I

STONEWORK AND THE ARCHAEOLOGIST INCLUDING A STONEMASON'S VIEW OF HADRIAN'S WALL

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IT DOES not seem unreasonable that opinions on technical subjects should be based on a sound working knowledge of the principles involved. The archaeologist, however, seems to have no inhibitions when discussing stonework in archaeological contexts, whether it be a discussion of excavated masonry or papers and books on the techniques of the mason. A sample of archaeological reports have their problems ventilated in the Appendix, and a few examples here will illustrate the second case.

By one authority we are told that "... to cut long straight lines over a metre in length by means of a chisel alone is an almost impossible task ..." This is a denial of the basic training of a mason in any age, the ability to dress stone against a straight edge being one of the more important indicators separating the skilled workman from the amateur; a deviation from the mean of under 1 mm can readily be achieved[1] without recourse to any secondary work with abrasives.

Elsewhere, the gouge is variously referred to as "... unsuitable for stonework ..." and "... useless for working stone", statements readily refuted by a visit to the nearest masons' workshop,[2] where any number of these tools may be found in use on both hard and soft stones.

A discussion of the "drove", more properly called a "boaster",[3] contains the assertion that "Its size would have made it difficult to push evenly along the stone, and anyway if this had been done the resulting surface would have been very patchy and unpleasant." It need only be said that it is used in precisely this way with excellent results, and is in fact the basic tool used in finishing a clean, flat surface.

These few examples from a very rich field are of necessity selective in a partial approach, and are perhaps somewhat extreme, yet it remains true that almost all writers on this subject perpetrate similar inaccuracies and tend to rely too heavily on work of other authors who are themselves working at second-hand. The Latin scholar will as a matter of course recognize gaps in his experience and consult an epigraphist about an unusual inscription, yet is quite prepared to perpetuate this almost circular transfer of what is in some cases little better than a collation of imperfectly grasped hearsay evidence.

It is as a first move to redress the balance that this paper has been written.[4] Wide ranging references to archaeological contexts will not be found in these pages, as the purpose is to give, for the first time, sufficient, accurate information to enable the archaeologist to identify, on sites of any period, the tools used and to assess

the quality of the work on a common basis. Quarrying is not covered as this is largely outside the author's experience and any observations would of necessity be second-hand. Figure and foliage carving is likewise not specifically referred to, although the tools and basic stoneworking techniques are identical.

1. Identification of Stone Types

The starting point in any examination of masonry[5] must be to identify as closely as possible the type and source of the stone.[6] It is not sufficient, for example, to refer to "limestone", or even "oolitic limestone". The distance the stone has travelled has an obvious bearing on the difficulty and cost of the construction,[7] and information on the nature of the stone gives some guidance on the degree of labour expended to achieve a given finish. It should be the aim where possible to give at least a narrow geographical area, if not the precise quarry, and to this end a petrological analysis is clearly desirable, although a local stonemason may be able to give an accurate indication. As a general rule, sandstones tend to be uniform within a given quarry, whereas limestones may vary markedly in colour, texture and hardness several times within so small a compass as a 300 mm cube.[8]

Once the stone is known, some indication of its hardness and ease of working[9] (not always the same thing) should be attempted, and for this a banker-mason trying a chisel on an unimportant part of the work is indispensable. It will be very difficult to relate the nature of the stone to a fixed standard but an experienced subjective opinion should have some value.

A common misconception is that limestone is softer and easier to work than sandstone, but the proportion of hard to soft stones commonly used in building is probably about equal between the two types, and many sandstones are much more pleasant to work[10] than limestones of similar hardness.

2. Types and Descriptions of Masonry

Stones appearing on the face of a wall should be referred to in general terms as "facing stones"; any more detailed description of stonework should be on the lines of the categories set out below. [11] The term "ashlar" must *never*, contrary to popular practice, be used as a synonym for "facing stone" unless it is strictly appropriate.

The following categories are given in descending order of the degree of labour required.

1. Ashlar

This term should be confined to masonry which meets the following criteria. The stones should have carefully worked beds and joints, finely jointed (generally under 6 mm) and set in horizontal courses; stones within each course should be of the same height, although successive courses may be of different heights. Where the centre of the face, however it is finished, intentionally projects beyond the wall line

it should be bounded by a well chiselled margin, some 20–25 mm wide, worked straight and square to the beds, to allow of accurate setting both to adjacent stones and to the general line of the wall. These drafts should twist in reasonably well and ideally the stone should be perfectly rectangular in elevation. Ashlar should be described according to the surface finish, of which the more common are now listed.

(*i*) *Plain or Rubbed Ashlar* is that where the surface has been rubbed, usually with a piece of sandstone, to remove all toolmarks leaving a perfectly smooth surface.

(*ii*) *Boasted or Axed Ashlar* is left finished from either of these tools. The regularity and form of the toolmarks will vary according to the style of the mason, but will in general show a row of diagonal grooves set in a series of drafts although the individual drafts may not be distinguishable.

(*iii*) *Punched Ashlar*. The surface is left from the punch after the marginal drafts have been worked. The marks may be random or regular, the latter being the most likely on the stone worked carefully enough to be called ashlar. A very finely worked surface with very small and even indentations is referred to as being "pecked".

(*iv*) *Rock Faced Ashlar*. The centre of the stone is left boldly projecting in its natural state, or with a little assistance from a pitching tool, again within the chiselled margins.

(*v*) *Tooled or Batted Ashlar*. This is left with regularly spaced chisel marks set vertically on a rubbed surface. It represents not so much a stage of work but rather a deliberately applied design, introduced within the last 150 years or so. It is thus one of the few surface finishes to give any indication of date. It is sometimes seen today, often diagonally, on a sawn surface, as a vain attempt to simulate non-mechanical work.

(*vi*) *Rusticated Ashlar*. The face projects from the wall line in a distinct step; the simplest indication is that the joints are set in a rebate behind the marginal drafts around the face, which may be finished in any fashion. The term is *not* a synonym for rock-faced work.

2. Block-in-Course

This is a class of masonry, nowadays seen largely in railway and dock engineering, in which the stones are squared and brought to fair joints, the faces usually being dressed with the walling hammer or punch. It may resemble ashlar or coursed rubble according to the degree and quality of work applied to it, although the stones will usually be larger than coursed rubble. The distinction may be rather nice at times, but reference to the section on measurement should assist. Joints may be wider than in ashlar work, and there will not normally be a good chiselled margin. The tools used for dressing the face should be specified where possible.

3. Coursed Rubble[12]

The stones are squared up, more or less roughly according to the quality, to about the same height within each course, usually not above 250–300 mm. The faces may be left rough or dressed with walling hammer or punch; the joints and beds will

tend to be in excess of 15 mm, and on elevation the corners of the stones will tend to exhibit roundness rather than angularity. It is normal for the joints to be worked to a taper, as this increases the hold of the mortar and makes accuracy in working, and thus cost, less important.

4. Random Rubble

This is walling in which the stones have received little attention beyond knocking off the sharpest angles. Only minimum attention is paid to coursing, although the stones are laid horizontally as far as possible. Generally this work occurs where stone of a highly stratified or fissile nature is available, as the resultant thin flat slabs, usually between 100–200 mm thick, are easily broken into a suitable size and can be bedded with a minimum of labour.

When the stones are so placed as to level up to a horizontal course at intervals, the work is known as *Random Rubble Built to Courses.*

5. Polygonal or Rag Walling

In this work the stones are of any shape as they come from the quarry, placed so as to fit best with their neighbours after a minimum of hammer-dressing. The effect is somewhat after the fashion of crazy paving set vertically.

3. An Approach to the Measurement of Dressed Stonework

This section is relevant largely to the assessment of ashlar and block-in-course work, the various types of rubble walling being identified from part 2 and described accordingly in as much detail as may be practicable.

The principal indicators to the quality of work are the truth of the surface against a straight edge and the squareness of the stone on both elevation and plan. It is essential that physical checks of these factors be taken; the eye alone will not give the necessary objective evaluation.[13]

To test the straightness an edge is held so that it lies parallel to the notional face of the stone; where the distance at "a" in fig. 1(a) is no more than 2 mm in 300 mm,

TABLE 1 Recording of data

Straight	Square	Range	
Deviation per 300 mm			Possible description
(a) mm	(b) mm	(c) mm	
under 2	under 2	under 1	Ashlar
2–4	2–4	1–2	|
5–12	5–6	3–5	|
over 12	7–12[14]	7–12	Block-in-course

that surface may in general be regarded as straight. Greater deviations should be recorded in steps as suggested in the Table, to assist in comparative studies. The amount of acceptable deviation will depend to an extent on the nature of the work and the type of surface finish. On good finely chiselled or rubbed ashlar, or mouldings, the deviation may well be no more than 1 mm, whereas on run-of-the-mill ashlar walling up to 3 mm in 300 mm would not necessarily be out of place. The same test should where possible be applied to the beds and joints. The latter are relatively unimportant and need only be examined closely to confirm the excellence of first-class work, although for both ashlar and block-in-course work they should be reasonably parallel as they run back into the wall. Bedding surfaces should be checked with some care; although they will often not be worked particularly cleanly, the deviation should again not exceed 2 mm. The principle to follow is that the stones should rest on one another with minimum use of mortar to give stability; on the other hand beds should *never* be worked concave as this causes pressure to fall on the arrises, with consequent spalling of the face. It is an axiom in masonry that mortar is used to keep the stones apart rather than to hold them together. Structures in ashlar and block-in-course depend for their stability on the large size of the stones, the well fitting beds and joints and the arrangement of the bonding. Where the strength depends largely on the mortar, the classification is more appropriately some type of rubble work.

To test for squareness, the square should be held with one arm parallel to the notional line of one face, and any discrepancy measured on the other arm (fig. 1(b); anything under 2 mm in 300 mm may be regarded as square. As before, any greater deviations should be recorded as in the Table.

The angles to be checked are the quoins, the corners on the elevation of the faces and where possible the beds and joints against the face. The beds should always be square to the face, but the joints are again of less importance; up to 6 mm in 300 mm under square is not out of place in good work.

Note should be taken next of the surface finish which should be accurately described according to the tools used and the regularity of the tooling. The profile of typical portions of the surface should be taken, especially on the better finishes, as an aid to identifying the general standard of the work. On good straight finely chiselled work the range may well be less than 0·5 mm, although this will vary according to the heaviness of the chiselling. The key lies largely in the regularity of the surface; punched work in which the peaks and troughs are all at similar levels will clearly have been worked with more care, or ability, than roughly chiselled work in which the range is perhaps less but where much unevenness is apparent, although the labour on the former is likely to have been less. Examples are given in fig. 1(c).

Where the maxima of more than one column of the Table are exceeded, the work is tending towards coursed rubble. Measurements taken on the margins are the best guides to nomenclature, especially where (c) approaches the maximum when measured across the face. Isolated holes in an otherwise good face may be disregarded for measurement, but should be noted as detracting from the quality.

An indication of the size of stones used should be given, the dimensions being *invariably* quoted in the order length of face, depth into the wall, and bed height.

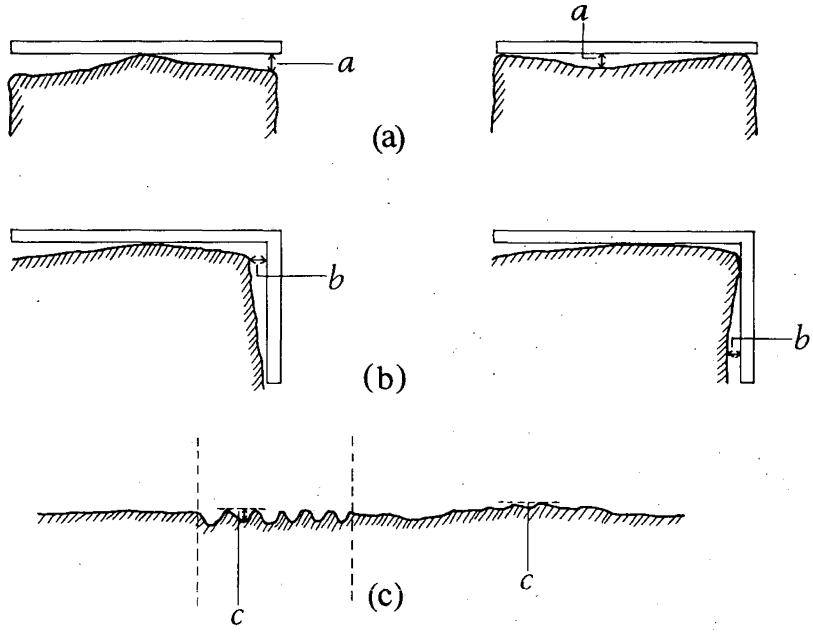

Fig. 1

The overall assessment of stonework must be based on a combination of the above factors. Because of the infinite variety possible in stone dressing, it is difficult to establish a coherent system of grading; an experienced eye must take precedence over rigid rules, but it must be backed by physical measurement. Some of the standards given may seem over exacting but they are no more than may readily be achieved, as required, by a skilled mason. It is only by using the best as a base that we may establish that common standard of appreciation which is lacking at present.

It is worth noting in passing that, especially in regard to medieval work, the final position of a stone in the building should have relatively little bearing on the quality of workmanship. When the stone is being worked it is a matter of inches from the eye of the mason (and his fellows), who will be satisfying a fixed standard with small regard to its destination.

To assist the archaeologist with stonework it may be well at times to take direct advice from a stonemason, but care is necessary here. "Stonemason" can cover a number of different trades—the one to choose is the man who has been trained as a banker-mason, and who spends the greater part of his time dressing stone with a mallet and chisel to a high standard. It is important to appreciate the distinction; one who has spent his life pointing or building rubble walls is no more competent to judge the dressing of ashlar than a banker-mason is to assess a dry-stone wall. An attempt may be made in each case, but this is hardly the approach for the professional archaeologist. But whether excavator or mason finally judges the work, it must be within the framework of this or some other common standard of approach.

4. Tools, Toolmarks and Methods

The tools discussed below are, with a few specified exceptions, known to have been in use in one form or another from Roman times to the present day. When considering dating of stonework it is of prime importance to bear in mind that the majority of modern masons' handtools are very similar in number, style and use to those of the medieval and Roman mason; indeed tomb drawings dating from *c.* 2600 B.C. to *c.* 1100 B.C. found at Saqqara and Thebes[15] show tools indistinguishable from those in daily use by the present author.

The marks left from the use of the tools are described and differentiated so far as is possible; however it cannot be too strongly emphasized that in some cases it is quite impossible to differentiate between work done by different tools. This may be disappointing for the archaeologist, but it is a matter of simple fact which can be demonstrated by any competent banker-mason. Also, it is often the case that there will be a greater difference between the work of two contemporary masons than between works of two different millennia. As a general principle, it is not possible to use toolmarks to provide dating evidence; even relative dating is extremely hazardous, and is best avoided.

The illustrations (fig. 2) used do not relate to any specific period, rather are they representative types showing the general form of the tools. They are described in approximate sequence of use.

Axe/Adze (fig. 2a, b). These tools occur in a number of variations, including having both tools combined in one;[16] they may in their different forms be used for either initial roughing out or in final dressing. For rough dressing of rubble, an acceptable result can readily be achieved, particularly where the tool consists of a vertical axe blade and a hammer head,[17] in which form it resembles one type of modern walling hammer. Other versions of the axe have two vertical blades, whereas the adze has a horizontal blade, which may be combined with a hammer head,[18] pick[19] or axe.[20] For the use of these tools for final finishing, and the resulting toolmarks, see below, *Chisels*. The adze does not seem to figure in medieval records, but it may not have been distinguished by name from the varieties of axe. Neither of these tools is in general use today.

Pick (fig. 2c). This tool may have a point at each end or it may have at one end a hammer head,[21] or an axe or adze blade; to this extent axe, adze and pick may on occasions be the same tool. They are all referred to here according to which working surface is being used.

The pick is mainly used for rough working of the stone, either for rubble work or in the early stages of ashlar. Use of a heavy pick, especially the type weighted with the hammer head on the back, will show a relatively long (according to the softness of the stone) striation which may be V-shaped or U-shaped in section, depending on the form to which the tool has been sharpened and how blunt the edge has become. A small pick will leave marks largely indistinguishable from the use of a punch struck by a hammer, and reference elsewhere in this work to the one may be read as including the other as an alternative, with the proviso that the finer dressed or smaller work

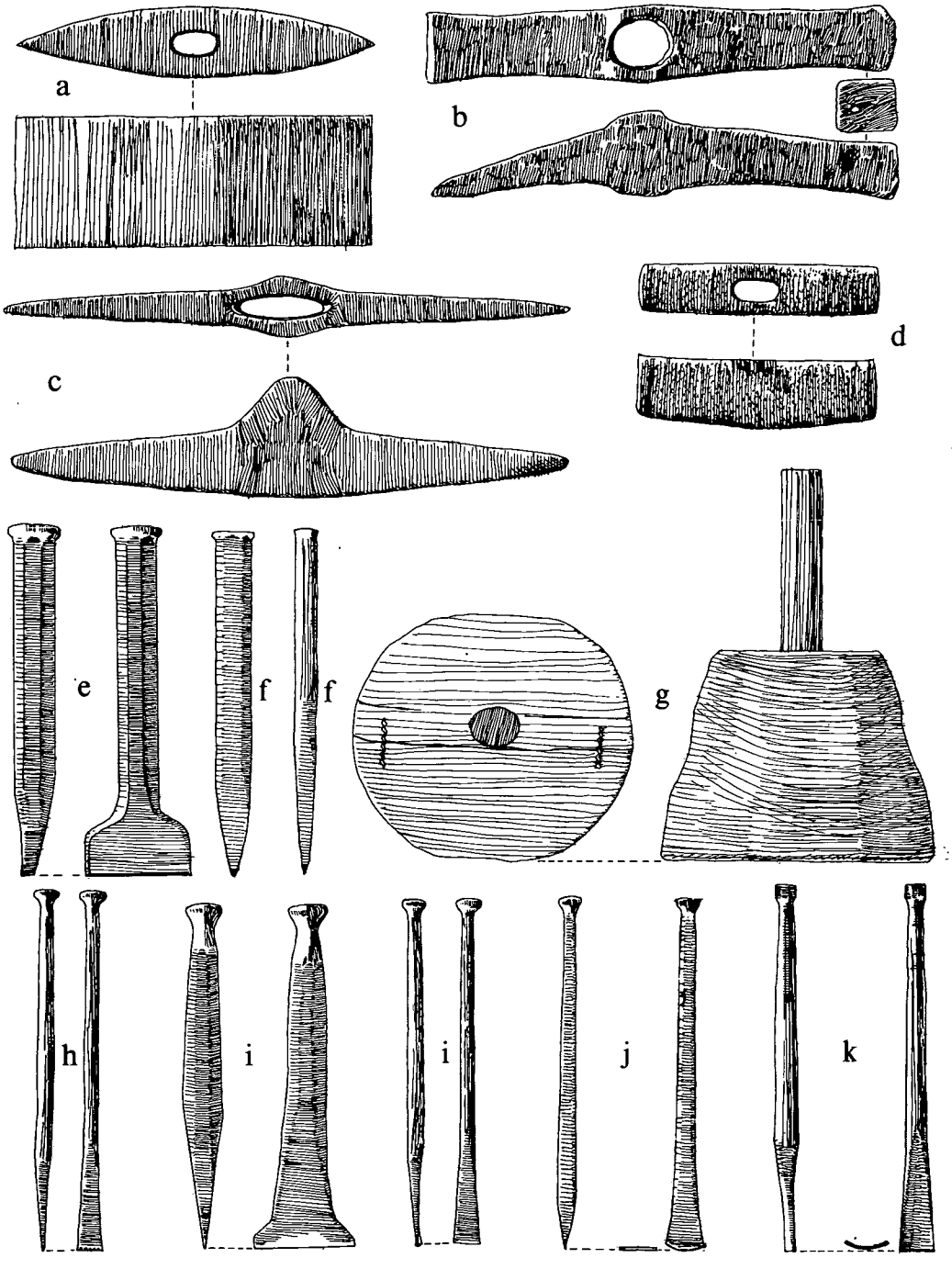

Fig. 2.

will be more likely to have involved the punch. The effects of both will be treated together.

Hammer (fig. 2d). The tool referred to is not for direct dressing but is the hammer for driving other cutting tools. The general pattern[22] is several inches long, hafted centrally, and weighing 2 to 3 kilos with a relatively small striking face. Tools designed to be used with the hammer have the struck end of about the same diameter as the shank.

Pitcher or Pitching Tool (fig. 2e). The antiquity of this tool is uncertain as it has never been positively identified in an archaeological context[23] and its use leaves no trace; it is included for the sake of completeness. In form it resembles a very heavy chisel with a blade from 40 mm to 75 mm wide. Instead of a cutting edge the end is up to 8 mm thick and almost flat. It is used with a heavy hammer blow to remove surplus stone by fracture; one good blow may detatch a piece weighing 2 or 3 kilos. The only trace of its use is a slight bruising where the blade has been in contact. This mark is usually removed by further working and will in any case disappear after only slight weathering.

Punch (fig. 2f). An extremely versatile tool,[24] normally used with a hammer, for removing either large or small amounts of waste, depending on the size of the punch, the hammer and the weight of the blow. It is, incidentally, by no means the case that the softer stones are quicker to rough-off with a punch than are the harder stones. Soft stone will often largely absorb the blow with only small effect, and it may be easier to dispense with this tool in favour of a claw-tool or chisel. A good example of the variety of punched work is afforded by the east-central pier of the east gate of Chesters Fort (Plate Ia). The upper right-hand side has been roughly worked-off with a punch to give a very irregular surface; the lower right-hand side has been more neatly worked over with the same tool to give a rather flatter finish. The left-hand side has been punched (or picked) to give an intermittently furrowed effect.

With both the pick and the punch a single heavy blow in the right place will detach a large flake of stone, perhaps as big as a fist, by fracture alone, with only slight trace of abrasion at the point of contact. Repeated use of the tool over the surface will show as a number of pock-marks, whilst repeated blows of the hammer without removing the punch from the stone between each blow will result in furrows which may be a few millimetres long or may extend across the face of the stone. Careful use of the pick can give the latter effect, but more irregularity will be likely. The variety of different effects to be obtained from the punch is almost infinite, and the quality of finish depends largely on the skill and effort put into the work.

The cutting edge of a punch may be around 6 mm wide for use on softer stones, but is normally drawn out to a point for harder stone. Where the tool has a head suitable for use with a mallet it is generally known as a point, as is the much more delicate hammer-headed tool of the carver.

Mallet (fig. 2g). A modern mason's mallet is circular or oval on plan, about 150 mm across, and tapering in towards the handle. This is precisely the shape shown in the Egyptian tomb drawings mentioned above,[25] but the medieval illustrations show

a. Chesters East Gate, Central Pier.

b. Housesteads, west gate.

a type more akin to a joiner's mallet, that is, rectangular in plan and elevation. The Roman mallet is shown on tombstones, but its precise form is not discernible.

Chisels intended for use with a mallet nowadays have their heads mushroomed out to present a larger area to the mallet; previous practice is not known, as none have survived in this form, and contemporary illustrations are not clear on the point.

Claw-Tool (fig. 2h). This is basically a chisel, for use either with hammer or mallet, with the cutting edge indented to form a series of straight-ended or pointed teeth. Its purpose is to reduce the surface still further after the punch, either as a finish in itself or to bring it within perhaps 2–3 mm of the finished surface prior to chiselling. Its use is optional on the softer stones, but it is of great value on the harder stones and on those stones which have a tendency to pluck into holes when equivalent amounts are removed with an ordinary chisel of the same width. Because of the reduced length of the working edge it requires less effort to drive than the equivalent full bladed chisel.

The effect of the tool is to leave an irregularly "combed" surface in which the tooth marks may easily be seen; where the stone has been further chiselled or rubbed the indentations may be very short and shallow, looking more like pin-pricks. No examples of claw-tools are known to have survived in archaeological contexts in Britain, but its use is attested at many sites of Roman date and on the majority of medieval churches. The vexed question of the date of the re-introduction of this tool at some point in the early medieval period is quite outside the scope of this work. It must be put on record, though, that it is surprising that such a useful tool, used by the Ancient Greeks, and perhaps earlier, apparently went completely out of use for a period of several centuries.

Chisels (fig. 2i). The term is used to cover all cutting tools, driven by mallet or hammer, whose edge forms a straight line when viewed from the cutting end;[26] they are generally classified according to the width of the cutting edge, those of over 50 mm also being referred to as boasters,[27] and used for final dressing of the stone to give a true surface. When the tool has, in elevation, a rounded edge it is known as a bull-nose chisel[28] (fig. 2j) and is used for working concave surfaces. The gouge, with a cutting edge curved on end view (fig. 2k), is used for largely the same purposes as the bull-nose.

The smaller chisels, from say 20 mm down to 3 mm, tend to be used for working mouldings and for carving, and as Mr. Blagg[29] points out can be as finely drawn out as wood-chisels, making recognition difficult after years in the ground. A chisel of about 25 mm is usually used for cutting-in marginal drafts, but this may vary according to the type of stone and the whim of the mason. No two masons today work in exactly the same way, and there is no reason to suppose that they have ever done so. The same tool is also often used, especially on the harder stones, in sequence after the claw, clearing successive parallel drafts across the face which may then be left or finished off with a boaster according to the quality of the work in hand.

The most commonly used chisels for work not going beyond simple bold mouldings are probably 12 mm, 25 mm and 50 mm; with these three, plus appropriate roughing out tools a surprising variety of work can be undertaken.

The identification of marks left by the chisel is by no means always easy, due to weathering, further finishing by abrasion and interference with the surface due to careless roughing out. A plain chisel, used with a little vigour on a hard close-grained stone will leave a series of contiguous straight grooves. The width of the grooves will correspond to the size of the chisel except where successive drafts have overlapped (which is the norm). On coarse grained or soft stone there may well be no clear evidence of the tools used, even immediately after working. Where flat surfaces are being cleared the grooves are at an angle to the line of approach which is normally across the body of the mason, the right-handed man holding the chisel in his left hand, and working from right to left. If the mason stands square to his job the chisel marks will slope from bottom left to top right, at an angle of about 60°–70° to the lower edge of the stone. The opposite slope will result from left-handed work, but it is not always possible to tell which was the edge of the stone nearest the mason. Holding the chisel at an angle is not done for any particular effect but because it is the easiest and most natural way to dress ashlar, *whether chisel or axe is being used.* The belief that diagonal tooling is a mark of axed work[30] does not stand the test of close examination. Comparative studies carried out by the author and other experienced masons have shown that providing all the work is carried out to the same standard it is quite impossible to tell which portions of a surface have been worked with a boaster and which with an axe of similar sized cutting edge. Even on occasions where differences were apparent it was not possible to say which tool had worked which part.

The adze can be equally difficult to distinguish as, *pace* Blagg,[31] it does its work with a paring action, cutting the stone in precisely the same way as a chisel used with a good swing of the mallet. Moreover, marks from the boaster may, depending on the coarseness of the surface, be as much as 5–6 mm apart and 3–4 mm deep whereas the axe or adze can be used, as can the boaster if desired, to give a finer, shallower effect. Again like the axe/adze, in heavily boasted work one corner of the chisel tends to dig in with depressing ease and frequency. The slightly radiating marks sometimes claimed as axed work can also readily be achieved in boasted work with only minimum carelessness.

The problems of differentiating between the different tools applies equally to the work of all periods; a point to bear in mind also is that all edged tools used on stone tend to wear first at the corners, both by abrasion in use and by the action of sharpening. This can lead to some confusion—for example a pick, in the possession of the author, which has suffered heavy use can leave a mark not dissimilar to that made by some indeterminate type of curved chisel.

Given the survival of individual marks, the work of the bull-nose chisel is readily identified, and distinguished from that of the gouge. Although the grooves from both tools are curved on plan, those of the bull-nose have the centre of the curve ahead of the sides, with the contrary effect shown by the gouge. The direction of movement is easily determined, as the groove tends to show a slow descent and a sharper step up in a forward movement.

On the general question of toolmarks it should be noted that, on all but the hardest

stones, they are easily removed or at least softened by rubbing with a piece of sandstone or other abrasive. This is particularly true following use of the smaller chisels, which tend to be used with a light blow, and where in careful finishing with the larger chisels the tool is not removed from the job between strokes. The latter technique may well of itself leave a surface devoid of all but the faintest of marks.

Basic Stone Dressing

At this point a brief outline of the basic principles of working stone may be of interest. The tools described are those most familiar to the author, but in both the initial reduction of the surface with the punch, and in the final dressing of the plane surface the archaeologist may care to substitute the use of an axe or adze; whatever tool is used the basic principle is not affected.

To produce a piece of ashlar from the quarried block, a 25 mm chisel is used in conjunction with a straight edge to cut two rebates at opposite sides of the stone; these are checked for twist and adjusted as required. They are joined by similar rebates on the two remaining sides. These marginal drafts should now be straight and lie in the same plane; on their completeness and accuracy depends to a large extent the quality of the finished work.

For rock-faced ashlar the stone in the centre is left standing or perhaps reduced a little with the walling hammer. For better class work the waste is removed with the axe/adze, pick or punch followed by the claw tool, 25 mm chisel or boaster according to the nature of the stone. These last three tools are all used in similar manner, successive drafts being worked across the face, moving away from the mason, the accuracy being judged by laying the straight edge between the marginal drafts. The other four surfaces (the back normally being left rough) are squared off from the marginal drafts, being worked with a care appropriate to their function.

Where convex profiles are required, the surface is normally worked in a series of successively smaller drafts at a tangent to the curve, using whichever tool best suits the nature of the job. Curved work will normally be finished by chiselling around the circumference, with the chisel held parallel to the axis.

The profiles of mouldings have since at least the early medieval period been transferred to the stone with the aid of a wooden templet or profile of the design. Surprisingly the Roman masons seem not to have used the technique, as examination of the West Range of Site XI at Corbridge makes clear. The stones there seem to have been cut roughly to size in the workshop and finally dressed when set in position, a method which is exceedingly laborious and time consuming. This may account for the generally poor quality finish of the work, but it is certainly remarkable that so simple a device was not developed by such practical engineers.

The basic method of using templets is first to square the stone to the overall size demanded by the moulding and then to apply the templet to each end of the stone in turn; the profile is marked on with a sharp point and the shape worked through between the two ends, using a straight edge for straight mouldings and an edge cut to the correct radius for voussoirs, tracery and other curved work.

Columns, other than those cut on a lathe, are produced by the application of the

same principle. If one long side is dressed flat and the two ends squared off from it, thus being parallel to each other, the centre point of the column may be marked on at each end. Circles of a size appropriate to whether the column is to be a true cylinder or is to have an entasis, are scribed, and the stone worked in the manner described above.

If complex stepped circular mouldings are to be worked the basic method is the same, but the successive diameters are marked on the top bed of the stone, transferred to the appropriate point by squaring, and worked in a series of sinkings.[32]

APPENDIX

The Masonry of Hadrian's Wall: A Stonemason's View

The initial impetus for this note was the description in the Handbook[33] of the curtain of Hadrian's Wall "... clad in carefully squared freestone blocks ...", and "Between the ashlar faces ...". For those with a more than passing familiarity with the Wall these comments are readily translated into a view of what actually exists, but read objectively the image created is of a structure more resembling the mathematically accurate walls of the average Gothic cathedral. The majority of the Curtain Wall is in reality a text-book example of the style of walling known as Coursed Rubble.

In 1931 F. G. Simpson[34] described the north gates of milecastles 22 and 48 as "... badly finished ...". Now whilst, as has been demonstrated, it is impossible to judge masonry effectively from photographs, it is clear from Plate LIX of the report that the inner responds at least of the north gate of milecastle 22 have been dressed with something like a hammer and punch, or possibly a pick, to a fairly regular shape. The north gate of milecastle 48 on the other hand, as may be verified on the ground, has been very roughly dressed with minimum use of any tool beyond the walling hammer; this gate in fact exhibits probably the poorest quality work of any specific structure extant on the Wall.

Three years later P. Hunter Blair[35] noted that the gateways of milecastle 37 are of "massive and carefully tooled" stones. Some of the stones of the north gate are certainly very large, but the quality of the work varies considerably, as we shall see, and in any case "carefully tooled" is at best a vague description which, away from the site, conveys not the slightest indication of either the true appearance or quality of the subject. In the same year the North of England Excavation Committee, working at Benwell,[36] passed over, without comment, what is probably the finest example of stone dressing visible on the Wall today.

Messrs. Richmond and Child,[37] in their discussion of fort gateways, refer to them as being "... built of massive ashlar, dressed with rock face and chisel drafted margins." Apart from the term "ashlar", of which more later, this is reasonably accurate as a very broad generalization, yet it gives very little indication of the precise nature of the work. A comparison between, for example, Housesteads west gate and another building in similar style, equally well covered by their description,

a. Rock-faced, chisel-drafted quoins.

b. Mile-castle 48, North gate, south-west respond.

shows at a glance (pl. Ib and IIa) the need for greater accuracy. It is no matter that the comparison building is relatively modern; the fort gateways never looked like that.

Coming forward to a modern, 1969, excavation of a fort gateway, we turn to the south gate at Chesterholm-Vindolanda.[38] From the description "... re-used material, smaller and better finished than the Diocletianic stonework, although the latter was of a high enough standard", one cannot with the best will in the world form any impression of the standard or appearance of the gateway. Photographs, except insofar as they differentiate between rubble and well chiselled stone, are of very little help in qualitative assessments unless many and detailed.

As a token that the problem is not confined to Hadrian's Wall the report on the gates of Roman Lincoln[39] is a useful example. The authors have paid closer than usual attention to the masonry of the North Gate, together with a close photograph of some of the tooling. However, none of the tools, which appear to include chisel, punch and claw, is specified, and no reference is made to the accuracy of the work. The latter is particularly unfortunate, as it rules out any comparison with the gates of Hadrian's Wall.

As an insight into what value it may be possible to extract from a more accurate examination of stonework, five structures along the Wall are reviewed below,[40] using the principles outlined above, parts 1–4.

North Gate milecastle 48

This is built of large blocks of gritstone[41] very roughly dressed with pick or punch. The north face shows some attempt at chiselled margins but damage and weathering makes the extent uncertain. The bottom course of the north-east respond shows neater work than the remainder, within 15 mm in 300 mm of both square and straight. The other stones are over 25 mm out of square and at least 15–25 mm out of straight. Owing to the roughness of the faces it was only possible to estimate their squareness from the beds, but the latter generally appear to have been dressed with greater care than the former. The joints are 10–20 mm wide.

The responds at this gate are of stones larger than those of the curtain wall, but appear to have been worked with very little more care (pl. IIb). They are best classified as large coursed rubble. The stone is, however, of an intractable nature, quarried locally; the Army seems not have been prepared to go to any more trouble than necessary despite the use of much better stone less than a mile away at Willowford Bridge.

North Gate milecastle 37

Built in large blocks of gritstone up to 850 × 350 × 475 mm, the north face is rough punched at least 15 mm out of straight at best. Some stones were clearly never finished, parts of them being distinctly rock-faced. There are occasional signs of chiselled margins but in very rough fashion. The beds were not easily accessible but appeared smoother than the faces.

The best part of the work is the south face of the south-west respond with most of the faces being fairly neatly punched in a tolerably regular furrowed pattern. The

a. Mile-castle 37, North gate, North face.

b. Mile-castle 37, North gate, South face.

arrises on the quoin stones are within 3–6 mm of square but the south faces are up to 25 mm out of straight. The quoin shows chiselled margins within 3 mm of straight. The beds were not accessible for measurement. The course below the impost shows a snecked joint, used presumably to reduce the dressing of an irregular block. The joints are an average of 5 mm wide.

This gate is best described as block-in-course work, the quality of which varies considerably. The impression is that the north and south faces were the work of two different gangs, not being under the control of the same man (pl. IIIa and b).

Housesteads West Gate (pl. Ib)
The north-west respond is built in large gritstone blocks similar to the neighbouring milecastle. The faces are dressed with a punch, sometimes in varying degrees of neatness, in other places with a more random effect. The chiselled margins on the quoin are within 3 mm of straight on the arrises but run off, up to 10 mm out, away from the edge. The quoin stones are between 3 mm and 12 mm out of square and 5–12 mm out of straight, both measurements being taken on the arrises. The joints are about 5 mm wide. The beds appear to be worked to a much higher standard of finish although precise measurement was not possible.

This part of the gate is good block-in-course work, of a rather more careless standard than the south-west respond of the north gate of milecastle 37, although the work is similar in character.

Chesters Bridge Abutment
The post-Hadrianic abutment (pl. IVa) is of good gritstone blocks averaging some 600 × 1125 × 350 mm. The faces are neatly punched, for the most part in regular curved furrows. The deviation from straight runs from 6 mm down to 3 mm; the squareness of beds to faces is within as little as 2–3 mm in 300 mm. The, mostly horizontal, chiselled margins appearing on many of the stones are of equal quality. The joints are close at 3–4 mm or even less, but the bonding leaves something to be desired with near straight joints in places.

The southward extension is less good in appearance, being of smaller blocks, less well punched, with no consistent pattern. The lack of straightness is of no greater range than on the main abutment although the higher figure appears more often.

The main abutment is of high quality block-in-course work. The distinction between this work and ashlar is somewhat arbitrary, but the lack of a chiselled margin on each edge of the stones tends towards the lower assessment. The extension is best described as small block-in-course work.

Benwell Vallum Crossing Gateway (pl. IVb)
Only three blocks of gritstone remain above the plinth, the largest weighing at least a tonne. The south face of this large stone in particular has been worked with minimum departure from the straight and it lies virtually square to the top bed. The generally smooth face shows a number of holes where a punch has been used with too much

a. Chesters Bridge. Post-Hadrianic abutment.

b. Benwell Vallum Crossing from south.

vigour, and there are clear chisel marks around the edge, but it is difficult to say whether the bulk of the face was cleaned up with the axe, adze or boaster. The return, west, face of the stone has been worked off with a punch in an irregular furrowed pattern inside chiselled margins. It averages some 5 mm from straight and 5 mm from squareness with both the face and the bed. It has, however, a decidedly coarse appearance as compared with the south face.

This stone is remarkable in that it is the only one visible on the Wall which can without any reservation be called ashlar. Due to the pock marks on the south face it cannot be called first-class work but it nonetheless serves as a visible standard with which excavated stonework may be compared at a glance. The manner in which the return face has been treated gives the initial impression that it was intended as a joint, but this is clearly impossible in regard to its situation. Perhaps, as it was not possible to see it from the approach road, it was felt that its appearance could safely be disregarded. Alternatively, it may have been plastered or rendered.

Conclusion

Even so brief a review as the above shows that there is much relevant information to be obtained by and for the archaeologist from a close examination of stonework. It is clear from milecastle 48 that in some places at least the legions were content to use whatever stone was to hand, and this together with the variations in the north gate of milecastle 37 emphasizes the point raised by other structures that there was clearly no overall quality control of the work (pls. IIb, IIIb). This may suggest that, by the Army at least, the Wall was regarded not so much as a superb monument to the Emperor as a gigantic exercise in utility civil engineering, albeit a soundly built one for in most cases care was taken where it was structurally necessary. A comparison between the west gate at Housesteads and the post-Hadrianic bridge abutment at Chesters shows that more time and trouble was expended on the latter;[42] does this indicate that the Wall was built in some haste? Or does the half finished aspect of much of the work indicate that even before it was finished authority had rather lost interest in it? Certainly the impression is of poorly trained men working under either poor supervision or great pressure. But such questions, and the enigma of the exceptional care taken with the Benwell gateway, are for the archaeologist both to pose and to answer, with the aid of such specialist techniques as outlined in part 3.

Glossary of Terms not defined in the text

Arris The sharp edge or line made by the junction of two surfaces forming an external angle.

Bed (i) Plane of stratification in a sedimentary rock; (ii) Upper or lower surface of a stone; (iii) Mortar on which stones are laid.

Note: The bedjoints in an arch are those between adjacent voussoirs, whether vertical or horizontal.

Draft A strip of surface worked to the width of the chisel.

Joint (i) Vertical surface of stone running into the wall; (ii) Mortar, or space, between adjacent stones in the same course.

Marginal Draft A *draft* worked along the edge of a stone.
Quoin Corner Stone.
Twist The failure of a surface to lie in a true plane.

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All opinions expressed are the author's and are not necessarily shared by those mentioned above.

NOTES

[1] See part 3 for a discussion of standards of workmanship.

[2] Indispensable for anyone writing on stonework.

[3] See note 27

[4] Based on the author's ten year continuing experience as a banker-mason on church restoration.

[5] *All* excavated worked stone should be fully reported; we have long since ceased to discard coarse pottery.

[6] For a useful general survey of building stones in Britain see A. Clifton-Taylor *The Pattern of English Building* (London, 1972).

[7] L. F. Salzman *Building in England* (Oxford, 1952) p. 119, quotes repairs to Tutbury Castle in 1314, where the cost of transport over 5 or 6 miles came to nearly twice the cost of the quarried stone.

[8] As a rough working average a piece of stone this size will weigh about 65 kg. (150 lbs per cube foot.).

[9] It can take twice as long to produce a given form in a hard limestone as in a soft one.

[10] Apart from the problems of silicosis.

[11] Correlation to A. Neuburger, *The Technical Arts and Sciences of the Ancients* (London, 1930), was considered, but the terms and definitions therein are insufficient in number and precision, and the exercise was not thought to be practicable.

[12] "Rubble" should not in any way be taken as a derogatory term. The majority of ancient buildings of stone in this country are in coursed or random rubble, and many have stood for centuries without any regular maintenance. Rubble is much more cost effective than ashlar, which has always been enormously expensive.

[13] The principle is not entirely new. W. F. M. Petrie, *Ancient Egypt* (1930), pt. ii 33–9, recorded that "... the mean variation of the cutting of the stones from the straight line and the true square is but 0·01 inches on a length of 75 inches up the face."

[14] The squareness of bed to face should not normally approach this figure except in rubble work. Results are unlikely to fall into the combinations shown, but where wide variations occur the classification is even more a matter of judgement.

[15] Illustrated in G. M. A. Richter, *AJA* xlvii (1943), fig. 8.

[16] *PSAS* 1952–3, fig. 6, E 16.

[17] Bushe-Fox *Richborough IV* (Oxford, 1949), Plate lxi No. 341.

[18] *Archaeologia* lxxviii, Plate xxxii No. 50.

[19] R. G. Collingwood and I. A. Richmond *Archaeology of Roman Britain*, Methuen, 1969, Plate xx(u).

[20] See note 16.

[21] In this form it is in effect a scappling hammer, not discussed here as it is a quarryman's tool.

[22] Roman examples may be seen in Chesters museum.

[23] A tool from Caerleon (*Archaeologia* lxxviii

pl. xxxii (51)), listed as a chisel, may be one example but the end has a rather greater bevel than is usual nowadays and such identification is tenuous.

[24] *PSAS* 1952–3 fig. 10, c64 c66 c67.

[25] See note 15.

[26] *Arch.* lxxxviii Plate xxxii (52).

[27] Richter, *op. cit.*, 188–193, refers to all chisels over 30 mm as "droves"—this is not the normal grouping or name, which appears to be an American name. Regrettably she has been followed in this by S. Adam *The Technique of Greek Sculpture* (British School of Archaeology at Athens, 1966) p. 23–5., and T. F. C. Blagg "Tools and Techniques of the Roman stone-mason in Britain" *Britannia* vii (1976) p. 161, who have both for some reason treated this tool as something quite distinct, not to say *recherché*. There is nothing remarkable about a boaster; it is simply a wide chisel and is properly regarded as such by S. Casson *The Techniques of Early Greek Sculpture* (Oxford, 1933) p. 184, in a couple of sentences. Unfortunately, he refers to it as a "pitcher", which is a very different tool altogether.

[28] Bushe-Fox *op. cit.* Plate LXI no. 343.

[29] Blagg *op. cit.* 163.

[30] e.g. Salzman *op. cit.* 334.

[31] *Op. cit.* 157.

[32] For a full explanation of this somewhat complex operation see E. G. Warland *Modern Practical Masonry* (London, 1928).

[33] J. C. Bruce *Handbook to the Roman Wall* 13th edn. by C. M. Daniels (1979), pp. 41, 43.

[34] *AA*[4] viii (1931), pp. 309, 317–18.

[35] *AA*[4] xi (1934), p. 107.

[36] *AA*[4] xi (1934), pp. 176–184.

[37] *AA*[4] xx (1942), p. 138.

[38] *AA*[4] xlviii (1970), p. 103.

[39] *Archaeologia* civ (1973), pp. 185–194.

[40] The review refers to the present (1979) condition, following any consolidation.

[41] The stone has not been closely identified as this note is principally concerned with the physical characteristics of the masonry.

[42] Also, a visual comparison between the coursed rubble work of the pre-Hadrianic Pike Hill signal tower and the neighbouring T.52a clearly shows up the more careful workmanship of the former.