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Bath Stone and Purbeck Stone: A comparison in terms of criteria for Global Heritage Stone Resource Designation

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Two limestone resources from the Mesozoic strata of south-west England, Bath Stone and Purbeck Stone, are compared in terms of criteria proposed for designation of Heritage Stone Resources. Both have been used locally for some 2000 years and have had significant wider use in the past 350 years. Bath Stone has been used widely in the UK and to some extent elsewhere. Its use throughout the city of Bath provides an overall architectural integrity that contributed to it achieving World Heritage City status. Purbeck Stone, with the exception of a variety known as “Purbeck Marble”, has been mainly used locally. It was used to build several structures now designated as Ancient Monuments but Purbeck Marble has been used extensively for interior ornamental work in many ancient and important buildings. Bath Stone has been widely recognised as a “cultural icon” but there is less awareness of Purbeck Stone. Both are still quarried, and have an assured future, subject to continuing demand. However, for both, Heritage Stone Resource designation might help to reinforce their status. Overall, the case for designation of Bath Stone appears to be stronger than that for Purbeck Stone.

Introduction

Criteria for designating Global Heritage Stone Resources (GHSR) and Global Heritage Stone Provinces (GHSP) have been developed by the Heritage Stone Task Group (HSTG) of IUGS and Commission C-10 of IAEG (Cooper, 2014). These can be summarized as:

a) historic use for a significant period;
b) wide-ranging geographic application;
c) utilisation in significant public or industrial projects;
d) common recognition as a cultural icon;
e) ongoing quarrying and availability; and
f) providing potential benefits (cultural, scientific, environmental and/or commercial).

It is important to test the criteria for designation of GHSR using real examples before any stones are formally considered for designation to establish whether any modifications of clarifications of the criteria are needed (Marker, 2014). With those criteria in mind, this paper compares two limestone resources from the Mesozoic of England: Bath Stone and Purbeck Stone.

Bath Stone

The Middle Jurassic strata of England contain several major horizons of oolitic and bioclastic limestones that have long provide high quality freestones for construction locally as well as for prestigious buildings through much of southern England or more widely. One of the most important is found in south-west England in an area between the City of Bath and the town of Corsham.

The Great Oolite Group (Upper Bathonian) consists mainly of limestones interbedded with clays and includes two important freestone horizons, the Combe Down and Bath Oolites. These are known commercially as Bath Stone but the term has also been used generally for some other oolites from the southern part of the Jurassic “stone belt”. Bath Stone (sensu stricto) consists mainly of current bedded and/or shelly oomicrites that are white, pale cream or buff. They are readily workable on extraction but weather to an attractive honey colour and toughen on exposure (Geddes, 2011; King, 2011). Some technical properties are summarized in Table 1. The stone is suitable for a wide range of uses including masonry, retaining walls, ashlar, cladding, columns, lintels, copings,

| Table 1: Bath Stone – some technical properties |
|-----------------------------------------------|
| Property                                      | Value(s) |
| Bed height                                   | 20-160 cms |
| Length                                       | 80-350 cms |
| Block size                                   | 0.2-2.8 m³ |
| Porosity (CEN) by volume                     | 23.4 – 26.1% |
| Saturation coefficient (BRE141)              | 0.80-0.83 |
| Water absorption by weight                   | 9.02-10.9% |
| Bulk specific gravity                        | 2066kg/m³ |
| Density (BSEN 1936)                          | 2010kg/m³ |
| Compressive strength                         | 15.0-24.6 MPa |
| Flexural strength (CEN) dry                  | 3.7-4.1 MPa |
| Thermal conductivity (BSE12524)              | 1.50kg³ |

Sources: Hanson Bath and Portland Stone plc and The Bath Stone Group plc
thresholds, paving, flooring, fireplaces, carvings, mouldings and sculpture.

From late 1st century AD a Roman city was constructed around thermal baths (almost unique in the United Kingdom) and Bath Stone was used for the major municipal buildings. The City fell into decay after the Romans left in the early 4th century AD and the remains of their settlement now lie at depths of 3-5m (Cunliffe, 2000). Following the Norman Conquest in 1066AD nearby religious and defensive buildings and transport infrastructure were built from Bath Stone, including an important abbey and cathedral, but most other buildings still consisted of wood, wattle and daub. In later medieval times, prosperity based on the wool trade supported the construction of prestigious stone houses in the vicinity of Bath. But reduction of trade due to competition from elsewhere led to decline and, by the early 17th century, Bath remained essentially a small walled city with poorly maintained buildings mostly built of wood (Hudson, 1971).

In the early 18th century the thermal baths became popular as a resort for the wealthy and famous leading to a revival of the economy of the city and a building boom. Extensive redevelopment took place from about 1727 at a time of increasing interest in Roman and Greek culture and antiquities and attracted important British architects, notably John Wood, his son also named John, John Eveleigh and Robert Adam (Colvin, 1997). John Wood the elder worked in Palladian style while John Wood the younger perfected English Georgian style. They worked mainly in Bath Stone from underground mines operated by Ralph Allen at nearby Combe Down and Bathampton Down (Perkins et al. 1983; Price, 1984; Willies et al. 2011). Some major achievements were the Thermal Baths and a Mineral Water Hospital (founded in 1738) now the Royal National Hospital for Rheumatic Diseases; Queen Square (commenced in 1739); Pultney Bridge based on the Rialto Bridge in Venice (1770); and the spectacular Royal Crescent (1767-1774) (Forsyth and Bird, 2003; Hudson, op.cit.). Some examples are shown in Fig. 1. A less important structure, Trim Bridge, contained the office of canal engineer and pioneer geologist William Smith from 1802 to 1804 (Torrens, 2003). Indeed, Smith’s 1799 map of the vicinity of Bath is believed to be the earliest map accurately showing strata in an ordered stratigraphical sequence (Hobbs and Jenkins, 2008). The opening of the Kennet and Avon Canal connecting the Rivers Avon and Thames stimulated wider use of the stone.

The popularity of Bath as a resort continued among the rich and famous into the early 19th century but it gradually fell out of favour by the mid 19th Century except for visitors to the spa for health reasons (Eglin, 2005). In 1871 a new King’s Bath was built during which the remains of the Roman spa were rediscovered and partly incorporated into the new baths. However economic decline led to poor maintenance of many buildings and all became discoloured by smoke from coal fires. Extensive bomb damage was suffered by buildings, particularly near the Abbey, in 1941. After 1945, there were plans to redevelop the damaged areas but also, in the interests of urban renewal, to replace large areas of the less prestigious buildings and some were demolished. By the 1960s this led to a major national campaign for

Figure 1. Examples of the use of Bath Stone in the City of Bath. (a) Queen Square, Bath, (b) Royal Crescent Bath, (c) Pultney Bridge, Bath, (d) York street, Bath with the Victorian surroundings to the Roman Baths to the left.
preservation of the city (Ferguson, 2011). From the 1970s onwards, extensive repair, renovation and cleaning of buildings took place. Local authority planning policies required new buildings to be faced with Bath Stone to be compatible with their surroundings. The widespread use of this stone gives the City an architectural integrity that partly led to its designation as a World Heritage City. Bath is now a major tourist destination.

Bath Stone was used more widely in England contributing to numerous major historic buildings of which a few are: the Royal Pavilion (1812) in Brighton; civic buildings such as Bristol Guildhall (1843); the Dartmouth Naval College (1905) in Devon; churches and cathedrals such as Truro Cathedral (1880) in Cornwall; engineered structures, notably the large Dundas Aqueduct (1795) on the Kennet and Avon Canal; major palaces and mansions such as Buckingham Palace and Apsley House (1828) in London and Gatcombe Park (1771-1774) and Tyntesfield (1860s) in Somerset; and early railway stations and structures including parts of Temple Meads Station, Bristol, built for Isambard Kingdom Brunel’s Great Western Railway (1839-1841). Some examples are shown in Fig. 2. More widely, Bath Stone has been used in Union Station in Washington DC; Toronto Bible College; the Town Hall at Cape Town, South Africa as well as recent development at Turkey Creek, Dallas, USA and the Waterford Medieval Museum in the Irish Republic.

Over the years the city grew across the stone mines operated by Ralph Allen and these have sometimes presented subsidence problems. This led to a shift of extraction in both quarries and mines to the east of Bath notably at Limpley Stoke to the east of Bath and around the village of Box in the neighbouring county of Wiltshire. From the late 1930s until relevantly recently many of the underground workings were commandeered for military use which limited the potential; for further extraction (Hawkins, 2011; Tye and Muir, 2012). Reserves permitted for extraction in both local planning authority areas are substantial and resources are extensive so the stone will be accessible in the long term. There is steady demand for stone for maintenance and repair of structures but also for new building in compatible materials so the future of the industry seems secure (North Somerset Local Authority, 2007; Wiltshire County Council, 2001).

Purbeck Stone

The Purbeck Group of uppermost Jurassic to lowermost Cretaceous age (Tithonian- Berriasian) outcrops mainly in the Purbeck and Portland areas of Dorset, England. The succession consists largely of thinly bedded limestones, mudstone and calcareous clays which were deposited in shallow freshwater to brackish lagoons with occasional marine incursions (Ensom and Turnbull, 2011). Most of
the usable limestones are collectively known as Purbeck Stone but the succession also contains an unusual type of limestone known commercially as Purbeck Marble.

Limestones, mainly biosparites that are thick enough to be useful occur at six main levels. Some technical properties are shown in Table 2. Colours vary from almost white to shades of brown and bluish grey and textures from smooth to fairly rough. The fairly thin bedding places limitations on the range of uses but the variations in thicknesses make individual beds suitable for different purposes including dimension stone, monumental and ornamental stone, roofing tiles, paving and flooring and rockery stone for garden features (Pennell, 2012).

Purbeck Stone has been extracted to some extent at least from Roman times (1st century AD) but fell into disuse when the Romans withdrew from Britain in the early 4th century. Following the Norman conquest of England in 1066AD there was an upsurge in stone building. There was a revival in the medieval period especially in the 12th to 15th centuries (Leach, 1975). Quarrying expanded greatly from about 1700 reaching a peak in the late 18th and 19th centuries (Stannier, 1996). The stone was initially used locally or was transported by sea principally to ports on the south and south-east coasts of England. Local use gave an important element of local character to villages and towns many of which are now regarded as

| Table 2. Purbeck Stone – technical properties |
|---------------------------------------------|
| Property                     | Value(s)       |
| Bed height                  | 20-80 cms      |
| Length                      | 80-120 cms     |
| Block size                  | 0.2-2.8m³      |
| Porosity (EN1341) by volume | 8%             |
| Saturation coefficient (EN1341) | 0.77         |
| Water absorption by weight | 2.43%          |
| Density (BSEN 1936)         | 2.24-2.56      |
| Bulk specific gravity       | 2498 kg/m³     |
| Compressive strength (EN1342) | 98.2 MPa    |
| Flexural strength (EN1341)  | 11.5 MPa       |

Source: Building Research Establishment for Purbeck “Spangle Bed”

Figure 3. Examples of the use of Purbeck Stone in the Purbeck area. (a) Village of Worth Matravers, (b) Langton Matravers Parish Church, (c) Chapel at St. Aldhelm’s Head, (d) font in the parish church at Kingston – upper part of Purbeck Stone and lower part of “Purbeck Marble”

Figure 4. Interior use of “Purbeck Marble” and weathering on exposure at Lincoln. (a) dark coloured pillars of polished “Purbeck Marble” in Lincoln Cathedral. (b) similar pillars of “Purbeck Marble” exposed to weathering in a ruined section of the Bishop’s Palace, Lincoln.
has largely been replaced in outside situations (Benfield, 2011, op. cit.) was found to weather badly in northern and exposed positions and slabs. It was used formerly for both interior and exterior purposes but (Fig. 4). Use of Purbeck Marble declined until the 19th century when working was revived for church widespread restoration (Clifton-Taylor, op.cit.). In the 13th century it was used for a time in effigies and memorial floor slabs. It was used formerly for both interior and exterior purposes but was found to weather badly in northern and exposed positions and has largely been replaced in outside situations (Benfield, op. cit.) (Fig. 4). Use of Purbeck Marble declined until the 19th century when working was revived for church widespread restoration (Clifton-Taylor, op.cit.). Outputs of Purbeck Stone are from few hundred tonnes to a few thousand tonnes per annum meet the continuing demand for repair and maintenance of historic structures and building in locally compatible styles. About 9 to 12 years of permitted reserves remain but only 1 quarry still produces Purbeck Marble. It is not easy to find new sites for future quarrying in south Dorset because potential extraction sites are in an Area of Outstanding Natural Beauty (Bristow et al., 2002). But the Planning Authority recognises quarrying as a traditional industry of the area and has policies requiring repair, maintenance and new building using local stone in conservation areas (Dorset County Council, 2013). The quarries are also geologically significant and are close to the internationally significant Jurassic Coast World Heritage Site.

But Purbeck Stone is not limited to the Purbeck area. It occurs also on the nearby Isle of Portland. The Purbeck Group immediately overlies the Portland Stone which was formerly extracted for building conservation areas. Some examples are shown in Fig. 3. From the mid 19th century rail transport promoted wider use within the UK. Initially the stone was taken from quarries but was later mined. However, the number of operating companies declined from 15 to 5 over the past 40 years, leaving only 10 active small quarries (Benfield, 2011).

Near the top of the sequence is an unusual dark grey to greenish or bluish easily carved gastropod biosparite known as “Purbeck Marble”. This was used in Roman times but also from the time of the Norman Conquest, particularly in narrow stone columns known as shafts, and was the most widely used British decorative stone in both periods (Clifton-Taylor, 1972; Haywood, 2009). By the 12th Century it was widely employed for ornamental and decorative purposes especially in churches and cathedrals for fonts, tombs, flooring and facings on columns, for example in the Medieval cathedrals of Salisbury, Exeter, Durham, York, Wells, Lincoln and Worcester as well as in Westminster Abbey in London (Clifton-Taylor, op.cit.). In the 13th century it was used for a time in effigies and memorial floor slabs. It was used formerly for both interior and exterior purposes but was found to weather badly in northern and exposed positions and has largely been replaced in outside situations (Benfield, op. cit.) (Fig. 4). Use of Purbeck Marble declined until the 19th century when working was revived for church widespread restoration (Clifton-Taylor, op.cit.).

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But Purbeck Stone is not limited to the Purbeck area. It occurs also on the nearby Isle of Portland. The Purbeck Group immediately overlies the Portland Stone which was formerly extracted for building stone in both areas but is now only worked for aggregate in Purbeck. There is a strong case for designation of Portland Stone as a GHSR (Hughes et al., 2013) but a weaker case in respect of Purbeck Stone. However the juxtaposition of both raises the possibility that the two, together, might constitute a Global Heritage Stone Province.

| Criteria                              | Bath Stone                                      | Purbeck Stone                                   |
|---------------------------------------|-------------------------------------------------|-------------------------------------------------|
| Historic use for a significant period | Major use for about 350 years but locally for about 2000 years | Significant use for over 350 years but locally for about 2000 years |
| Wide-ranging geographic application  | Widespread use in the UK and some use elsewhere | Mainly local use – “Purbeck Marble” more widespread |
| Utilisation in significant public or industrial projects | Major use in a World Heritage city and many other designated ancient monuments and historic buildings | Mainly small scale but includes some designated Ancient Monuments. “Purbeck Marble” used for ornamental purposes in many major buildings. |
| Common recognition as a cultural icon | Widely recognised                                | Less widely recognised with the exception of “Purbeck Marble” |
| Ongoing quarrying and availability    | Currently quarried and future assured subject to continuing strong demand | Currently quarried and future assured subject to continuing moderate demand |
| Potential benefits (cultural, scientific, environmental and/or commercial) | Reinforcement of present status                 | Reinforcement of present status                 |

### Discussion and conclusions

Both Bath and Purbeck Stone have been used for about 2 millenia, initially in Roman times but mainly since the 16th century, and were major extractive industries in the 18th and 19th centuries. Both are of heritage significance with continuing supplies being needed for repair and maintenance of important buildings as well as building in locally compatible styles. Both are high quality stones. They are still extracted and the future of their extraction seems to be secure but much of the demand is for sporadic repair and maintenance contracts while, to be economically viable, extractive operations also depend on contracts for new building to give steadier levels of sales. A comparison with GHSR criteria is in Table 3. Bath Stone has been used for many major buildings designed by noted architects particularly around Bath but also widely through England and to some extent overseas. It contributed strongly to the case for designating the City of Bath World Heritage Site. In contrast, Purbeck Stone had significant local use for more modest structures although many of these are now collectively recognised as being worthy of conservation. However the unusual “Purbeck Marble” has had exceptional use for ornamental and artistic works in historic buildings and might be regarded as more significant than Purbeck Stone in general. The obvious conclusion is that there is a stronger case for designating Bath Stone as a GHSR.

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