THE BUILDING STONES OF SOUTH EAST ENGLAND; MINERALOGY AND PROVENANCE

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Abstract

The South East of England (London, Kent, Sussex, Surrey and Hampshire), is characterized by a range of distinctive, traditional vernacular buildings. Stone from the local strata, which ranges from Late Jurassic to Palaeogene in age, has been widely used throughout the area for building purposes (footings, walling, roofing) and was also frequently imported into London, which itself has no building stone resource of any significance cropping out within its boundaries. Determining the provenance of some of these stones, away from their local context, however, can be difficult, but is greatly facilitated by studying their mineralogy, textures and fabrics under the microscope.

Keywords: England, Lower Cretaceous, Petrography, Building Stone,

Introduction

The South East of England area (Kent, Sussex, Surrey and Hampshire) is well known for its extensive stock of traditional vernacular buildings. These buildings incorporate a wide range of local building materials including wood, brick and stone. Stone, in particular, is widely used throughout the area as footings, walling and roofing material in many local buildings. Stone was also extensively imported into the City of London which has no building stone of any significance cropping out within its boundaries.

The building stones that were worked and used in vernacular buildings were all sourced from local rocks ranging from Late Jurassic to Palaeogene in age. Without, however, considerable and wide ranging local experience in their study, they are often difficult to distinguish one from another in a building. This is particularly so when they are found for example in isolation in a London building or at an archaeological site when outside their normal geological context and sphere of influence. There is an ongoing need to identify and the source these stones in support of both current conservation repair work, and to encourage new build in the area that is in keeping with the local vernacular styles. Currently only a small number of building stone quarries are operating in South East England and there would clearly be an obvious benefit in identifying further original stone quarry sources that might be re-established to maintain the existing historic building stock and encourage their use in new building projects.

Petrographic studies are particularly important in the process of identifying many of these stones, which include both sandstones and limestones, enabling their original quarry provenance to be more readily determined. The aim of this paper, therefore, is to illustrate, using a selection of thin section images from the building stones of the area, the different mineralogical and textural characteristics that can be used to distinguish them under the microscope.

1. The geological succession in South East England (Table 1; Figure 1)

1.1 Purbeck Limestone Group (Late Jurassic)

Occupying the core of the anticlinal structure, known as the Weald, are a series of small inliers extending from Heathfield to Battle, which expose about 100 metres of thinly interbedded, fossiliferous limestones (up to 0.50 metre thick beds) and mudstones of Late Jurassic age. The limestones, which contain the fossil bivalves *Cyrena sp*. and *Ostrea* sp., principally occur in two beds, were used locally as a source of building stone (Topley 1875; Osborne-White, 1928; Bristow & Bazley 1972). These fossiliferous limestone beds were significantly distinctive enough to be given individual names by the quarrymen, but there is as yet no evidence that they produced decorative, fossiliferous marbles comparable to their more famous equivalents in Dorset.

1.2 The Lower Cretaceous succession

The Lower Cretaceous succession of the area is divided into two distinct lithological intervals, a lower non-marine sequence, the Wealden Group, and an upper interval of marine sediments comprising the Lower Greensand Group and Gault/Upper Greensand formations. This simple division into non-marine and marine sediments provides one of the key elements in identifying the principal petrological differences in the building stones of the area.

1.2.1 Wealden Group

The Wealden Group comprises four formations each of which has lithological units sufficiently hard and durable enough to have yielded local building stone (Table 1). The basal formation of the group is known as the Ashdown Formation. It comprises a moderately thick (200 m maximum) interval of buff, fine-grained, non-calcareous, cross-bedded sandstone. There is widespread evidence of the non-marine nature of the succession, notably in the form non-marine bivalve casts, lignite and plant fragments. The sandstone beds in this formation are thick and yielded large stone block. At outcrop the sandstone is exposed in a series of prominent scarps in the axial core of the Weald anticline.

Conformably overlying this basal sandstone unit is the Wadhurst Clay Formation that consists of dark grey mudstone with thin beds of calcareous sandstone, shelly limestone and ironstone. However, thin, blue-grey, fine grained, calcareous sandstone ‘doggers’, known locally as Tilgate Stone, comprising beds c1m in thickness are also present and were extensively quarried predominantly for building stone along the whole of their outcrop. In the Hastings area their hard intractable nature lead to the use of the local term ‘Hastings Granite’. The presence of non-marine shell beds and ironstone units (the basis of an extensive pre-18th century Wealden iron industry) again emphasises the non-marine character of the formation.

A return to sandstone-dominated lithologies occurs in the overlying Tunbridge Wells Sand Formation. The non-marine sandstones of this formation are similar in character to those of the basal Ashdown Formation. Confusingly, the unit is also locally known as Ardingly Sandstone (Table 1). They comprise predominantly fine grained, cross-bedded, non-calcareous sands which are thickly bedded – termed ‘Sandrock’. Locally, there are some coarse grained pebbly intervals in the succession. Former quarries in this succession produced relatively large stone block sizes. The sandstone outcrop again forms numerous local scarps and crags and is up to 45 m thick in the vicinity of Royal Tunbridge Wells. Within the formation a thin mudstone interval – the Grinstead Clay - includes hard, carbonate-cemented sandstones, petrographically similar to the ‘Tilgate Stone’ known locally as Cuckfield Stone that were widely used locally for building.

Completing this non-marine Wealden Group succession is a thick mudstone dominated interval known as the Weald Clay Formation. Within this formation, which reaches up to 450 m around Guildford, there is a locally important thinly bedded sandstone unit known as the Horsham Stone. Unlike the more massively bedded sandstones in the underlying strata, this stone’s principal attribute was its thinly bedded character. This enabled the sandstone to be easily split into slabs thin enough to be dressed for roofing ‘slate’ or used as paving slabs. This fine-grained, calcareous sandstone is best developed around Horsham where it reaches 9 m in thickness (Hughes 2003). The non-marine nature of theses sandstones is emphasised by the common presence of lignitic plant fragments on some bedding planes.

The Weald Clay succession also includes a number of thin, fossiliferous limestones which formed part of a once locally important decorative stone industry similar to the Purbeck Marble industry of Dorset, though on a much smaller scale. These fossiliferous limestones were quarried at a large number of small pits across the Weald Clay outcrop and consequently have a variety of local ‘trade’ names including Sussex Marble, Bethersden Marble, Petworth Marble, Laughton Stone and Charlwood Stone. It has been claimed that at Kirdford, slabs of the marble up to 0.9 m thick and 2.1m long have been extracted in the distant past. Commonly, however, the limestones are rarely more than 0.15 m thick. In the geological literature the limestones are commonly termed Large- or Small-Paludina limestones, depending on the size of the gastropod fossils they contain. The term ‘Paludina’ is an historic term referring to the dominance of the freshwater gastropod *Viviparus* in the limestones. The large Paludina variety contains the gastropod *Viviparus sussexianis* (up to 25mm long axis) the small Paludina yields *Viviparus elongates* (c.15mm long). Other limestones occur within the succession, which are composed wholly of the bivalve *Filosina gregaria*

('Cyrena' limestones). The limestones range from shell fragmental types in which much of the shell debris is broken and fragmented to the units that include abundant uncompacted, whole gastropod shells. The latter limestones were usually the ones preferred for marble production.

1.2.2 Lower Greensand Group and Upper Greensand / Gault formations

A marked change in the depositional setting of the Weald area is reflected in a rapid change to marine dominated sedimentation, represented over much of the area by a thin mudstone unit known as the Atherfield Clay Formation. The marine transgression transformed the area from a low-lying, non-marine, lacustrine environment into a shallow marine embayment. The succeeding succession is still dominantly an alternation of sandstones, mudstones and limestones but their mineralogy and fossil assemblages clearly reflect these regional environmental changes. This interval comprises five formations, three of which have yielded locally significant building stones.

The basal unit is the Atherfield Clay Formation that is dominated by mudstones and does not contain any intervals suitable for building stone production. Conformably overlying this unit, however, is the Hythe Formation that is probably the most important interval in the succession in terms of building stone resources in the area, as it includes the Kentish Ragstone and its many local equivalents.

The Hythe Formation comprises a succession that shows considerable lithological variations, both vertically and laterally, across its outcrop area (Worrsam & Tatton-Brown 1993). The unit reaches a maximum thickness of 91 m near Farnham. Its dominant lithologies are limestones, sandstones (calcareous and non-calcareous) and a spectrum of hybrid lithological variants of these two end members. The individual beds suitable for building purposes are relatively thin (up to 0.90 m), and locally the succession comprises alternations of hard, bioclastic limestone (Ragstone) with poorly cemented sandstones (known locally as Hassock). Mineralogically both these grey to greenish, fine- to coarse-grained lithologies are most commonly characterised by the presence of the green, iron silicate mineral glauconite, which is ubiquitous in the succession. The proportion of this mineral present is significant in terms of its use as building stone as it is transformed by oxidation during weathering, from vivid green to softer yellow, brown and sometimes reddish colours. Also commonly found in the succession are hard, nodular chert (silica-cemented) beds sometimes containing sponge spicules. Brown, layered, chert bands are occasionally seen in wall fabrics. Across the Hythe Formation outcrop the hard, cemented ragstonne intervals are locally termed the Oldbury, Ightham, Pulborough or Bargate stones, each widely used in their local areas for building stone.

A thin, brown, ferruginous, coarse-grained sandstone, known as the Carstone, locally forms the basal interval of the overlying Gault Clay Formation. The bed is best developed on the Isle of Wight and was quarried for building stone at

Fittleworth, Pulborough and Trotton. It is a hard stone, dark orange-brown in colour and was commonly used for paving. In the wesern part of the area the Gault Clay mudstone passes laterally and vertically into a sandstone unit known as the Upper Greensand Formation.

The Upper Greensand Formation is a sandstone dominated succession, which is Lower Cretaceous (Late Albian) in age. The formation is the source of the Reigate Stone, which has many pseudonyms including Malmstone, Firestone and Hearthstone. These terms, in part, reflect the uses to which the stones were put – Firestone, a siliceous lithology, used both for building stone and lining fireplaces and Hearthstone, a calcareous lithology, used for whitening steps. The formation is very variable in thickness (up to 60 m) and shows widespread vertical and lateral lithological variations within its limited area of outcrop. On the Isle of Wight, around Ventnor and Blackgang Chine, the formation was also extensively worked as a local building stone.

1.3 The Chalk Group (Upper Cretaceous)

Upper Cretaceous sedimentation reflects a dramatic change in depositional environments across northern Europe as a whole. Sea-levels rose and the Wealden basin subsided allowing deeper water marine conditions to extended further across the area, reducing detrital sediment input into the basin. The terrigenous, clastic sedimentation typical of the Lower Cretaceous was gradually transformed into a chalk-dominated sea with only a minor terriginous input. Typically, the Chalk Group succession comprises a series of variably argillaceous and glauconitic, fine-grained, coccolith-rich chalk beds which are not generally durable enough for building purposes, except at a few limited localities. The Melbourn Rock (Holwell Nodular Chalk Formation - Cenomanian), a nodular chalky limestone, cropping out at Amberley, for example, was worked as a freestone. In contrast, the coarser, bioclastic and phosphatic chalk of the Newhaven Chalk Member (Lavant Stone - Early Campanian) was worked near Chichester. This harder, more indurated phosphatic chalk was particularly widely used in the local area as a building stone (Bone & Bone 2000).

1.4 The Palaeogene succession

The Palaeogene succession of south-east England represents a brief return to non-marine conditions in the area, followed by a subsequent reversion to more open marine conditions during deposition of the London Clay Formation (Early Eocene). Within this latter, clay-dominated formation thin, grey, fossiliferous, marine, carbonate-cemented, sandstones occur. They were worked for building stone, unusually, from the ‘reefs’ just offshore from Bognor Regis (Bognor Rock).

In the overlying Bracklesham Group strata at Selsey Bill, two thin, indurated sandstone beds are developed, the Barn Rock, a glauconitic, calcareous sandstone and the Mixon Rock, a foraminifera-rich, calcareous sandstone. Both were locally worked for building stone. The youngest sediments of the Bracklesham Group (Eocene) are non-marine and comprise clays, weakly consolidated sandstones and freshwater limestones. The limestones which form the Bembridge Limestone Formation (Daley & Edwards 1990) were the principal source of building stone and were quarried extensively in the past around Ryde where they were known as Quarr or Binstead stones.

2. The building stones of the succession

The principal publications describing the distribution and use of these stones for building purposes in the area are the Geological Survey memoirs by Topley (1875), Jukes-Browne & Hill (1900) for the Lower Cretaceous, and Jukes-Browne & Hill (1903) for the Upper Cretaceous. Since these early publications there have been substantial changes in the stratigraphic interpretation of the sequence based on revised mapping and stratigraphic re-interpretations (e.g. see Rawson et al. 1978 for references).

Modern geological descriptions of the building stones are included in more recent publications by the British Geological Survey (e.g. Gallois & Worrsam 1993) and in important publications by Worssam & Tatton-Brown (1993) for the Kentish Rag and other stones; Sowan 1975, Tatton-Brown 1980 and Sanderson 2004 for the Reigate Stone; Bone & Bone 2000 for the Lavant Stone.

3. Petrography of the building stones (Table 2)

3.1 Petrography of the Purbeck limestones

The limestones of the lower part of the Purbeck succession have not been described petrographically in any detail from the area of their outcrop. However, building limestones were produced from the beds known as the ‘greys’ (Grey Limestone Member), which are described as freshwater limestones containing thin-walled bivalves, with variably pelletal or hard crystalline fabrics.

3.2 Petrography of the Hastings Beds sandstones – Calverley, Ardingley, Cuckfield (Tilgate)

The sandstones from each of these three intervals are petrographically similar in character, consisting of very fine- to fine-grained, greyish white, quartzose, non-calcareous sandstones. In thin section they are typically moderately well sorted, very fine- to fine-grained sandstones with a framework mineralogy dominated by monocrystalline quartz and sparse feldspar grains, forming a highly porous rock framework (Plate 1A). The quartz grains show ubiquitous narrow, ragged and irregular margins of syntaxial quartz overgrowths with common euhedral faces. The feldspar grains are principally potassic varieties. However, the common occurrence of oversized pores suggests that the less stable sodic/calcic varieties may have been removed by leaching. Accessory minerals only rarely occur in the framework and include mostly zircon and tourmaline.

The principal difference in the Tilgate Stone beds in the succession is simply the presence of a pervasive ferroan calcite cement occluding all the porosity. The feldspars present include both potassic and sodic/calcic varieties, the latter are commonly leached and corroded with the resulting secondary dissolution pores infilled with carbonate cement (Plate 1B). Feldspars are more common than in the quartz-cemented Ardingly Sandstone suggesting the carbonate cementation phase was sufficiently early to protect the vulnerable feldspars from complete dissolution by corrosive pore fluids.

3.3 Petrography of the Horsham Stone sandstone.

In thin section, a typical Horsham Stone shows a very finely laminated framework of moderately well sorted, monocrystalline quartz grains, with subordinate feldspar and abraded bioclastic and accessory minerals, in a pervasive carbonate cement (Plate 1B). The quartz grains are rounded with the ubiquitous development of narrow, irregular, syntaxial quartz overgrowths. The feldspars include both twinned and untwinned potassic and sodic/calcic varieties, with the latter severely leached and corroded and forming open, secondary pore space. The detrital carbonate fragments present are predominantly well rounded, non-ferroan and commonly have a well-developed ferruginous rim. They represent abraded bioclastic debris including echinoid spines and benthic foraminifera tests. The principal accessory mineral is tourmaline. The pervasive carbonate cement is slightly ferroan to strongly ferroan in character. Porosity comprises isolated secondary, feldspar dissolution pores. The fine lamination in the fabric is picked out by concentrations of opaque, fine-grained, opaque, ferruginous material.

3.4 Petrography of the Paludina limestones (locally known as: Sussex, Bethersden, Petworth marbles; Charlwood and Laughton stones)

In thin section the limestones comprise concentrations of bivalve, gastropod and ostracod fragments with sparse foraminifera tests (Plate 1C). The fragmental material is generally angular with little evidence of significant transport and abrasion, suggesting they were compacted in-situ in a generally low energy environment. The shell material is commonly spar-replaced with little internal wall-structure surviving. Gastropod tests can be up to 2.5 cm along their long axis and may be partially pyrite-replaced. The intact gastropod valves dominate the so-called ‘marble-quality’ varieties quarried from the succession. In some samples the limestone is slightly phosphatic in character and in others there is a significant proportion of fine, detrital, quartz sand grains.

3.5 Petrography of the Folkestone Stone

In thin section the Folkestone Stone is a sandstone of moderately well sorted, coarse, detrital quartz grains, with sparse feldspars, glauconite and bioclastic grains, 'floating' in a pervasive carbonate cement (Plate 1D). The quartz grains (some very well rounded) are monocrystalline varieties occasionally with poorly developed, irregular syntaxial quartz overgrowths. The coarse, irregularly shaped glauconite grains typically show a pale yellow-green core and darker green outer rim. Although potassic feldspar is a common framework grain, there is evidence of skeletal remnants of leached, possibly sodic/calcic grains in the now carbonate cement-filled, intergranular areas of the fabric. The pervasive carbonate cement is strongly ferroan in character.

3.6 Petrography of the Bargate Stone (locally known as Pulborough Stone)

The Sandgate Formation includes a unit commonly known in older literature as the 'Bargate Beds' and today as the Bargate Member. The Bargate sequence is typically a mixture of fine-grained, glauconitic sands, with occasional harder carbonate or silica (chert) cemented 'doggers' - large concretionary or nodular or layers. These harder intervals were quarried as Bargate Stone. At some levels, dark coloured pebbles of quartz or chert commonly occur in the sands and were used for 'galletting' the stonework (i.e. placed decoratively in the mortar courses).

In thin section, the typical Bargate Stone is a complex mix of variably sandy bioclastic limestone and bioclastic sandstone. In general, the rock framework grains are very poorly sorted with the detrital siliciclastic grains present, dominated by rounded, medium to coarse grained monocrystalline quartz, sparse potassic feldspar and polymінerallic rock fragments (Plate 1E). Coarse bioclastic debris is abundant, together with green glauconite and rounded phosphatized grains, the latter occasionally oolitic in character. Identifiable bioclasts include common echinoid plates and spines, bivalve, bryozoan and foraminifera fragments. The intergranular cements show complex intergrowth of ferroan and strongly ferroan carbonate with cryptocrystalline siliceous patches.

3.7 Petrography of the Hythe Beds (Kentish Ragstone)

The Kentish Ragstone is so variable in its lithological character that it is difficult to select a few samples 'typical' of the many varieties that may be encountered in the outcrop. The two best known lithologies are the Ragstone and Hassock (Worrsam 1963). The Ragstone is a hard, bioclastic limestone with sparse detrital quartz grains and glauconite (Plate 1F). Much of the medium- to coarse-grained bioclastic debris present is ferroan spar-replaced, and identifiable fragments are restricted to the surviving non-ferroan grains. These include common bivalve debris, echinoid plates, small benthonic foraminifera tests, ostracod valves, sponge spicules, bryozoan and algal fragments. The sparse monocrystalline quartz and green glauconite grains are of very fine to fine sand grade. In other sections examined from the Ragstones, sponge spicule debris is more common, sometimes forming pervasive, polycrystalline siliceous patches.

In contrast the Hassock beds comprise a comparatively soft argillaceous, sandy glauconitic limestone (Plate 1G). The principal framework grains are medium- to coarse-grained, broken and abraded bioclastic fragments, similar to those found in the Ragstone, with common fine to coarse detrital quartz and glauconite grains. In contrast to the Ragstone, however, there are within the rock framework, irregular lenses and laminae of squeezed and deformed argillaceous material.

3.9. Petrography of the Carstone Formation

The Carstone is a coarse, often pebbly, dark orange-brown, ferruginous sandstone. When fresh and unweathered the sandstone is olive grey in colour. The detritial framework grains are dominated by quartz with subordinate feldspar, glauconite and sporadic phosphatic grains.

3.10 Petrography of the building stones of the Upper Greensand Formation

The Upper Greensand Formation includes a range of lithological types which have provided substantial amounts of stone for building in the past. The lithologies that occur in the formation show a range of colours including white, buff, pale yellow and green. Over a large portion of its outcrop, which extends from the Oxfordshire to the Isle of Wight, to quote Jukes-Browne (1900), it "*contains but a small proportion of quartz-sand and still less glauconite, so that it is not a sand nor is its colour green*".

3.10.1 Petrography of the Reigate Stone (locally known as Malmstone, Firestone, Hearthstone)

The Reigate Stone is quite variable in its mineralogy, but essentially comprises a highly porous framework of siliceous sponge spicules with variable proportions of detrital quartz, glauconite and mica (Hinde 1885). Hinde describes and illustrates in great detail the many different spicule morphologies found within the succession. The beds may be differentially cemented by silica and/or calcite but are still characteristically highly porous and consequently have a low density (103lbs/per cu. ft) compared to, for example Kentish Ragstone at 167lbs/cu.ft). Glauconite is a common component, usually occurring as moulds of spicule chambers or foraminifera tests. Fine-grained white mica flakes are also common, but few other detrital grains are present (Davies 1916).

In thin section, the Reigate Stone is composed of very fine-grained, elliptical or cylindrical cross-sections of siliceous (opaline silica) sponge spicules, rounded glauconite grains in a calcareous or siliceous, microcrystalline matrix (Plate 1H). There are, in general, no detrital quartz grains present. Sometimes glauconite infills the central canal of the monaxon sponge spicules. The proportion of glauconite to sponge spicules can vary considerably, but as neither of these minerals are particularly resistant to weathering, the Reigate Stone is generally very vulnerable to decay.

3.11 The petrography of the Chalk building stone (Lavant Stone)

The Melbourn Rock, once quarried at Amberley as a freestone, is a hard, white coccolith-rich chalk with some coarser bioclastic debris (Anon 1907). In contrast, the Lavant Stone, a phosphatic chalk, has been described in some detail by (Jarvis 1992; Bone & Bone 2000). It comprises variable concentrations of spicular, siliceous bioclastic debris (with phosphatic coatings), shell debris, glauconite and faecal phosphate pellets in a micritic, carbonate matrix.

3.12 Petrography of the Bognor, Barn and Mixon sandstones (Palaeogene)

These sandstones all form conspicuous indurated ‘reefs’ along the Sussex coast between Bognor and Selsey Bill. The Bognor Rock sandstone is a fine- to medium- grained, bioturbated and sparsely fossiliferous sandstone unit in which large carbonate cemented concretions are locally present. These concretionary sandstones were worked as the principal source of the building stone. The Barn Rock is a more fossiliferous, glauconitic, calcareous sandstone. The Mixon Rock can be distinguished from the others by the common presence of larger foraminifera test, including *Nummulites* and *Alveolina* (Curry et al. 1977).

3.13 Petrography of the Quarr, Binstead or Bembridge limestones (Palaeogene)

In thin section, the pale greenish-grey, freshwater limestones of the Bembridge Limestone Formation show two contrasting lithologies – a fine-grained porcellanous, bioclastic, micritic limestone and contrasting coarsely bioclastic, porous limestone. The micritic limestone contains numerous small, thin walled bivalve fragments in a micritized bioclastic matrix. In the coarsely bioclastic limestone facies, the fragmented mollusc shells are pervasively replaced with coarsely sparry calcite and the rock framework is highly porous (Plate 1I).

4. Current building stone activity

Building stone activity in the south east of England has declined markedly since the early 20th century. Currently, there are ten building stone quarries still active – four working the Kentish Ragstone or equivalents, one working the Folkestone Stone, three in the Ardingley Sandstone and one in the chalk. Encouragingly a new quarry has also recently begun working the Horsham Stone to produce roofing slate. However, as in other areas of Britain, many other stones are unobtainable at the present time. This lack of local building materials not only makes repair and conservation an ongoing problem, but restricts the construction of further new stone buildings to compliment the historic vernacular architecture so important in defining the character of the area.

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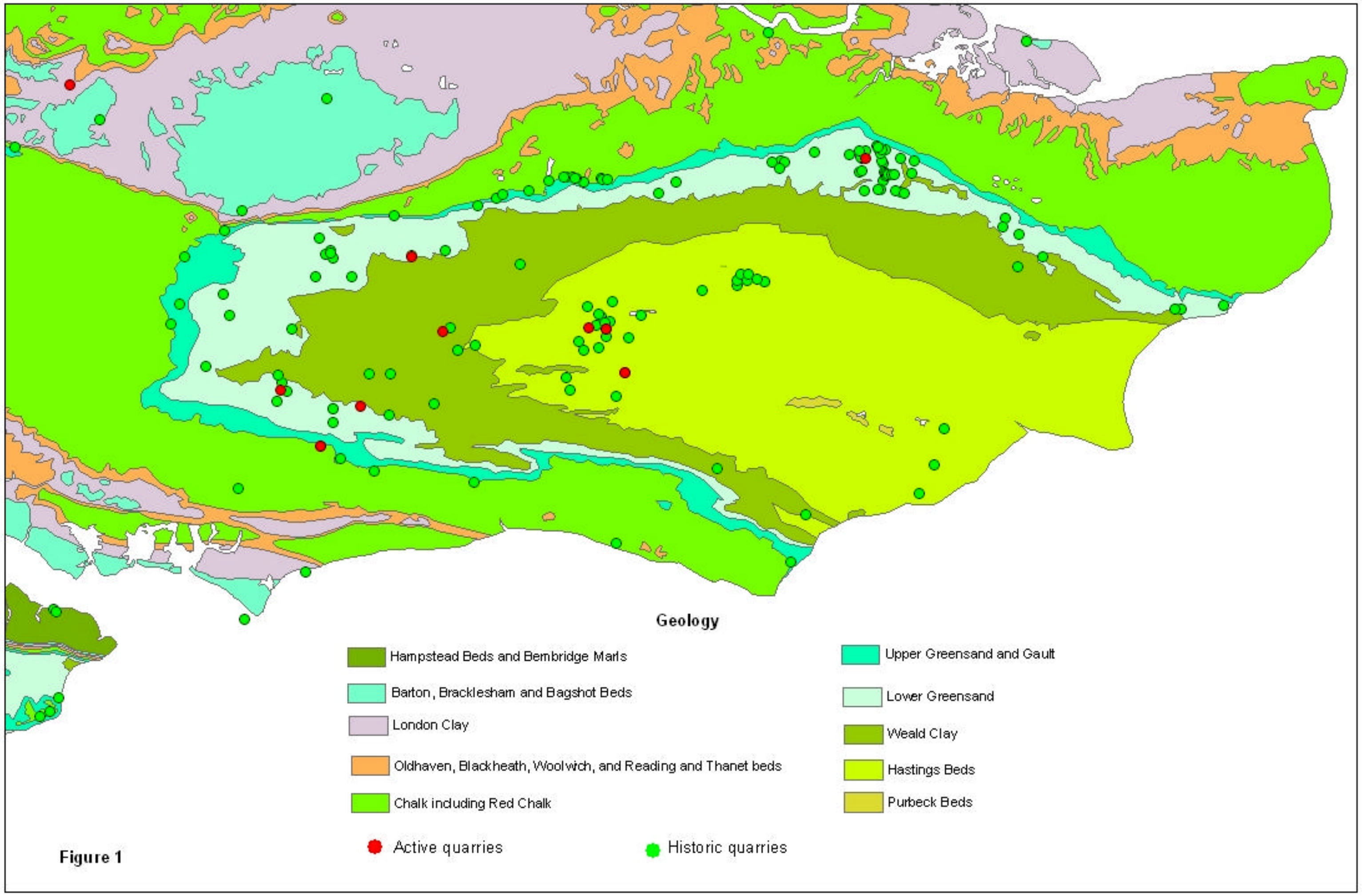

Geology
Hampstead Beds and Bembridge Marls
Barton, Bracklesham and Bagshot Beds
London Clay
Oldhaven, Blackheath, Woolwich, and Reading and Thanet beds
Chalk including Red Chalk
Upper Greensand and Gault
Lower Greensand
Weald Clay
Hastings Beds
Purbeck Beds
Active quarries
Historic quarries

Figure 1

EPOCH	CHRONOSTRATIGRAPHY		LITHOSTRATIGRAPHY (major units only)		BUILDING STONE
	SERIES	STAGE	SOUTHERN ENGLAND		
TERTIARY 65.5 Ma	PALEOGENE	PRIABONIAN		BEMBRIDGE LIMESTONE FM	QUARR & BINSTEAD BOGNOR, BARN, MIXON
LATE CRETACEOUS 97 Ma	UPPER CRETACEOUS	MAASTRICHTIAN TO CENOMANIAN	CHALK GROUP		LAVANT AMBERLEY & OTHER LOCAL VARIETIES
EARLY CRETACEOUS 146 Ma	LOWER CRETACEOUS	ALBIAN	UNAMED	UPPER GREENSAND FM GAULT CLAY FM CARSTONE FM	REIGATE (aka FIRESTONE, MALMSTONE, HEARTSSTONE) CARSTONE
		APTIAN	LOWER GREENSAND GROUP	FOLKESTONE FM SANDGATE FORMATION HYTHE FORMATION ATHERFIELD CLAY FM	OLDBURY, IGHTHAM SANDGATE, KENTISH RAGSTONE, PULBOROUGH, BARGATE, FOLKESTONE
		BARREMIAN HAUTERIVIAN VALANGINIAN	WEALDEN GROUP	WEALD CLAY FM: upper division (large Paludina); lower division (small Paludina)	PALUDINA LIMESTONE (aka SUSSEX, PETWORTH, BETHERSDEN MARBLES OR CHARLWOOD STONE) HORSHAM STONE
				'HASTINGS GROUP'	TUNBRIDGE WELLS SDST. (aka ARDINGLEY SDST, CUCKFIELD STONE)
		RYAZANIAN	PURBECK GROUP*	DURLSTON FM	PURBECK LIMESTONE

* THE LOWER PARTS OF THE PURBECK GROUP ARE OF LATE JURASSIC AGE

TABLE 1

Plate caption (following page)

Plate 1A Tilgate Stone (fov 2mm)

Plate 1B Ardingley Sandstone (fov 2mm)

Plate 1C Horsham Stone (fov 2mm)

Plate 1D Large Paludina limestone (fov 8mm)

Plate 1E Kentish Ragstone - hassock (fov 2mm)

Plate 1F Kentish Ragstone – ragstone (fov 2mm)

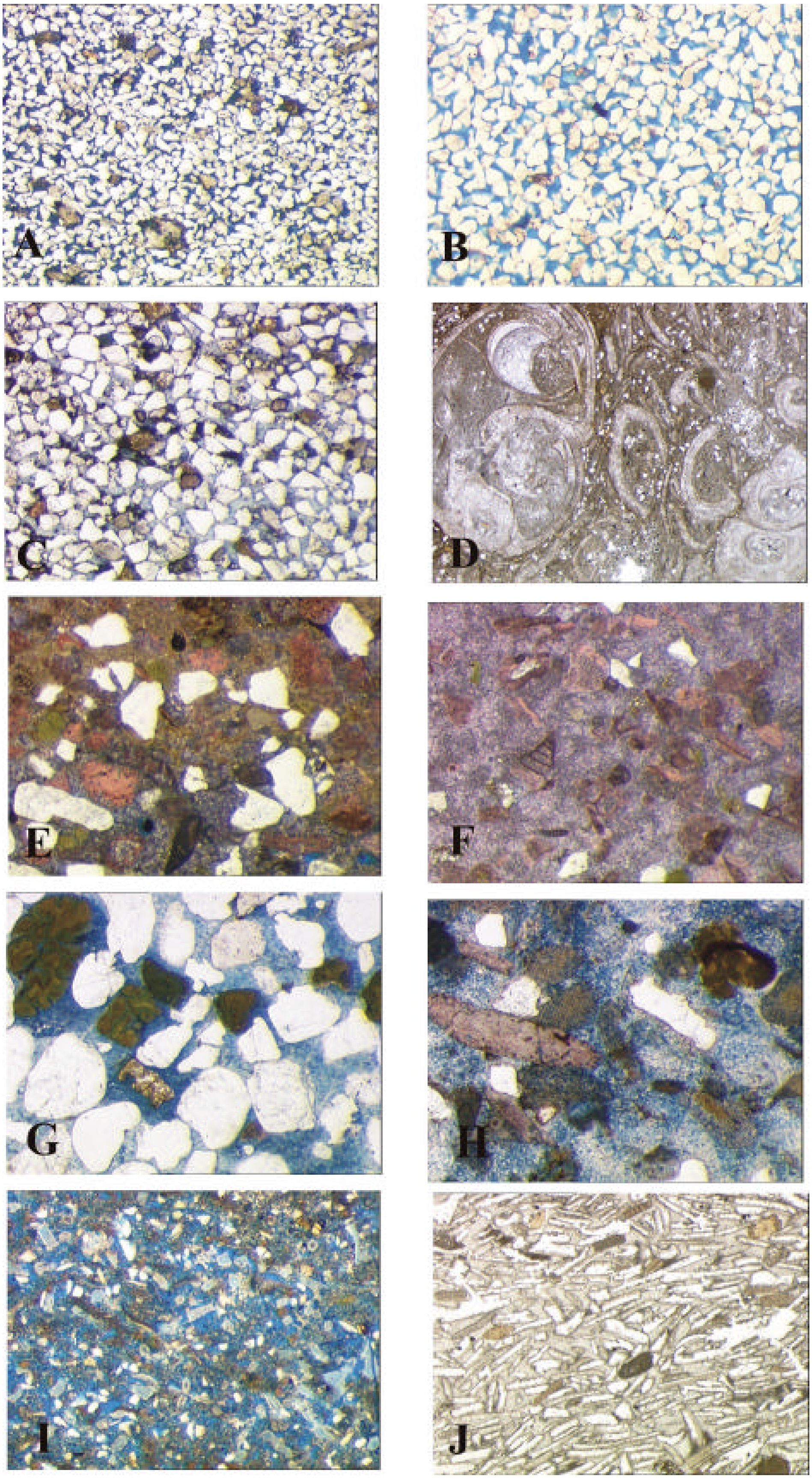
Plate 1G Folkestone Stone (fov 2mm)

Plate 1H Bargate Stone (fov 2mm)

Plate 1I Reigate Stone (fov 2mm)

Plate 1J Quarr Stone (fov 8mm)

fov = field of view dimension, left to right


A
B
C
D
E
F
G
H
I
J

Building Stone	Lithology	Q (d)	Q (b)	Glauc.	Bio	SiC	CarbC	Phos	Mica	Forams	Lithostratigraphy	Age
Quarr / Binstead	Limestone				*		*	*			**Bracklesham Group**	Palaeogene
Bognor / Mixon	Sandstone	*			*		*			*		Palaeogene
Lavant	Chalk		*	*		*	*	*		*	**Chalk Group**	Upper Cretaceous
Reigate	Sandstone		*	*		*	*		*	*	**Upper**	Lower Cretaceous
Carstone	Sandstone	*		*							**Greensand/Gault**	Lower Cretaceous
Folkestone	Sandstone	*		*			*				**formations/**	Lower Cretaceous
Kentish Ragstone	Limestone	*	*	*		*	*			*	**Lower Greensand**	Lower Cretaceous
Bargate	Sandstone	*		*	*	*	*				**Group**	Lower Cretaceous
Paludina limestones	Limestone	*			*		*					Lower Cretaceous
Horsham	Sandstone	*			*		*				**Wealden Group**	Lower Cretaceous
Tilgate	Sandstone	*					*					Lower Cretaceous
Ardingley	Sandstone	*										Lower Cretaceous
Purbeck	Limestone				*		*				**Purbeck Limestone Group**	Upper Jurassic

Q(d) detrital quartz; Q(b) biogenic quartz; Glauc. Glauconite; Bio carbonate bioclasts; SiC siliceous clasts; CarbC carbonate clasts; Phos phosphatic grains; Mica; Forams foraminifera tests