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PETROLOGY REPORT

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PRE-CONSTRUCT ARCHAEOLOGY

St Lawrence Church, London Road, Morden, London Borough of Merton SM4 5QT

Petrological Identification of the stone types used in the East Window and Quoins and comment on the brickwork

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BACKGROUND AND METHODOLOGY

Petrological analysis of the 17th century architectural stone mouldings used in the external east window of St Lawrence Church, Morden, London Borough of Merton (**Plate 1**), was undertaken on 20th May 2019 in order to establish their geological character(s) and if possible geological source(s). Comment on the stone types used in the quoins and the fabric and date of the brickwork both used in the east-elevation was also made.

Vertical elements of the 17th century east window had suffered extensive weathering and flaking particularly in areas strengthened by a very hard impermeable hydraulic pale cream-brown gritty mortar (19-20th century), causing these vertical mullions and window jambs to spall, warp and break-up in places (**Plate 2**). Spalling began in the lowermost vertical sections of the window tracery and jambs at the juncture with large horizontal stone elements. These basal elements, forming the external stone sill of the window, were later post-medieval replacements made from a slightly different darker pale cream brown rock. The application of the hard impermeable mortar with same hue as the stone sill at this juncture and above was meant to show a seamless boundary between the sill and vertical elements giving the impression that the stone was all made from the same rock type.

On-site analysis and description of the stone type(s) used in the window tracery mullions and quoins was undertaken using a hand lens (Gowlland x10) with small samples from the damaged section of the window, bagged and analysed at a high magnification in-house using a binocular microscope. Here comparison was made with Pre-Construct Archaeology stone reference collection in order to provide an exact match. The brickwork was examined on site in a similar way, and measurements and photographs were taken of the fabric and coursing.

RESULTS

East Window Tracery Stone Types

Hand specimen comparative analysis has been successful in identifying three different rock types used in the external east window of St Lawrence's Church. They are all freestones that is limestones with a soft, even-grained open porous texture with enables the rock to be carved in different directions yet be hard enough to withstand external weathering (Sutherland 2003). A majority of these limestones have been quarried since Roman times (Hayward 2009) from the Middle to Upper Jurassic 400km long NE-SW trending scarp face which runs from Humberside down to Dorset. All three

lithotypes identified from the east window of St Lawrence Church come from different parts of these outcrops.

17th Century Vertical Mullions and Jambs

Headington or Wheatley stone: Upper Jurassic, Wheatley Limestone Member (Oxfordian), Oxfordshire

e.g., **Location**: Lye Hill Quarry SSSI (SP 592068) (Explorer Sheet 180; BGS Sheet 237)

Nearly all of the vertical mullions (typically 95cm long) and jambs of the primary 17th century external east window of St Lawrence's Church had an identical petrological match with samples of Headington stone from the Upper Jurassic (Oxfordian), Oxfordshire. This banded pale cream to yellow-cream open textured shelly (echinoid and coral) grainstone (Dunham 1962) (**Plate 3a**) lies on the easternmost edge of the Jurassic limestone outcrop in Oxfordshire immediately to the east of Oxford in the villages of Headington and Wheatley, easily accessible to London via the River Thames (outcrops lie just 6km away). It is in fact the closest limestone freestone resource to London (80km).

Detailed hand specimen comparative analysis shows it to have thin, gently curved, but not laminated, shelly fragments which stand out above the surrounding pellet grained sometimes light cream sparry matrix, which weathers very pale brown. In thin section, these are probably *Ctenosterium* brachiopod (Hayward 2009). Stems of crinoids (possibly *Plegiocidaris florigemm*a) (**Plate 3b**) and a near complete echinoid (possibly *Nucleolites cluncularis*) (**Plate 3c**) were observed in comparable materials identified from quoins from the north-east corner of the church (see below). Both are common fossil types from the Upper Jurassic (Oxfordian) of Oxfordshire. Unlike the replacement limestone types, which did not contain ooids.

Its open porosity (BRE E5236; 34.7%) which makes it conducive to fine, accurate carving also makes it highly vulnerable to polluted atmospheres, creating widespread characteristic blistering (Arkell 1947 Sass & Viles 2010), accentuated by the render covering of the impermeable hydraulic seal of the 19th to 20th century Roman cement.

Later post-medieval external replacement sill

Clipsham stone. Middle Jurassic (Bajocian) Clipsham. South Lincolnshire

E.g. Location Medwells Quarry (SK 988160) (Explorer 248; BGS map 143)

Individual long (1m 6cm) moulded elements forming the replacement window-sill of the east window had a good petrological match with samples of Clipsham stone from the Middle Jurassic (Bajocian) of South Lincolnshire. In hand specimen this limestone is homogeneous hard interlocking shelly oolitic grainstone (Dunham 1962), consisting of a mosaic of large (1mm) round pitted carbonate grains called ooids and a whiter shell component, containing often-complete bivalves and brachiopods. (**Plates 4a** and **4b**). It has a deeper creamy-brown hue than the Headington stone and its fresh hard

surface is an indication of its greater resistance to weathering borne out by its much lower porosity (14-15%) (Leary 1989, 24) than Headington stone and its durability, recorded as one of the toughest limestone types (Class A) in the British Isles and the hardest of the Lincolnshire Limestones (Leary 1989, 22).

Insets unknown date

Taynton or Burford stone. Middle Jurassic (Bathonian) Taynton Limestone Formation

E.g. Location Lees Quarry, Taynton (SP 236152) (Explorer 45; BGS Map 236)

Five small (15cm high) insets (**Plate 5**), set one metre up in the vertical mullions and jambs between the Headington stones in the east window have a good petrological match with samples of Taynton stone from Middle Jurassic (Bathonian) of West Oxfordshire. This much deeper coloured pale orange brown coarse banded shelly oolitic grainstone (Dunham 1962), contrasts markedly with the much paler cream Headington stone, forming a two-tone window surround. Outcrops lie close to the River Windrush and would have been easily accessible by boat to London via the River Thames (Sumbler *et. al.,* 2000).

It is not clear whether their fresher sharp edges are down to their lower porosity (19%) and durability Class C (Leary 1989, 73) and/or the possibility that they could be later replacement stones.

17th Century Quoins

Headington or Wheatley stone: Upper Jurassic, Wheatley Limestone Member (Oxfordian), Oxfordshire

e.g., Location: Lye Hill Quarry SSSI (SP 592068) (Explorer Sheet 180; BGS Sheet 237)

Set into the south-east and north-east corners of the east elevation of St Lawrence Church, Morden are 500mm long x 315mm wide x 185mm high blocks of stone having an identical petrological match to Headington stone or Wheatley stone used in the vertical mullions of the 17th century east window. They have suffered the same type of spalling and weathering, especially at the quoin edges and contain examples of crinoid stems (possibly *Plegiocidaris florigemm*a; **Plate 3b**) and a near complete echinoid (possibly *Nucleolites cluncularis*; **Plate 3c**), both typical of the Oxfordian (Upper Jurassic).

DISCUSSION

Stone Types and Chronological Use

The identification in hand specimen of Headington stone or the related Wheatley stone from the Upper Jurassic of Oxfordshire in the vertical mullions and jambs of the 17th century east window of St Lawrence Church in Morden as well as in the north-east and south-east quoins of the same east elevation was an unexpected discovery. The entire window was provisionally described as Clipsham

stone from Lincolnshire, when in fact it was only the substantial replacement external window-sill that was made of this harder oolitic limestone.

The use of Headington stone and Wheatley stone in London is usually associated with Tudor and Elizabethan palatial builds. This includes, Wolsey's first phase of work at Hampton Court between 1514-1522 at the Base Courtyard (Thurley 2003, 18) and at excavations (Hayward pers. obs.) from Henry VIII's 1515-1523 Bridewell Palace; as well as recent petrological work in 1518-1522 Brandon House (Hayward in prep).

The use of freestone in 17th century London is usually associated with Portland stone with its early introduction in Inigo Jones 1630s banqueting hall and Portico of Old St Pauls and more extensively in the restored post Great Fire St Pauls (Campbell 2007, 91). Burford stone from West Oxfordshire, Ketton stone from Rutland are also usually considered the materials of choice from this period.

However, the use of Headington and Wheatley stone in London during this period tends to be overlooked due in part to geological misidentification but also because so much of it probably decayed due to its open soft porous texture. Indeed in 17th century Oxford the demand for Wheatley and Headington stone was at its greatest for use in the extensive college building programme (Arkell 1947, 49) and Wren used it for building the Sheldonian Theatre between 1664-1669 as well as primary ingredient in the construction of the New St Paul' in London (Campbell 2007, 91). Given these as well as other recent identifications such at its use at 17th century York Place at Battersea (Hayward pers. obs.), it is not surprising that it was considered as the key freestone building material for this 17th century church. The blocks perhaps shipped down the River Mole from Battersea and offloaded when it became unnavigable then brought overland.

19th century Deterioration and Replacement

Deterioration in the fabric of the 17th century stone window tracery of St Lawrence, seen elsewhere in the church in the quoins is typical of Headington and Wheatley stones. The sill of the east window, more vulnerable to water infiltration from the roof above was replaced in harder Clipsham stone.

Headington stone's high overall porosity and low strength, were the reasons these stones also underwent wholesale replacement in late 19th century Oxford. Replacement by much harder freestones, especially Clipsham stone from Lincolnshire was common-place and made possible with the advent of the railways. Sir Thomas Jackson first used Clipsham stone nationally to replace Headington stone beginning with the Examination Schools at Oxford (1876-8) (Arkell 1947) and it is possible that these replacements occurred at St Lawrence Church around this time. The insertion of the Taynton stone insets probably occurred around this time, although there is no direct evidence for this. The addition of the light brown hydraulic cement above the sill may have also occurred at this time, as it was only in the latter part of the 19th century that these impermeable harder cements were

widely used. The addition of the cement, however merely accelerated the process of decay seen today in Headington stone in both the tracery, jambs and quoins of the church.

RECOMMENDATIONS FOR REPLACEMENT STONE

The fabric of the Headington stone used in the 17th century vertical jambs and mullions of the east window as well as the quoins of St Lawrence Church, Morden is decaying rapidly. It requires replacement stone urgently.

Obtaining replacement Headington and Wheatley stone today is impractical as all the old workings east of Oxford have been infilled or have been designated geological SSSI sites.

The obvious choice would be to use Clipsham stone from the Middle Jurassic (Bajocian) already successfully employed as a replacement stone in the windowsill of the east window. Of a similar if not identical hue to the Headington stone, Clipsham stone has the added benefits of having a lower overall porosity (15%) rather than (35%) of Headington stone and greater strength, making it resistant to long-term chemical and physical decay. It is also recommended that the impermeable hydraulic cement render is not replaced with a comparable material but a more breathable lime sandy mortar cement.

Clipsham stone is being quarried today by the Clipsham Quarry Company

http://clipshamstone.co.uk/

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APPENDIX 17th century Brickwork

A brief description of the brickwork fabric (**Plate 6**), form and bonding beneath and surrounding the east window at St Lawrence Church follows.

Fabrics and Forms

1) Brown-maroon fabric, (with small chunks of clinker set within the fabric) London Fabric *3032* Post Great Fire brick (1664-1900). These account for two-thirds of all bricks in the east elevation. Each unfrogged poorly made, small (211mm x 104-108mm x 55mm). The size (narrow depth) and the fact that they are poorly made would suggest a mid-late 17th century date.

2) Red sandy fabric London fabric *3046*. (1450-1800). These fabrics account for one-third of all bricks in the east elevation. Again, like the maroon *3032* bricks they are unfrogged, poorly made and small (similar dimensions 211mm x 104-108mm x 55mm). Bricks in this fabric can be mid-15th century and out of the confines of the City of London and Southwark these bricks continue to be produced into the 18th century from local brickearths. Both fabrics are frequently found used together in the mid-late 17th century.

Bonding

There are two types of bonding. The thirteen courses beneath and level with the window sill are all essentially Flemish Bond (each course consisting of an alternate header and a stretcher). Those above the stone still replacement are in Old English Bond (alternate courses consisting of stretchers or headers). Flemish Bond only became common in the latter part of the 17th century and into the mid-19th century. Old English Bond was used between the 15th century and mid-late 17th century.

Comment on the date of the brickwork at St Lawrence Church

The overall fabric, bonding and form of the brickwork observed in the east elevation of the church are what would be expected in the construction of a 17th century church. Both red and maroon post-Great Fire bricks are frequently used together in the seventeenth century when both English bond and Flemish Bond are also in use.

The use of Flemish Bond in the lowermost 13 courses, essentially beneath the later post-medieval window sill replacement in Clipsham stone is also in keeping with the later 18th and 19th century rebuilds. As is the use of English Bond above the 13 courses as this would be in keeping with the relict 1635 primary fabric of this post-medieval church, undisturbed by later post medieval changes.

What is perhaps surprising are the inclusions of post-Great Fire bricks (post 1664) in Old English Bond (**Plate 6**) especially If the Old English Bond relates to the primary 1635 build[1], then these bricks must be later repairs. One further possibility was that the church was built in stages and that the far eastern end may have been added after the 1660s but there is no other evidence to support this.

Note: It would be worth examining, if practical, the bedding mortar in different areas of the brick walls surrounding the window to see if there are different mortars for different parts of the build. Samples could be examined in hand specimen under a binocular microscope and then compared to one another.

[1] Lysons' Environs of Surrey (1792) states it was built "about the year 1636". Victoria County History IV (1912) adds "A general collection was also ordered to be made in the year 1635; towards the rebuilding of the church". There no baptisms, marriages or burials that had taken place between October 1635 and April 1636,; seven months" (Bill Rudd pers. comm.). Which may indicate that the church was closed during the period of work was undertaken.

Plate 1 East window at St Lawrence Church, Morden

Plate 2 Blistering of Headington stone in the jamb of the east window

Plate 3a Close up of Headington stone in the jamb of the east window

Plate 3b Close up of Crinoid *Plegiocidaris florigemma* in north-east quoin of St Lawrence Church, typical of Headington stone (Upper Jurassic) Oxfordshire

Plate 3c Close up of echinoid *Nucleolites cluncularis* in north-east quoin of St Lawrence Church, typical of Headington stone (Upper Jurassic) Oxfordshire

Plate 4a Stone window sill in Clipsham stone

Plate 4b Close up of Clipsham stone

Plate 5 Taynton stone inset

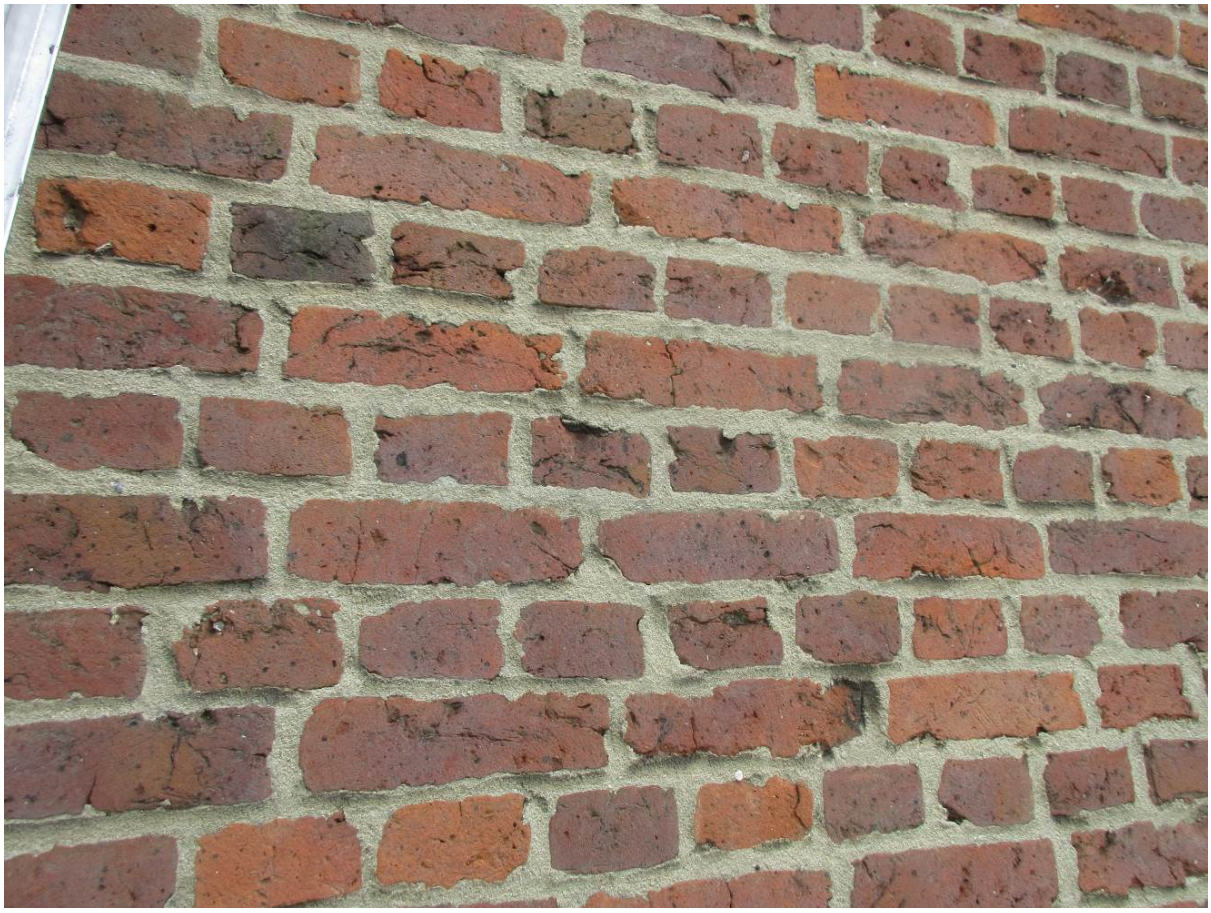

Plate 6 Post-Great Fire bricks in English Bond in the east elevation

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