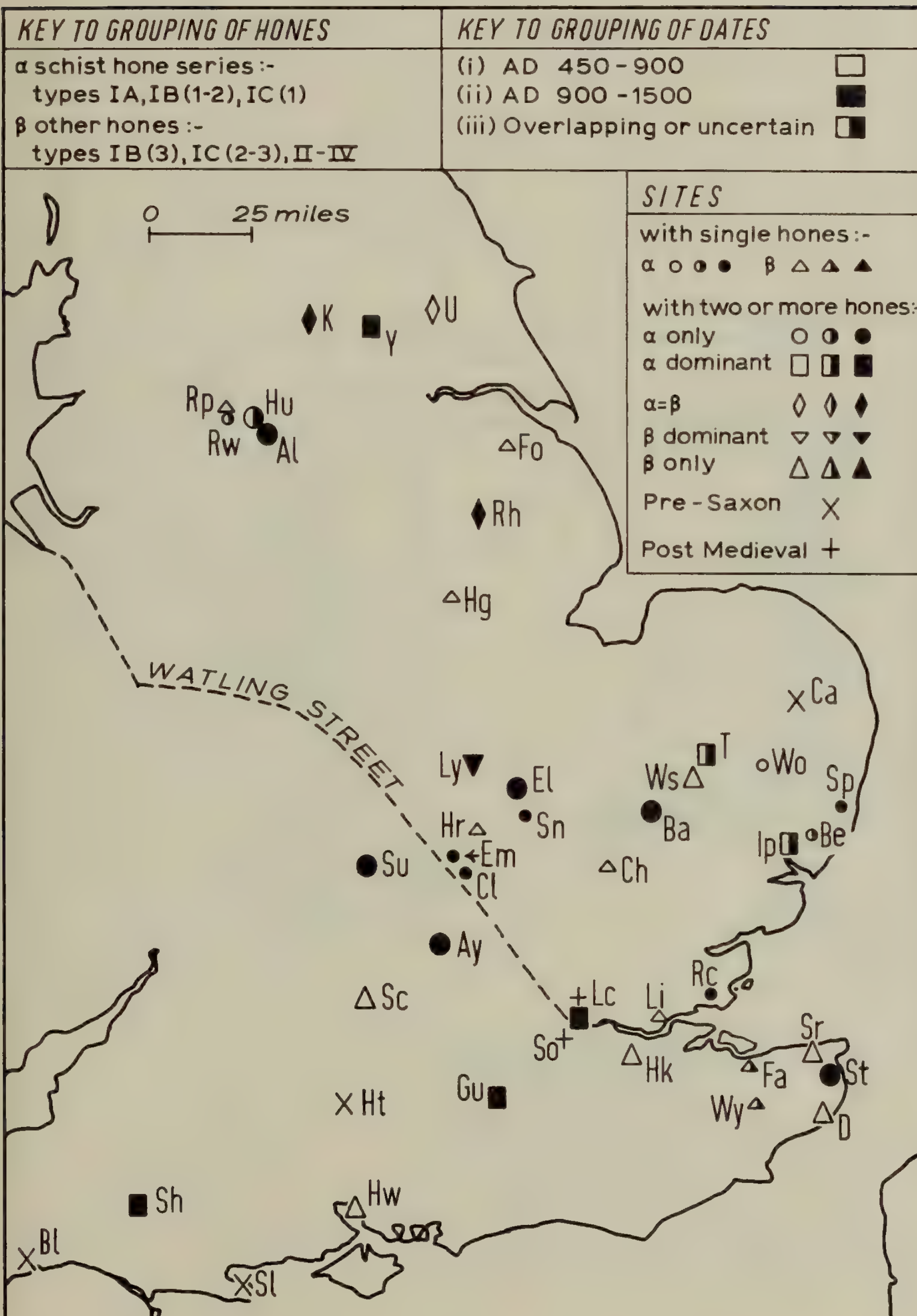
KEY TO GROUPING OF HONES
α schist hone series :-
types IA, IB (1-2), IC (1)
β other hones :-
types IB (3), IC (2-3), II-IV
KEY TO GROUPING OF DATES
(i) AD 450-900
(ii) AD 900-1500
(iii) Overlapping or uncertain
SITES
with single hones :-
α β
with two or more hones:-
α only
α dominant
α=β
β dominant
β only
Pre-Saxon
Post Medieval
0 25 miles
K
Y
U
Rp
Hu
Rw
Al
Fo
Rh
Hg
WATLING STREET
Ca
T
Ws
Wo
Sp
Ly
El
Sn
Ba
Be
Ip
Hr
Em
Su
Cl
Ch
Ay
Rc
Lc
Li
Sc
So
Sr
Hk
Fa
St
Ht
Gu
Wy
D
Sh
Hw
Bl
Sl

FIG. 5

FIG. 6. Localities of rocks matched or compared with hones; and sites of hones outside England.

I, IIB, C, IIIB: Indicates general prevalence of rocks belonging to these sub-groups in the areas indicated. Key to possible source localities, and other places mentioned in text:—

AB	Allt Bronn	Ma	Maidstone
Af	Ashford	Mo	Morrinton
An	Angers	MT	Mam Tor
Ay	Aylesbury	My	Mayen
Ba	Bastogne	OB	Oykell Bridge
Ca	Carhaix	Ot	Otley
Cc	Chilcorrach	Po	Portland
Co	Corby	Pu	Purbeck
Cy	Cynwyd	Ra	Radstock (Somerset Coalfield)
Do	Dorestad	Re	Reigate
Ei	Eidsborg	Ro	Rokleiv
Er	Erquy	SC	Salm Chateau
FD	Forest of Dean	Sh	Sherborne
GL	Glen Loch	Sp	Spilsby
HH	Howardian Hills	St	Start Point
HI	Holy Island (Anglesey)	Sw	Swindon
Ho	Houdain	TH	Tyne Head
La	Lankrigg	Wa	Walters Ash
Li	Lincoln	Wf	Watford
Ll	Llangollen	WH	Whittle Hill (Charnwood)
Lm	Longmynd	Y	York


0 100 miles
LOCALITIES OF ROCKS COMPARED WITH HONES
METAMORPHIC ROCKS [GROUP I]
(i) "Schist hone series", IA,B,C (1-2)
(ii) Other metamorphics, IC (3-5), D
(iii) "Schist hones" with other metamorphics
SEDIMENTARY ROCKS [GROUPS II, III, IV]
Group II: A B,C,D A with B,C,D
" III: A B,C A " B,C
" IV: A±C B±C A " B±C
Archaeological sites outside England

FIG. 6

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PLATES

PLATE 7

Photomicrographs of honestones and matching rocks: lineated mica-quartz schists of type IA(1) (" Schist hones "). All with crossed polars. See text, pp. 139–143, 149–150.

FIG. 1. Fold mullion from Bealings, near Ipswich, Suffolk (text-figure 1; B.M. 1964, 723). Transverse section, × 150.

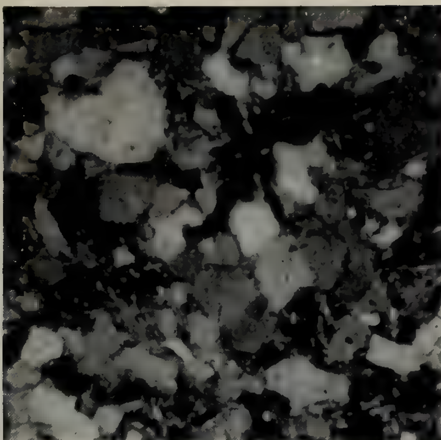
FIG. 2. The same; longitudinal section, × 150.

FIG. 3. Unshaped hone (irregular mullion) from Salters' Hall, Walbrook, London, ca. 1500 (Guildhall Museum 18787; B.M. 1966, P17 (1). Transverse section, × 80.

FIG. 4. The same; longitudinal section, × 80.

FIG. 5. Honestone (cleavage mullion) from *in situ* at Eidsborg, Telemark, Norway (B.M. 1967, P50(8)). Transverse section, × 80.

FIG. 6. The same, longitudinal section, × 80.



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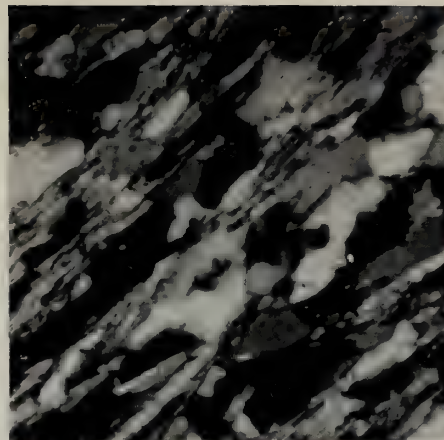

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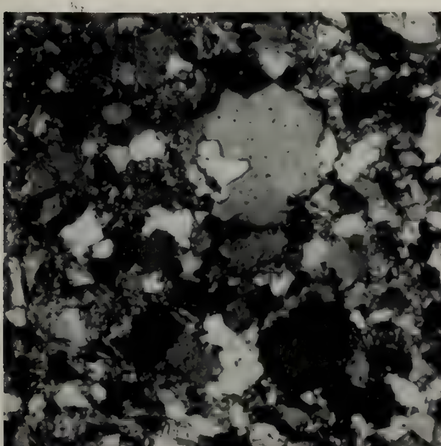

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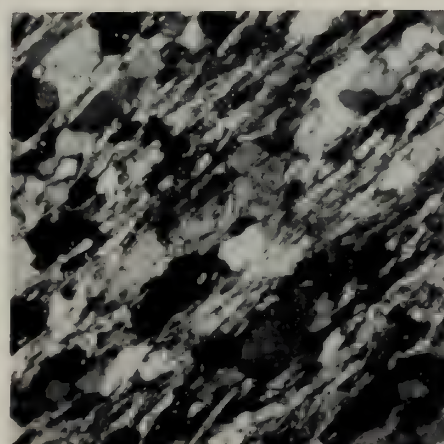

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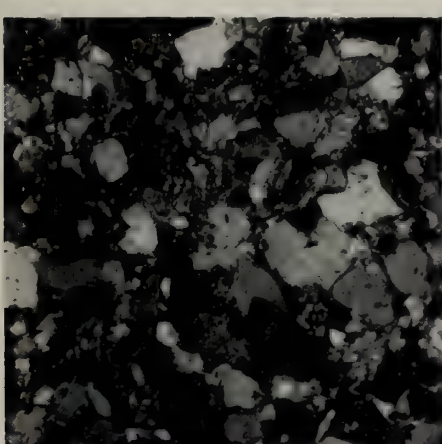

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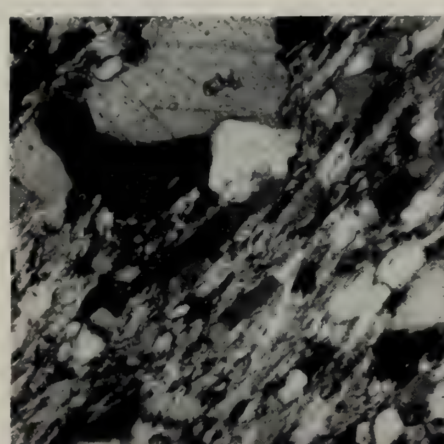


6

PLATE 8

Photomicrographs of honestones (other than " schist hones ") and matching rocks.

FIG. 1. Lineated mica-quartz-phyllite (metasiltstone), Thetford 622 (site 2), B.M. 1959, 210(13); honestone of type IB(1): see text, p. 145. Transverse (slightly oblique) section, × 180 (crossed polars).

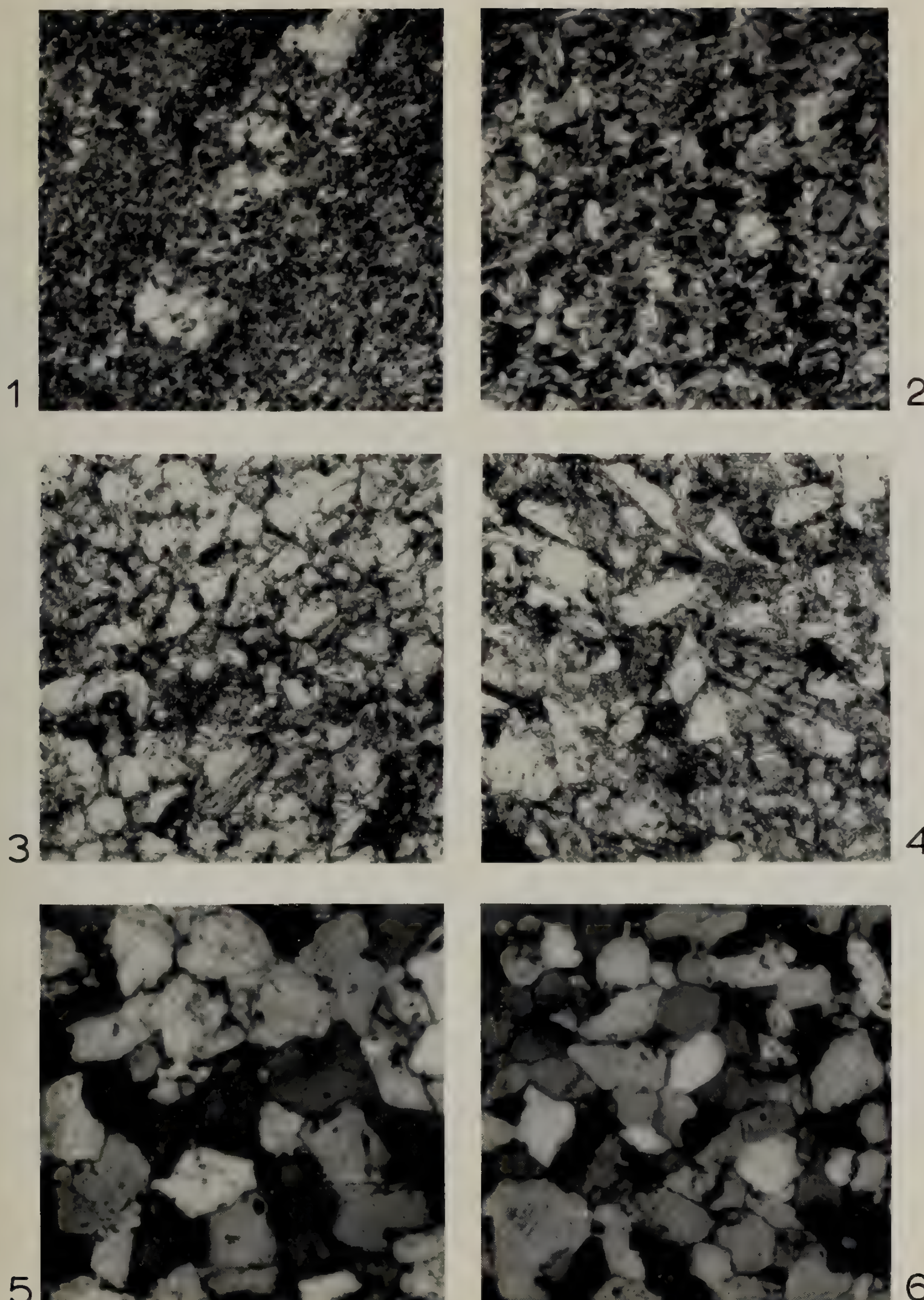
FIG. 2. Lineated mica-quartz-phyllite (metasiltstone), Thetford 278(2), B.M. 1959, 210(17); honestone of type IB(1) enclosing material transitional in character to type IA(1) (" schist hone "): see text, p. 146. Transverse (slightly oblique) section, × 80 (crossed polars).

FIG. 3. Greywacké-siltstone with sericite-chlorite-quartz matrix: honestone of type IIC(4), Hamwih P51 ⊕, G.S."A", B.M. 1964, 730(4). See text, p. 163. Magnification × 180 (ordinary light).

FIG. 4. Greywacké-siltstone with sericite-chlorite-quartz matrix: from the later pre-Cambrian (Brioverian) of Erquy, Cotes-du-Nord, Brittany, France: B.M. 1960, 566(36). For comparison with fig. 3: see text, p. 165. Magnification × 180 (ordinary light).

FIG. 5. Siliceous sandstone with secondary quartz in optical continuity with grains: honestone of type IIIA(2), Sutton Courtenay 1923, 825a, B.M. 1959, 212(9). See text, pp. 167 and 168. Magnification × 150 (crossed polars).

FIG. 6. Concretionary siliceous sandstone (" sarsen ") from gravel at Watford, Hertfordshire: B.M. 1955, 66. For comparison with fig. 5. See text, p. 168. Magnification × 150 (crossed polars).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