

The Reigate Stone Research Project

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The Reigate Stone problem

MEMBERS OF *Subterranea Britannica* and the Wealden Cave and Mine Society have been working with the Historic Royal Palaces Agency in researching Reigate stone and the underground quarries from which it was worked from late Saxon times to the 19th century.

The Historic Royal Palaces Agency has the care of the Tower of London, Hampton Court, and several other properties. They contain much Reigate stone, from the east Surrey quarries, from 11th-century work onwards, much of which is now badly weathered. The Agency are anxious to:

1. establish how, if possible, to arrest further decay of the stone;
2. secure fresh samples on unweathered stone for scientific study in connection with this, and, possibly,
3. investigate the feasibility of quarrying new stone for repairs.

There are several practical problems in making progress with these three issues:

1. Reigate stone is neither a limestone, nor a sandstone; nor is it (as it is usually described) a calcareous sandstone, as very little of the silica in it is in the form of detrital sand grains; Reigate stone is in fact a unique building stone type in Britain, and established conservation measures for straightforward sandstones, calcareous sandstones, or limestones may not be appropriate. The rock has a porosity of around 30%; the silica is extremely fine-grained and chemically deposited, and the rest of the rock is made up of very fine grained calcite, clay minerals, mica flakes and glauconite;
2. the stone was quarried underground, from the Upper Greensand in east Surrey, all of the quarries having been long out of use, their original drift entrances collapsed, and parts of the quarry galleries themselves subject to flooding and roof-falls;
3. archaeological evidence within the quarries makes it clear that much of the stone taken from the working faces was rejected for building use and was left underground as large areas of backfilled quarry waste behind dry-stone retaining walls;
4. during the 19th century some of the quarries were mined for hearthstone, a mineral pigment for whitening stone hearths, floors, doorsteps, etc. Nineteenth-century descriptions of the quarries/mines, by geologists and by miners and quarrymen, indicate that build-

ing stone and hearthstone beds alternated in the underground working faces. However, visual inspection of these working faces often fails to reveal the bedding planes, and even if the individual beds were clearly visible and demarcated, it is not known which beds would be suitable as building stone, and which fit only for use as hearthstone; often the stone looks identical and homogeneous from quarry floor to ceiling, apart from occasional chert bands;

5. published descriptions of the lithology of the building-stones and hearthstones are confusing and sometimes contradictory, and very few detailed petrographic descriptions based on microscopic study of thin sections have been published;

6. published descriptions of the stratigraphy cannot be correlated from quarry to quarry, or with described weathered sections at outcrop, although the latter generally show far more evidence of bedding than is usually seen underground . . . indicating that there is considerable lateral variability, and that individual beds are generally quite thin, of the order of 0.2 m in thickness (borne out by the usual depth on bed seen in stones used in buildings.)

The beds exploited, therefore, appear to consist of lenticular masses of good building stone which would weather well, intercalated with similar masses of inferior stone fit only for use as a mineral pigment. Which bed is which, and how to recognise them, is lost quarrymen's knowledge. For examination in connection with alleviating the stonework problems at Hampton Court and the Tower, the need is to identify the good building-stone beds, and to be able to determine precisely their upper and lower limits in the quarry faces. Some massive pieces of Reigate stone in exceptionally good condition in Canterbury Cathedral and in the church at Merstham (east Surrey), for example, indicate that the ancient quarrymen knew the answers to these problems, and were able to identify and work sound building-stone block up to 0.3 m thickness on the bed. Extensions to Merstham church in the 1860s and 1890s, illustrate use of the local stone, in much smaller pieces, which can now be seen to have weathered and decayed far more than the larger blocks in adjoining fabric some centuries earlier.

Vince Alkins (Wealden Cave and Mine Society) and Paul Sowan (WCMS/SB) visited the underground quarries at Merstham in February 1998, attended by Robin Sanderson and Bernard Worssam (geologists and special-

ists in the scientific study of building-stones), and Keith Garner, an architect working for the Historic Royal Palaces, and a number of his colleagues. This was followed by a number of liaison meetings at the Tower of London, leading to an HRPFA-funded research project, of which Stage I has now been completed -- systematic collecting of samples from the quarries for scientific analysis.

Stage I -- the sampling project

It was decided to take samples from quarries known to have been used exclusively as sources for building-stone, and to avoid workings where hearthstone mining was known to have taken place. For this reason, no sampling was done in the Godstone quarries. Samples were to be taken using a diamond-tipped drill to take oriented cylindrical cores approximately 4.4 cm diameter by 15 cm long. An electrically-driven drill was essential in view of the inadvisability of using petrol-driven equipment in the very confined underground spaces; to minimise voltage drop a maximum cable length of 50 m was used, linking back to the petrol-driven generator on the surface outside the quarry entrances.

Preliminary visits were made to the selected sampling sites (Quarry Field, Quarry Dean, Bedlams Bank, and Rockshaw quarries) to decide on exact locations for drilling. These sites were selected with roof stability very much in mind, where complete floor-ceiling sections could be accessed, and where some indications of bedding demarcations could be seen (better indicated by changes in the toolmarking than by the appearance of the stone itself). A vertical row of samples at approximately 15 cm intervals was taken, exact drilling points being decided by such evidence for distinct bed boundaries as could be seen.

Each site was photographed before and after drilling. A detailed archaeological record of bedding features, toolmarks, and jointing was made for each sampled face and the immediately joining area. All the quarries sampled have already been surveyed to a very high degree of accuracy by Chris Bailey, Peter Burgess, and others, of WCMS.

Detailed geological and archaeological descriptions of each site will in due course be offered for publication in appropriate academic journals, possibly the *Proceedings of the Geologists' Association* and/or the *Surrey Archaeological Collections*.

It had been hoped to locate sampling sites in out-of-the-way parts of the quarry workings, where they would not generally be visible to visitors. Unfortunately, the restricted cable length made this impossible, and it has to be admitted that the vertical rows of holes are visually very intrusive: one of the delights of visiting the quarries is their 'time capsule' atmosphere, where everything is virtually unchanged since the last quarrymen left (roof-falls and washed-in debris apart). However, to the informed eye, the sampling sites are no more an affront than the various digs carried out by the

caving clubs over the years, or indeed the well-beaten floors now marking the main 'tourist' routes through the networks of galleries (totalling some 16 km of accessible tunnel in the Merstham-Chaldon complex). Exploration and the excellent topographical surveys of the current known extent of the workings would not have been possible without those 'digs'. Likewise, it is considered, the recovery of the quarrymen's lost knowledge and understanding of the stone beds being exploited, and the prestige of partnership with the Historic Royal Palaces Agency which guaranteed Stage II of the investigation, more than justify the presence, at four locations, of a total of about 50 two-inch diameter holes. If nothing else, they will serve to remind visitors how important the quarries were, in supplying stone to some of the most important parts of Hampton Court, the Tower of London, Westminster Abbey, Canterbury and Rochester Cathedrals, Windsor Castle, and numerous other important monuments throughout London and the south-east.

Stage II -- the scientific analysis

Except at Rockshaw, duplicate cores were taken at each site. Each core has been marked so that its original orientation within the bed is known. One half of each pair will be cut in half laterally, one half being retained as an archived hand-specimen (probably, ultimately, this archive will be held by HRPFA). The flat surface of the half-core will be photographed, recording stone colour and texture. The other half-core will be subjected to various forms of destructive testing. Thin sections for microscopic study and petrographic description (by Robin Sanderson) are already being made. Depending on the results of this, decisions will be taken on further testing, including scanning electron microscope photography, and chemical analysis.

At the end of the exercise, we should know a great deal more about Reigate stone and hearthstone than we did before . . . and we might even be able to tell the difference, and explain it in chemical and mineralogical terms.

All of this is essential groundwork in assisting HRPFA, and indeed the conservators of many other ancient buildings, to understand and possibly alleviate the deterioration of the important medieval carved work and ashlar in the monuments in their care. It might also, just possibly, have a bearing on the feasibility, or otherwise, of extracting new Reigate stone for repairs (it is difficult to find a good 'match' from currently available British or French building-stones, although at Merstham some use was made of Lepine stone from France). However, renewed quarrying is *not* the objective of the current exercise, and would clearly be an altogether large, costlier, and more complex project both in technical and planning and legal terms.

Most of the costs of the research project have, to date, been met by the Historic Royal Palaces. The writer was awarded the 1999 SERIAC bursary (£250) at the South Eastern Industrial Archaeology Conference at Reading in April, which sum will be used to support Stage II of the project.