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North Lodge to Heath House, Tean, Staffordshire

A petrographic assessment of reclaimed sandstone blocks with a view to their use in connection with planned refurbishment works

Building Stone Assessment:

The BGS Building Stone Assessment service combines geological expertise and building conservation expertise to provide authoritative advice to clients wishing to specify natural stone for repairing or building stone structures. Samples of stone supplied by clients are compared with samples from active quarries held in the BGS Collection of UK Building Stones to identify the closest-matching currently available stone(s). Using the closest-matching stone type in repairs to stone structures maximises the likelihood that the replacement stone will co-exist harmoniously with the 'original' stone and will weather sympathetically.

GeoReport ID: BGS_342180/59569/3

BGS sample number: ENQ20117

Client reference: Heath House – North Lodge

Date sample received: 28/03/2025 (sic)

Date commissioned: 24/02/2026

Date of report: 25/05/2026

Introduction

The North Lodge is a Grade II-listed structure (see HE List Entry Number: [1037928](#)) associated with the approach (originally the main carriage drive) to Heath House in Staffordshire. The building was constructed between 1830 and 1831, and thus slightly pre-dates Heath House itself (of c. 1836).

We understand that the North Lodge is to undergo general refurbishment, which will include “the reinstatement and repair of the existing ashlar to the rear elevation”. There is a consequent need to identify the closest-matching currently available stone(s). Use of the closest-matching stone type in connection with the planned works will maximise the likelihood that the replacement stone will co-exist harmoniously with the existing stone and will weather sympathetically.

BGS has previously examined samples representative of the existing ashlar masonry of the North Lodge and provided advice on the closest-matching currently available stones (see BGS GeoReport *BGS_342180/59569/1*). Subsequent to this, a pile of reclaimed (?)White Hollington stone blocks was found on the Heath House Estate (see Figure 1), which was presumably generated through the demolition of a structure somewhere nearby. Due consideration is being given to repurposing this material in connection with the North Lodge refurbishment project. BGS has therefore been asked to petrographically examine a sample of the reclaimed stone, identify it and comment on its suitability as a match for the existing North Lodge stonework.

This report summarizes the analytical work undertaken by BGS and briefly sets out our findings and conclusions.



Figure 1. Image showing the pile of reclaimed stone blocks found on the Heath House Estate. A sample of one of these blocks was supplied to BGS for analysis. © Donald Insall Associates.

Macroscopic description of supplied sample

The sample supplied for analysis, which was assigned the BGS sample number ENQ20117, consists of a single piece of moderately friable, variegated but predominantly dull greyish pink¹, cross-bedded sandstone with approximate maximum dimensions of 115 x 55 x 30 mm. Sporadic light grey mudstone intraclasts are present. The stone shows no discernible reaction with a dilute (10%) solution of hydrochloric acid (HCl), consistent with the absence of the carbonate mineral calcite. A simple qualitative water bead test indicates high permeability.

¹ Most similar to shades of 'pink' with hue 7.5YR on a Munsell® soil color chart.

Microscopic description of supplied sample

Sample preparation and examination

A thin section was produced from the supplied sample to enable petrographic analysis of the stone represented. The section was cut perpendicular to the inferred direction of the sedimentary bedding and prepared to a standard thickness of 30 microns (30 µm) by the staff of the thin sectioning laboratories at the BGS Headquarters (Keyworth) as follows:

- A representative portion of the sample was impregnated under vacuum with blue-dye resin before further processing in order to facilitate identification and description of the stone's pore space characteristics.
- The thin section was treated with a standard dual carbonate *alizarin red-S* and *potassium ferricyanide* chemical stain to help determine the composition of any carbonate minerals present. The staining differentiates non-ferroan calcite (pale pink) from ferroan calcite (mauve → purple → dark blue with increasing Fe-content), dolomite (no colour) and ferroan dolomite (pale to deep turquoise with increasing Fe-content).
- The thin section was also stained using sodium cobaltinitrite ('yellow-stain') to aid in the determination of the feldspar content.

Subsequent petrographic analysis (under both plane- and cross-polarized light) was undertaken using a Zeiss Axioplan 2 polarizing microscope equipped with a Zeiss digital imaging system. A number of thin section photographs (photomicrographs) were taken as part of this process.

Thin section description: ENQ20117

Notes describing each numbered item below (¹ etc.) are provided at the end of the report (see *Information about this Report*). See photomicrographs on page 5.

Stone constituents ⁵	Granular (detrital) constituents	Intergranular constituents	
	Quartz	40–45%	Silica (overgrowth) c. 1%
	Feldspar	15–18%	Feldspar (overgrowth) c. 1%
	Rock fragments	c. 12%	Carbonate 0%
	Mica	<< 1%	Iron/manganese oxide < 1%
	Opaque material	< 1%	Clay minerals c. 2%
	Other	<< 1%	Other (e.g. baryte) c. 1%
	Intragranular pores	10–12%	Intergranular pores 10–12%

Stone type ¹ (detailed classification): feldspathic-arenite

Stone fabric ⁴: weakly defined cross-lamination

Grain-size ⁶: fine-sand-grade to coarse-sand-grade

Grain sorting ⁷: moderately sorted

Grain roundness ⁸: angular to sub-rounded (occasionally rounded)

Stone permeability ⁹: high

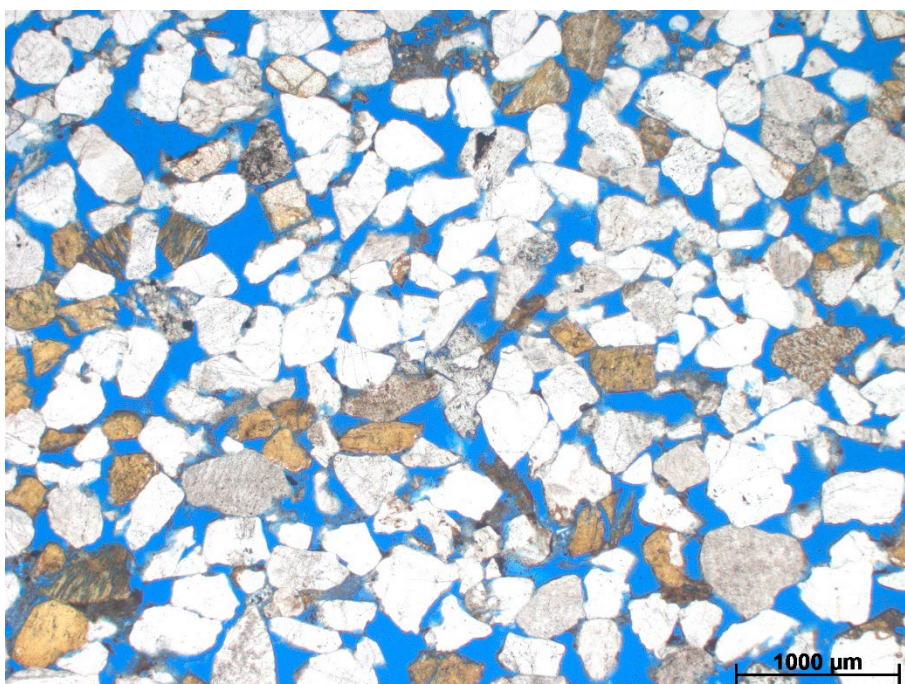
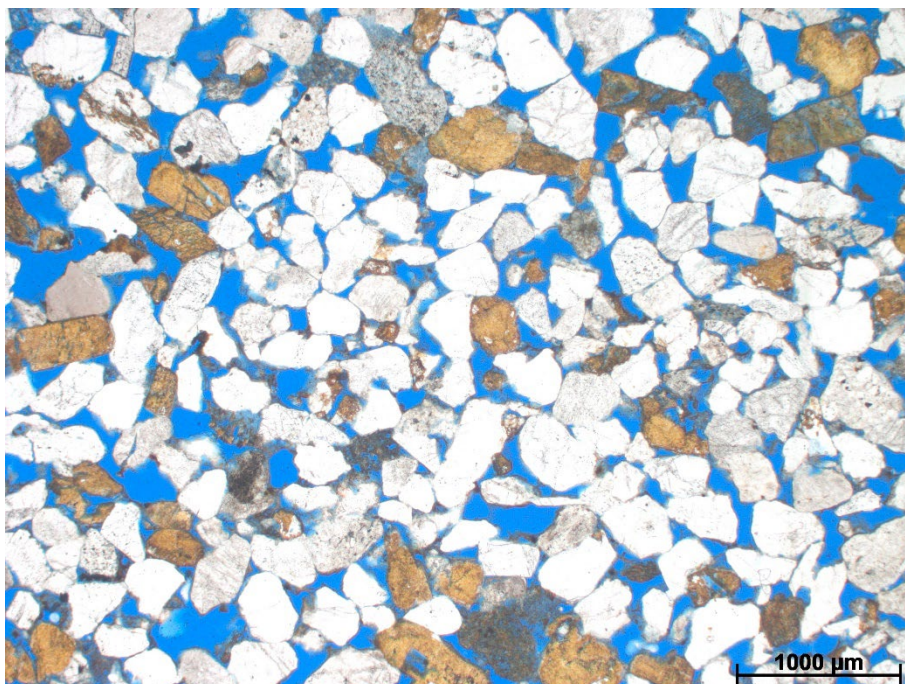
Cement distribution ¹⁰: silica cement isolated; feldspar cement isolated

Supergene changes ¹¹: alteration and dissolution of feldspar grains and chemically unstable lithic fragments

Distinctive features: occasional poikilotopic developments of baryte

Comments

- 1) The detrital quartz grains include mono- and poly-crystalline varieties and typically show undulose extinction. They have undergone a degree of compaction-related suturing, although quartz overgrowths have developed only sporadically and mostly to a limited extent. Illitic coatings are seen on some grains.
- 2) Feldspar is plentiful in this sandstone, and would originally have been more abundant. The grains have experienced alteration (to clays/micromicaceous material) and dissolution to a greater or lesser extent. A significant number of grains have been effectively removed altogether, leaving behind open, secondary pores; this has been taken into account in the detailed classification of the stone (see 'Stone type' above). The extant grains are chiefly potassic in nature (yellow-stained). Some of the grains have assumed a notably blocky form owing to the development of feldspar overgrowths.
- 3) The constituent lithic fragments are dominated by quartzitic and quartzofeldspathic debris (conspicuously so), but also include pieces of argillaceous/micromicaceous and arenaceous sediment (presumably equating to intraclasts). The more chemically unstable examples have been affected by alteration and/or dissolution.
- 4) Occasional, localised, poikilotopic developments of baryte are present, the largest of which has a maximum dimension of c. 2 mm.



Photomicrographs of ENQ20117. General views of the supplied sample at low magnification (plane-polarized light; scale as indicated). Quartz grains and quartzitic lithic fragments appear white or a finely speckled light grey. 'Fresh' potassic feldspar grains appear a variably uniform yellow, while altered feldspar grains appear brownish yellow or brownish grey. Iron oxide minerals and other 'opaques' appear black. The conspicuous (*high relief*), light grey 'patch' seen just below centre in the lower image is baryte. Pore space appears sky blue.

Conclusions

Source of the sandstone represented by sample ENQ20117

Our assessment of the source of the stone represented by the supplied sample, in terms of bedrock geology, bedrock age and quarry, is summarized below. The letters D (definite), L (likely), P (possible) and NK (not known) indicate the level of confidence attached to the assessment. Identification of the bedrock unit is based on the similarity of the stone sample to reference specimens of that unit held in the BGS Petrological Collections (which include the National Building Stones Collection).

Bedrock unit:	Helsby Sandstone Formation	L
Age:	Middle Triassic (Anisian, c. 247–241.5 Ma)	L
Quarry area:	Staffordshire (Hollington–Churnet Valley)	L
Quarry name:	Various possibilities	NK
Quarry status:	Only one quarry is currently active	

Additional comments on source

The characteristics of the sandstone represented by sample ENQ20117 are indicative of a Triassic bedrock source, more specifically the **Helsby Sandstone Formation** (part of the Sherwood Sandstone Group). Helsby Sandstone Formation strata are not present in the immediate vicinity of the North Lodge/Heath House, but do occur in the broader local area – most notably around Hollington and along the Churnet Valley near Alton. Both the Hollington and Alton outcrops of the ‘Helsby Sandstone’ have an associated history of building stone production (as revealed by records held in the BGS Database of Mines and Quarries, *BritPits*), and we suspect that the source lay in one of these two areas. Unfortunately, there is nothing sufficiently diagnostic about sample ENQ20117 in terms of its mineralogy and texture to enable its actual quarry of origin to be pinpointed.

We note that sample ENQ20117 is closely similar in overall character to samples examined previously from the North Lodge and from Heath House itself (see BGS GeoReport *BGS_342180/59569/1*). It is entirely possible that the sandstone used for the various C19th buildings on the Heath House Estate had a common origin, at least in terms of quarrying area.

Suitability of the sandstone represented by sample ENQ20117 as a match for the existing sandstone of the North Lodge

As noted above, the sandstone represented by sample ENQ20117 is closely similar in overall character to the sandstone masonry of the North Lodge (as represented by samples previously supplied to and examined by BGS), and a common origin for these sandstones is suspected. How close the macroscopic colour of the reclaimed sandstone blocks is to that of the existing sandstone masonry is hard to fully assess based on the small samples we have been able to examine directly, but images provided to us by

Donald Insall Associates would suggest a similarity. To all intents and purposes, then, the reclaimed sandstone blocks found on the Heath House Estate offer a like-for-like match for the existing sandstone masonry of the North Lodge, and we can see no obvious reason for 'incompatibility' problems arising from the use of the reclaimed sandstone blocks in connection with the North Lodge refurbishment project. Careful vetting of the blocks by a stonemason will nonetheless be vital to ensure that they do not carry fractures or other structural defects beyond the scope of this assessment that could potentially compromise their performance under load, for example.

Please also note the following:

Mortar plays an important role with respect to the free movement of moisture and air through stonework. It will be important, therefore, to use a permeable mortar (e.g. lime mortar, which ideally should be at least as permeable as the 'original' stone), as well as a compatible replacement stone, in any repair, to increase the chances of a long-lasting, successful outcome. Portland cement, which is essentially impermeable, should not be used as mortar in stonework.

Do not hesitate to contact us for further advice if required.

Dr Steve Parry
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25 May 2026

Information about this Report (cont.)

A BGS Building Stone Assessment is usually performed in three stages.

(i) The sample of 'original' stone (usually supplied by the client) is first subjected to a detailed petrographic examination, to establish the range and character of its intrinsic properties.

(ii) The range of properties is then compared with those of stone samples held in the BGS Petrological Collections, to constrain the source of the stone. Historical records and other forms of documentary evidence, if available, and the likelihood that the stone was sourced locally or 'imported', are also taken into account.

(iii) Finally, the closest-matching currently available stone(s) are identified. If the quarry from which the stone was sourced originally has been identified and is still open, it will usually provide the closest-matching stone. If the quarry from which the stone was sourced originally has not been identified, or is closed, the closest-matching currently available stones are identified by comparing the properties of the 'original' stone with those of samples of currently available stones held in the BGS Collection of UK Building Stones.

Comparing stone properties to identify the source and/or the closest-matching stones is known as stone matching.

Stone matching

Where possible, the source (quarry and bedrock unit) of the 'original' stone is determined by comparing it with samples held in the BGS Petrological Collections; historical records and other forms of documentary evidence, if available, and the likelihood that the stone was sourced locally or 'imported', are also taken into account, if appropriate. Many thousands of quarries in the UK have supplied building stone in the past, and in many instances it is not possible to relate a stone sample back to one particular quarry or bedrock unit.

Where the source cannot be identified unambiguously, the closest-matching currently available stone(s) are identified by comparing the intrinsic properties of the 'original' stone with those of similar stones that are currently being supplied by quarries in the UK.

The following factors are taken into account when comparing an 'original' stone with a potential replacement stone.

- 1) *Mineral and textural features* – ideally, these should be as similar as possible in the replacement stone and 'original' stone, to increase the likelihood that the two stones will respond in similar ways and at similar rates to the various physical and chemical processes associated with weathering, and will therefore co-exist harmoniously. Replacement stones are selected to match the 'original' stone in its fresh (rather than weathered/decayed) state, unless otherwise requested.

- 2) *Permeability* – ideally, the replacement stone and ‘original’ stone should have similar permeability characteristics, thereby minimising the degree to which fluid (water and air) migration between adjacent blocks of ‘original’ and replacement stone might be impeded. Accelerated stone decay can occur where fluid migration is impeded.
- 3) *Appearance* – for aesthetic reasons, the replacement stone and ‘original’ stone ideally should look similar to the unaided eye in terms of colour and stone fabric at the time the repair is made. However, the closest-matching stones in terms of the properties that govern weathering performance (mineral-textural features and permeability) are not necessarily the closest match in terms of appearance. A repair using stone selected primarily because it is the closest match in terms of appearance may look good initially but could quickly show signs of decay or of being incompatible with the ‘original’ stone. For that reason, priority is generally given to the properties that govern weathering performance, thereby maximising the likelihood of long-term compatibility of the ‘original’ stone and replacement stone. A degree of compromise may in some cases be desirable and acceptable if the closest-matching stones in terms of ‘weathering properties’ are not a close match in terms of appearance. Immediately following repair, the fresh surfaces of a stone insert or indent will usually contrast in appearance with the soiled or discoloured surfaces of adjacent ‘original’ masonry, but if the ‘weathering properties’ of the two stones are a good match the new stone should blend in over time and the contrast should become less obvious.
- 4) *Functional and performance requirements* – specific functional and performance requirements of a replacement stone are taken into account if requested. For example, if the ‘original’ stone performed a load-bearing role, the choice of matching stones should include only those that are at least as strong; and if the ‘original’ stone was carved or shaped in a particular way, the choice of matching stones ideally should include only those that can be carved or shaped in a similar way, with a similar level of detail and quality of finish.

One or more replacement stone types are proposed taking these factors into account.

Information about this Report (cont.)

Sample examination and petrographic description

A macroscopic examination of the sample is performed both with the unaided eye and using x10 magnification hand lens. A microscopic examination is performed on a petrographic thin section, using a polarizing microscope. Observations from these examinations are recorded in a systematic manner and included in the relevant section of the report. One or more images (photomicrographs) illustrating the typical character of the stone as it appears in thin section are provided. Each numbered

note that follows relates to a superscript number in the *Microscopic description of supplied sample(s)* sections of the report.

- 1 The determination of stone type follows the classification and nomenclature of the BGS Rock Classification Scheme.
- 2 The 'visual' determination of stone colour is based on a simple assessment with the unaided eye in natural light. The determination of stone colour is made on a broken (not sawn), dry surface.
- 3 A simple, non-quantitative assessment of the degree to which the stone is cohesive. This property is recorded in terms of four conditions, each representing one segment of a continuum: *strongly cohesive*, *moderately cohesive*, *moderately friable*, and *very friable*. The grains in a *strongly cohesive* stone cannot be disaggregated by hand, whereas the grains in a *very friable* stone can be readily disaggregated by hand.
- 4 A record of whether the distribution of granular (detrital) constituents in the sample is essentially isotropic (uniform) or anisotropic (non-uniform). The type of anisotropic fabric is recorded.
- 5 A record of the identity and relative proportions of all granular (detrital) and intergranular (authigenic materials and pore space) constituents currently in the stone. The proportions are estimates, expressed in %, which are based on a visual assessment of the whole thin section area.
- 6 The terms are those used for grain-size divisions in the BGS Rock Classification Scheme.
- 7 A simple, non-quantitative assessment of the degree to which detrital constituents display similarity in terms of physical characteristics (in particular the size and shape of grains).
- 8 A simple, non-quantitative assessment of the degree to which detrital constituents are abraded.
- 9 A simple, non-quantitative assessment of stone permeability, presented as one of five conditions (*very low*, *low*, *moderate*, *high*, *very high*) expressed relative to a nominal 'average' permeability in building stone sandstones. The assessment is based on: (i) a water bead test; (ii) the proportion of pore space in the stone; (iii) a visual assessment of the degree to which pore spaces appear connected in the thin section.
- 10 A record of the type and extent of authigenic mineral cement that acts to bind detrital grains, as observed in thin section. *Isolated* means the cement occurs in discrete locations (e.g. as overgrowths on individual detrital grains) that are typically not connected in the plane of the thin section. *Discontinuous* means the cement is formed in patches, each of which typically encloses several to many detrital grains. *Continuous* means the cement is more-or-less connected across the thin section.
- 11 A record of the evidence observed in thin section for mineral alteration that occurs in the stone when it is near the ground surface. Such alteration processes typically begin before stone is quarried, but some may continue, or be initiated, after stone is extracted from the ground.

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