

Building stones of Edinburgh: quarrying methods

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"There is no part of Scotland where the working of freestone is better understood or executed than in Edinburgh" - George Smith, 1835

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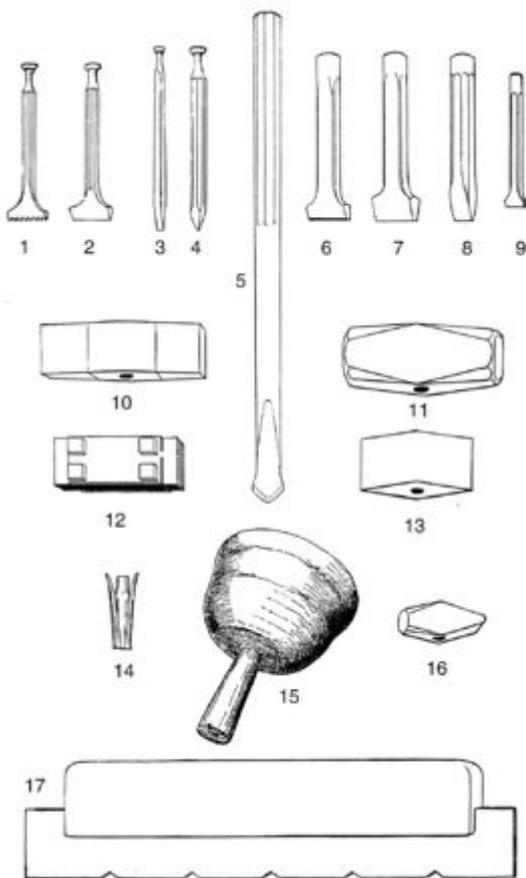
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Quarrying methods

Working of the stone



Corncockle Quarry, Lochmaben. The close up shows use of the chisel wedge method to split the stone to the required dimensions. BGS Photograph C3606, P000100. (1937).



Hand implements used in stone working. Adapted from Merrill, G R Stones for Building and Decoration. (1910, New York: John Wiley & Sons) 1. Tooth chisel used on soft stone 2. Chisel or drove 3 Chisel used on soft stone and driven with wooden mallet 4. Point, cutting end in form of a pyramidal point 5. Hand drill or jumper used for making holes for 'plug & feather' splitting 6& 7. Point for use on hard stone 8. Splitting chisel for splitting and cutting of hard stone such as granite 9. Chisel used on soft stone and driven with wooden mallet 10. Face hammer, square-faced, for roughly shaping blocks 11. Sledge or striking hammer used in driving large wedges for splitting stone 12. Patent or bush hammer with deeply grooved faces 13. Ax or pean hammer with two opposite cutting edges 14. Wedge (plug) and feather used in the process of splitting (up to 8cm long); long wedges (30 cm) for splitting off large blocks 15. Mallet, wooden, cylindrical head, used in cutting of soft stone 16. Hand hammer, smooth-faced, for hand-drilling, pointing and chiselling hard rocks 17. Grub saw for cutting stone by hand

The ability of the quarryman to appreciate and exploit the geological character of stone is of prime importance to its successful use in buildings. Sandstones from different quarries differ in quality in their colour, texture, hardness and ability to resist weathering. The qualities of a stone may not be obvious until it has been exposed to the weather in a building for several years. Differential weathering is often seen in a quarry face particularly if the quarry is used only intermittently and the experienced quarryman uses a knowledge of weathering characteristics to predict how the stone will stand in a building. Minute fissures (vents or dries) or 'sand holes' may only show when the stone is used in a building. Almost as troublesome as fissures are the nodules of hard material 'white' or 'bastard whin' found, for example, in the Redhall quarries, Edinburgh and the beds of whin which had to be blasted in Binny Quarry, West Lothian.



Corsehill Quarry, Annan. In the dressing yard masons are shown at work using mells (wooden mallets) and chisels on the stone. Note that many of the blocks were sawn and that the small holes cut in the faces were used for gripping the block with dogs and chain sling (see block in the foreground). BGS Photograph C3603. P000097 (1937).



Corsehill Quarry, Annan. Dumfriesshire. New section of quarry. Just after a blast loosened blocks are being raised to surface using a chain sling. Note the differential weathering, the hard sandstones stand proud while the interbedded fine-grained silty mudstones being softer, are

weathered back into the face. The structure at the top of the cliff is there to hold down a stay of the crane (out of view). The rock is early Triassic fine-grained water-laid sandstone. The interbedding indicates different conditions at the time of deposition of the sediments.

The equipment and methods used to work sandstone have changed little over the centuries. Examples of some of the manual tools are shown in this illustration. A photograph of quarrymen at work in Corncockle Quarry, taken in the 1930s illustrates the use hammers and wedges. Mattocks, hoes, shovels, rakes and spades were for uncovering the stone, removing the overburden or `tire as it was called. Hammers of various shapes and weights were used to shape the stone or to drive in the drills. Crowbars or picks were often employed to lever the stone off the bed so that it could be lifted with a crane. It is these simple tools which are most often mentioned in early records of the Masters of Works and the Town Council. Payment is recorded for the sharpening of three dozen picks at Ravelston and Salisbury quarries (July 1530). Old picks and mattocks were made into a new mattock and six new wedges in October 1531. During the work at Newhaven in April-May 1556 iron was bought for picks and mattocks and wood for mattock shafts. Repairs were also carried out on heavy hammers, picks and crow bars. The main modern development has been in the use of mechanical equipment for moving stone. From the earliest times cranes were used, first operated by muscle-power (human or horse) then powered by steam, diesel and electricity. Some old Edinburgh quarries still have the stone seats for steam cranes (e.g. Ravelston Black and Barnton Park). Mechanical methods of stripping the overburden, either glacial drift or useless strata, were introduced during this century.

When there is no natural jointing to yield a manageable lump of stone, it has to be split. For small blocks of stone splitting is effected by hammering in wedges. The plug and feathers method is used for larger pieces. In the latter method a row of shallow vertical holes is drilled along the line of the intended split at intervals, the distance of which depends on the hardness of the stone. Often, an interval of about 23cm is chosen. Split iron rods (feathers) are dropped into the holes and iron wedges (plugs) are driven in. This produces a clean break a few metres deep. The same plugs and feathers are further used to shape the block so produced. Another method is to make a 5 to 8 mm deep groove along the desired fracture within which a row of holes for the feathers can be drilled. The grooves and holes can be cut with a hammer and chisel but for deeper holes a pneumatic drill is used. When the great Edinburgh quarries were in operation holes were drilled with a jumper, a bar of iron, steel-tipped and forged into a chisel-shaped wedge. Sometimes this bar was used as a percussion drill, being driven into the sandstone by one man, under its own weight. Alternatively the drill was struck with an iron headed hammer, known as a mash. Used in this way, two or three men were required, one sitting holding the jumper vertically between his knees, and rotating it slightly between strokes which were delivered by one or two hammer men. In the first method, also known as 'churn drilling', when a 30 cm hole had been made, water was usually poured into the borehole and a leather collar or washer made of straw placed on the drilling rod to stop the water spilling out. Muddy material would be removed from the borehole with a scraper which consisted of a thin iron rod with a disc at the end.



Locharbriggs Quarry, Dumfriesshire. A close-up showing the 'shot-grove' and chisel wedge method of splitting stone. Widely spaced holes are drilled and filled with black powder; once blown and the blocks dislodged, chisel wedges are driven in along planes of weakness (usually bedding planes) to further work the stone. Note the quarryman wielding the large crowbar. The Locharbriggs Sandstone Formation is of Permian age.



Locharbriggs Quarry, Dumfries. This photograph shows a general view of the working face. The sandstone was worked 'against the dip'. Situated at the top of the quarry is a regiment of modern electrically powered cranes with steel lattice jibs capable of lifting up to 150 cubic feet of stone. Blocks 12 x 6' on their natural bed could be lifted. In the foreground a block of stone is ready to be raised to the surface for cutting and dressing. An LMS wagon can just be discerned in the background, a reminder that stone was transported by railway directly from the quarry. BGS Photograph C3598. P000092.(1937).

When the quarry shows strong vertical joints (as in many Scottish quarries) wedges are hammered in horizontally to cleave a suitably sized block from the face enough to allow the attachment of a

chain. A crane at the quarryhead can then be used to pull the block free. Sometimes a small charge of black powder is used to split a stone. Whatever the nature of the stone it is essential that it be carefully handled both during and after quarrying. Large charges of explosive are rarely used when regularly shaped building stone is required. The use of excessive explosive produces minute cracks in the rock into which water may enter to accelerate the decay of the stone. Even a dropped or knocked stone may develop scaling at the site of the shock when the stone is exposed to weathering. In their hey-day, most of Edinburgh's sandstone quarries used little blasting powder. For example, in 1835 Smith noted that at Craighleith:

'On an average 25 pounds will cover the annual use of gunpowder'.

When powder was used it was generally to bring down stone to be used for rubble work. A tool called a reamer is used to cut a groove down each side of a previously drilled shot hole in the direction of the desired break and the elongated hole is then charged and fired. Coarse-grained black powder is preferred to other blasting agents (e.g. dynamite) since it acts more slowly and less shattering is produced. Generally the use of gunpowder was not popular in sandstone quarries. James Gowans introduced a new technique which was said to be an improvement on the traditional wedging method at his quarry at Redhall in about 1850. A row of 7.5 to 10cm diameter holes of considerable depth was drilled at a suitable distance from the quarry face. These were then charged with gunpowder and fired simultaneously by an electric battery. The method produced a large amount of stone cheaply. An alternative method of blasting used more recently in some Scottish quarries (e.g. Locharbriggs and the new Dunmore quarries) uses the rapid conversion of liquid carbon dioxide into a gas to produce the relatively slow heaving action necessary to move the sandstone without shattering it. This method is known as Cardox blasting.

Some quarries were worked by channelling which involved cutting a groove or channel 6m long and 3m deep along the side and back of the piece of stone which was to be extracted. Channelling was a suitable method in quarries where the beds dipped at a shallow angle. Long ago channelling was done with picks but later a specially adapted drill was able to cut a deep groove in any direction using a set of bits working by percussion. Channelling using the Ingersoll-Sargeant channelling machine was first introduced into Scotland by the owners of North Auchinlea Quarry, Motherwell and was in use by 1911. Once the channel was made the block could be split off the bed with wedges and crowbars.

Most sandstone in Scotland has been worked in open quarries. The size of stone block which the quarry can produce depends on the lifting power of available cranes. The Locharbriggs crane lifts blocks from depths of between 9 and 36 m. Occasionally stone was found at a depth where the removal of overburden proved uneconomic. In some cases the stone was considered to be valuable enough to be mined by pillar and stall methods, as at the Braidbar quarries, Giffnock where galleries about 9m high by 18m wide were opened. At Huntershill Quarry, Bishopbriggs, where galleries 15 m high were opened, sandstone was mined for more than fifty years until a serious roof fall killed five men at the beginning of this century. Sandstone was mined until more recently at Dalachy near Burntisland in Fife.



Huntershill Quarry, Bishopbriggs The Bishopbriggs Sandstone was quarried and mined in Huntershill Quarry, Bishopbriggs. The sandstone is developed as two units, the lower part 18m thick and the upper part 14m. Mining by the stoop and room (pillar and stall) commenced in the 1850s as the overburden of poor quality strata and till increased in thickness. The galleries were some 15 m high. The quarrying process was started by 'miners' who drove horizontal mines near the top of the post (bed). Quarrymen then wrought downwards from the mines, a few feet of solid sandstone being left to support the roof. Mining continued until about 1907 when a serious roof fall killed 5 men. BGS Photograph C2417 P000050. (c.1908).

It has been estimated that more than three tonnes of stone have to be quarried to produce one tonne of principal stone products. The rest (75-80%) is sorted for sale as rubble, roadstone or shivers, or rejected as spoil. Rubble was used extensively during the 19th century for the back walls, gables and internal walls of tenements and other buildings. Some quarries (e.g. Hailes) became known for the high quality of the rubble produced. Today there is little demand for rubble in modern building work although ornamental rubble walls are still built. The principal stone lifted from the quarry is often 'blocked' (cut to roughly rectangular shape) for immediate sale or transported to dressing sheds.

It is in the finishing of building stone that the main cost lies. Until quite recently the roughly shaped stone which left the quarry was hand-dressed. Sometimes it was left rough on the exposed surface (rock-faced) or droved, tooled or polished with special equipment.

Stone dressing is now mostly done by machines. The irregular lump from the quarry is first cut into slabs with a frame saw. This saw has a rectangular horizontal frame suspended by rods holding several parallel steel blades from 76-150mm (3-6") deep, 5mm (3/16") thick and 2 - 4.5m (6-15 feet) long. These blades are at adjustable distances from each other and are driven backwards and forwards to cut the stone. Water, together with an abrasive, which may be sand, steel shot or carborundum to help the cutting process, is sprayed over the cuts. In order to cut the remaining faces on the stone the slabs may then be clamped to a moving table which feeds them against one or two revolving circular saw blades, the tips of which may have small diamonds set into their edges. More accurate, though slower cutting work is done with a carborundum rimmed steel blade. Water has to be fed on to the circular blades to keep them cool. If a very fine finish is required, relatively

expensive wire sawing methods are employed. Wire saws (single or multi-wire) are used with water and an abrasive to cut sandstone which is mounted on a bogey. Any marks made by the cutting process can be removed by placing the stone on a rotating circular steel table. The abrasive action of carborundum, sand and water between the fixed stone and the rotating table smooths the stone. Computer controlled profiling machines have revolutionised the 'running' of moulding in recent years.

Hand finishing, now aided by power tools such as a pneumatic hammer or pointed pick or punch, is still used to remove final rough edges or to texture the stone. Compressed air and abrasives are also used for texturing. Hand work on a bench is still very important in the repair and replacement of carved stone in old buildings where the work can only be partly done mechanically.

Organisation of work

Accounts of early building in Scotland provide little information about the organisation of quarrying. Certainly detail is much scarcer than in English documents. Some information comes from the building accounts for larger works like Holyrood Palace, Edinburgh Castle and Parliament House. From the 16th century onwards the Town Council records are helpful. Almost certainly the first large-scale widespread quarrying in Scotland took place in Roman times when the Roman Army had its specialist *quadratarii* or stone cutters. More notable examples of Roman masonry above the ground north of Hadrian's Wall include Cramond Fort and Bearsden Bathhouse. In mediaeval times, abbeys and castles were very often built from locally quarried stone. An example is **Craigmillar Castle** which must have required large supplies of local stone. In the few surviving early accounts little is said about transport of stone which suggests that many Scottish buildings used local stone. However, even in 16th century Edinburgh, when major work was being undertaken at Holyrood Palace stone was brought from as far away as Cramond, Barnbogle and Queensferry and even from Culross in Fife. Quarries near these coastal villages supplied stone which was transported by ship to Leith and thence to **Holyrood Palace** [146] or **Edinburgh Castle** [9]. Transport costs could be a significant factor in the price of Edinburgh building stones. The cost of carting or sledging stone from the quarry to the building site could be almost as much as the cost of winning the stone at the quarry face (e.g. Ravelston).



Old College, South Bridge, Edinburgh. Built of Craigeleith sandstone.

In the early days of quarrying in Edinburgh the demand was mainly for rubble which was used in the Old Town tenements. These comparatively small stones could be supplied from local quarries where the depth of working was not great (e.g. Bruntsfield, Quarry Holes and Society). In the 17th century prestigious buildings in the Old Town, such as Heriot's Hospital (**George Heriot's School**) [33] and **Parliament House** [21] and the great undertakings of the New Town in the late 18th century, such as **Register House** [128] and the **Old College of the University of Edinburgh** [28], demanded stone of consistent size, colour, durability and quantity which the small-scale workings could not supply. It was then that the great quarries of Craigeleith and Ravelston came into full production as the thickness of the beds in these quarries was sufficiently great to provide the large ashlar blocks which these buildings demanded as well as abundant rubble for wall cores. Indeed it was said that Craigeleith quarry could produce stone of any size providing there was powerful enough machinery to move it.

Quarries were often worked by groups of men ('marrows'). For example, 24 workmen and 7 quarriers were paid for a week's work in May 1529 but they worked four quarries during the course of the week, namely Salisbury, Ravelston, Leith Hill and a quarry at Culross. Sometimes the work involved the clearing ('redding') of the quarry as well as 'putting down' the stones ready for use at Holyrood. These men probably worked in small groups to enable the quarry face to be developed in a series of short lengths, each of which was in advance of the next. The vertical face was probably divided into a series of terraces, as at Clashach, Corsehill and Locharbriggs today, so that the whole face was carried back uniformly. The number of men working at a quarry at any time depended on the demand for stone for a particular building and the number employed could fluctuate according to the season. Most, though not all, work was carried on in the sunnrner months and the shorter winter day was reflected in a reduced wage for quarriers as it was for masons.

The length of working day for quarriers was probably the same as that for masons. In Edinburgh during summer-time in the early 16th century quarriers worked from 5 am to 7 pm. A two hour break was taken at midday and two short breaks observed of half-an-hour for breakfast ('disjune') and, except in the depths of winter, another half-hour afternoon break for 'nunshankis'. In winter they worked from dawn to 11.30 am then from 1 pm till dusk. By the 18th century summer hours had been reduced to 6 am to 7 pm with one hour for breakfast and another for lunch. Pay day was Saturday.

The workmen

In Scotland there was less distinction between the different types of stone workers than in England. The work of winning stone was undertaken by men variously described as quarriers or workmen. It seems that those described as quarriers were the skilled men with whom the masters of works made the contracts to quarry specified amounts of stone. Workmen did the labouring. Often the men who quarried the stone also did some of the shaping. Sometimes quarriers may have moved up the social scale to become masons who were members of a trade. (e.g. John Merlion, a quarrier at Barnbogle in July 1535 was described as a mason working at the kitchen of Holyrood Palace in August 1538). This was certainly the case with one of the few stone cutters to achieve fame, Hugh Miller, who began his working life as a quarryman in February 1820 in the Cromarty quarries.

"It was the necessity which made me a quarrier that taught me to be a geologist."

His first job as a quarryman was to 'red up' the quarry, using a shovel to move loose rocks which obscured the working face. This done,

'Picks and wedges, and levers, were applied by my brother-workmen; and, simple and rude as I had been accustomed to regard these implements, I found much to learn in the way of using them'

When these simple methods failed gunpowder was used. 'We had a few capital shots: the fragments flew in every direction Miller provides a glimpse of an aspect of the skilled quarrier and mason's life which must have applied throughout many parts of Scotland for hundreds of years. Shortage of work often led to these men travelling around the country to where major building work was being undertaken. In Miller's case it was to Cononside then later to Edinburgh where work on Niddrie House took place during the building boom of the mid-1820s. In these travels Miller experienced the hard life of the barrack, or workman's lodging.

Most quarrymen were probably illiterate so it is hardly surprising that we have few accounts of what it was like to work in a quarry when stone was won by human muscle. However, in addition to the writings of Hugh Miller, there is the autobiography of Alexander Somerville, born in East Lothian in 1811. In the course of a very varied life he spent some time in 1830 as a labourer in the Pan Doocot (Dovecot) quarry in East Lothian. Here, stone was quarried for the new Cove Harbour then being built 3 km away. The labourers cut the stone from the quarry face and the masons then hewed the stone blocks into shape. According to Somerville the masons looked down on their assistants, who did not have a trade, and treated them very badly to the extent of striking them at small provocation.

Life for stone workers was never very healthy as the comments about respiratory problems at Craighleith Quarry make clear. It was probably slightly healthier for the quarriers than the masons as the former worked in the open air while the latter, working in groups as at Holyrood in February 1530, dressed stone in sheds or lodges in which much dust was created.

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