An Introduction to the Quaternary of southern England Geological Conservation Review sites

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Introduction

This paper introduces four detailed papers describing Geological Conservation Review (GCR) sites that were chosen to represent the full range of depositional environments and climatic events preserved in the Quaternary sediments of Southern England. These site descriptions cover two GCR blocks (Figure 1, Table 1), with one site (Selsey East Beach) also selected as part of the Pleistocene Vertebrates GCR block (68):

80 Quaternary of South-Central England (22 sites, coded SC E in Table 1)

81 Quaternary of South-East England (26 sites, coded SE E in Table 1)

Geological Conservation Review

The Geological Conservation Review (GCR) was initiated by the Nature Conservancy Council in the early 1970s to assess and document the most important parts of Britain's remarkably rich geological heritage (Ellis et al., 1996; Ellis, 2011). The principle of this process was to record the current state of knowledge of nationally and internationally important Earth science sites in Great Britain and provide a firm basis upon which site conservation could be founded in years to come.

Ellis (2011) notes that the GCR, formally launched in 1977, was a world-first in the systematic selection and documentation of a country's best Earth science sites, comprising an inventory of over 3000 GCR sites, selected for 100 categories covering the entire range of the geological and geomorphological features of Britain. The GCR criteria for site selection outlined by Ellis et al. (1996, p. 45) are as follows:

'1. sites of importance to the **international** community of Earth scientists

2. sites that are scientifically important because they contain **exceptional** features

3. sites that are nationally important because they are **representative** of an Earth science feature, event or process which is fundamental to Britain's Earth history'

Sites with international importance comprise international stratotypes or type localities, or locations where geological or geomorphological concepts or phenomena were first recognised. Sites selected for their exceptional features are usually unique within the British Isles, for example in the GCR South-East England and South-Central England blocks described in this volume, the periglacial sites at Allington Quarry and Fyfield Down, or the archaeologically spectacular raised beach sequence at Eartham's Pit, Boxgrove (Table 1). Ellis et al. (1996) note that the Quaternary blocks are uniquely classified on a regional basis, rather than relating to a particular stratigraphic unit. The complexity of deposits and features preserved from the Quaternary period required a further classification to ensure a balance was maintained between different types of sites across multiple regions. These were (Ellis et al., 1996, p. 51):

- '*environmental history and change based on the stratigraphy at different localities, age and fossil content*, e.g. glacial-interglacial history, sea-level changes
- *processes and patterns of landscape evolution*, e.g. glaciation, periglaciation
- *the history and development of the flora and fauna*, e.g. vegetation history, evolution of vertebrates.'

The majority of GCR sites described in this volume have been chosen for criteria 3, i.e. because they are representative of nationally important Earth science features (see Table 1). The GCR sites described have been subdivided according to the Quaternary-specific criteria above. The papers on periglacial landscapes (PG, Whiteman and Haggart, this volume) and chalk landforms (CL, Whiteman, this volume) elucidate mainly processes and patterns of landscape evolution. The paper describing evidence for former sea levels in the region (SL, Briant et al., this volume b) falls into the environmental history classification and that describing rivers, tufas and mires (RTM, Briant et al., this volume a) both environmental history and vegetation history. In addition, the sites have been selected on the basis of two operational criteria: '1. there should be a minimum of duplication of interest between sites and 2. it should be possible to conserve any proposed site in a practical sense' (Ellis et al., 1996, p.75).

Within these papers and similar volumes, the GCR sites are described in detail in self-contained accounts, consisting of an introduction (with a concise history of previous work), a description, an interpretation (providing geological analysis of the features of interest and assessing the fundamentals of the site's scientific interest and importance), and a conclusion. Each site report is a justification of the particular scientific interest in a locality, of its importance in a British or international setting, and ultimately of its worthiness for conservation. Networks of sites are also described from the Solent and Stour river systems and covering vegetation history of the New Forest during the Holocene. By listing and describing the sites in this way, we can ensure that nationally and internationally important geological sites are conserved for future generations to study and as an educational field resource, both separately and as part of an integrated network (Ellis et al., 1996). Selection as a GCR site, however, does not guarantee public access to a site. These are often on private land, or best conserved by minimising footfall.

The present Special Issue of the Proceedings of the Geologists' Association is part of the GCR series. It should be noted that this volume deals with the state of knowledge of the sites available at the time of writing, and it must be seen in this context. Future readers of these papers would do well to do their own literature searches to see if further work has been published after this publication was completed, particularly where the text indicates that research is ongoing in a region. There is still much to learn about many of the GCR sites documented here. It is also likely that increased or hitherto unrecognized significance may be seen in new sites in the future, as was the case during the writing of this project, when two boundary changes and two new sites were considered for inclusion and one site deselected. Thus Briant et al. (this volume a) contains two provisional descriptions of completely new sites and one provisional description of a site extension because they are far enough through the GCR site selection process to be assured of acceptance. As outlined above, all were chosen on the basis of uniqueness because the GCR is intended to select only the minimum number of sites required to effectively characterise the geological feature or time period under consideration.

The Quaternary of southern England

A key feature of the South-Central and South-East GCR blocks is that they preserve no direct sedimentary evidence of glacial advance during the Quaternary period (past suggestions of glacial activity are reviewed and dismissed by Whiteman, this volume). This provides an excellent opportunity to study the development of a 'relict periglacial landscape' (Ballantyne and Harris, 1994) over multiple cycles of periglaciation and sea level fluctuations. The area has long been seen as one of considerable antiquity, with the believed recognition of a Neogene erosion surface (Mio-Pliocene peneplain) on the Chalk of south-east England forming the basis of Wooldridge and Linton's (1939, 1955) thesis that post-Cretaceous denudation was essentially of Neogene age. This view has since been extensively critiqued (e.g. Catt and Hodgson, 1976; Jones, 1980; Gibbard and Lewin, 2003). Gibbard and Lewin (2003) in contrast suggest that landscape development occurred throughout the Cenozoic, although producing relatively subdued landscapes. This was then followed by more dramatic climatically driven changes during the Pleistocene allowing the development of deeply incised river valleys (Briant et al., this volume a) and other geomorphological features (Whiteman, this volume; Whiteman and Haggart, this volume). The antiquity of this landscape is also reflected in three enigmatic sites that seem to record high elevation Early Pleistocene river activity predating the current valley configuration (Upper Common, Upper Hale, Mountain Wood – Briant et al., this volume a).

Eighteen of the GCR sites in this volume are located on chalk bedrock, which also has significant implications for the Quaternary landscape development of this region. This can be seen in unique and sometimes spectacular landforms such as the North and South Downs escarpments, the extensive upland of Salisbury Plain, incised coombes (e.g. Bratton) and dry valleys (e.g. Devil's Dyke, Rake Bottom; Whiteman and Haggart, this volume). There is also evidence for solution of the chalk in this GCR region, in the form of swallow holes at the Mole Gap, and an infilled solution hollow at Rimsmoor in Dorset (Briant et al., this volume a). Whilst early researchers attributed the formation of these incised features to temperate climate processes, by the later parts of the last century the importance of frozen ground was starting to be recognised. For example Kerney et al. (1964) cited a range of processes - rapid frost weathering, niveo-fluvial erosion *and* solifluction - as key contributors to the development of one particular coombe, the Devil's Kneading Trough in Kent (Whiteman and Haggart, this volume). There is considerable debate, summarised in Whiteman and Haggart (this volume) about the timing of denudation of the chalk, the likelihood of scarp retreat during the Quaternary and the relative role of periglaciation and temperate climate geomorphological processes in forming these landforms. However, recently Matsuoka and Murton (2008) have pointed to brecciated bedrock and solifluction deposits as evidence of the dominance of periglacial processes acting in combination with periglacial fluvial systems in forming characteristic chalk landforms. There are no age estimates available to test any of these theories in detail, although a polygenetic formation of these landforms seems likely. There is considerable future research potential in many of these sites if suitable geochronological techniques were to be developed.

Thus, periglacial processes (either continuous or discontinuous permafrost – see discussion in Whiteman, this volume) have likely prevailed in this region for most of the last 2 million years of the Quaternary period. In addition to river sequences laid down under periglacial conditions (Briant et al., this volume a), southern England contains a number of classic indicators of periglacial processes such as frost-shattered bedrock (e.g. at Pegwell Bay), solifluction lobes (e.g. Hubbard's Hill, Devil's Kneading Trough) and solifluction valley fills (e.g. North Cliff, Broadstairs; Birling Gap). These are seen to be important practically, as well as theoretically, e.g. for engineering geology/geotechnical surveys for infrastructure development, as when solifluction lobes at Hubbard's Hill reactivated following undercutting during building of the Sevenoaks Bypass (Whiteman, this volume; Skempton and Petley, 1967). Further characteristic periglacial features are seen in cambering, gulling and sandstone micro-weathering features in the Weald (e.g. Allington Quarry, Spot Lane Quarry, Oaken Wood around Maidstone and those at Rusthall Common, High Rocks and Chiddingly Wood near Tunbridge Wells). Southern England also contains Britain's thickest sequence of loess at Pegwell Bay in Kent. The streams and spreads of sarsen stones at Fyfield Down (Wiltshire) and Valley of Stones (Dorset) are also generally attributed to solifluction (gelifluction) and so are included here.

Periglacial activity is also seen indirectly in the multiple elevations of thick, coarse river terrace deposits interpreted as having formed braided periglacial river systems. These are in the erstwhile River Solent (Solent Cliffs West, Calshot Cliffs and Hillhead Cliffs, Dunbridge Pit), Hampshire Avon (Wood Green Gravel Pit), Medway (Aylesford) and Kentish Stour (Fordwich Pit, Sturry Gravel Pits, Wear Farm Pit, Chislet, Bishopstone to Reculver Cliffs). With the exception of Wood Green Gravel Pit and Aylesford, these sites have been chosen to form local networks that characterise these significant terrace sequences. There has been considerable past debate about the driving force behind the formation of these deeply incised sequences of river gravels, with Bridgland (2000) advocating for the importance of uplift in accentuating climatic cycles of erosion and deposition, possibly relating to erosional unroofing and associated lower crustal flow (Westaway et al., 2006). However, Gibbard and Lewin (2003) argue that climatic fluctuations are sufficient to drive incision on this scale and additional explanatory factors are not required.

In addition to river activity, the GCR region preserves evidence of multiple cycles of sea level rise and fall with classic raised beaches abutting fossilised chalk clifflines and shore platforms found at Eartham Pit, Boxgrove and Black Rock (Briant et al., this volume b). A further raised beach is found cut into softer rock (Bembridge Marl Member, Bouldnor Formation) and associated with a short sequence of salt marsh sediments at Bembridge Foreland on the Isle of Wight. Also on the Isle of Wight, the archaeological site at Priory Bay has in the past been interpreted as marine, although most recently Wenban-Smith et al. (2009) suggest that the relevant gravels have been reworked. Estuarine channel fills of varying ages also occur in the region, such as at Bembridge (Steyne Wood Clay), Stone Point, Earnley, Selsey West and East Beaches (Briant et al., this volume b). These are concentrated on the eastern edge of the Hampshire Basin, from the Isle of Wight east to Brighton. The gradually increasing extent over time of the mapped marine sediments on the Sussex Coastal Plain shows the development of a more open coastline, from the closed embayment associated with deposition at Eartham Pit, Boxgrove at a time prior to the opening of the Straits of Dover, to a more open coastline with a fully open Strait similar to the present day during deposition at Selsey West and East Beaches. In conjunction with the chalk landforms, periglacial features and river deposits, these sites demonstrate a complex interplay of periglacial weathering, erosion and transportation and rising and falling sea level over multiple glacial and interglacial cycles.

In addition to the sediments preserved, many of the GCR sites in this region also contain rich archaeological and fossil assemblages, enabling human activity and environmental conditions to be reconstructed in more detail. The richest archaeological assemblage, most of it representing an *in situ* landsurface in association with cut-marked animal bones and hominin bones is found at Eartham Pit, Boxgrove (e.g., Roberts and Parfitt, 1999). Abundant Palaeolithic artefacts are also found in secondary contexts in river gravels at Priory Bay, Isle of Wight (Briant et al., this volume b); Dunbridge Pit, Wood Green Gravel Pit, Aylesford and the network of four River Stour sites, all described in Briant et al. (this volume a). The Pleistocene vertebrate GCR site at Selsey East Beach (often known as the Lifeboat Station site – West and Sparks, 1960); Wear Farm Pit, Chislet and Aylesford also have significant vertebrate assemblages reported from them, along with other fossil groups at Wear Farm Pit, Chislet (Briant et al., this volume a) and smaller assemblages elsewhere (e.g. at Black Rock, Briant et al., this volume b). Tracking of artefact types and densities across wide areas has allowed changing patterns of human occupation (e.g. Ashton and Hosfield, 2010) and tool use (e.g. White et al., 2024) to be described and explained.

Towards the end of the Pleistocene and into the Holocene, fossil preservation potential increased. Nonetheless, detailed sequences of Holocene vegetation change remain sparse in this GCR region, because the dominant fluvial, dissolution, slope and coastal processes that have formed these landscapes create less accommodation space for the accumulation of long organic sequences. Those that are present are biased towards calcareous fossils. For example, there are a number of coombes containing datable valley-fill sediments at Asham Quarry, Cow Gap, Devil's Kneading Trough, Holywell Coombe and Upper Halling (Whiteman and Haggart, this volume). Given the calcareous nature of these sites, it is not surprising that molluscs provide most of the source of environmental information. The exception is Holywell Coombe (Preece and Bridgland, 2012) where unusual hydrological conditions have allowed pollen and insects to survive in addition to molluscs. Radiocarbon (C^{14}), thermoluminescence (TL) and Amino acid racemisation (AAR) dating techniques have been used to determine the age of these deposits, often using charcoal. The Devensian (specifically late Devensian) and Holocene age of the sediments at all these sites indicates the relatively recent timing of significant amounts of landscape incision during the most recent episode of cold climate, and subsequently when human influences were at work on the landscape. Only at Upper Halling has the molluscan assemblage been used to infer an earlier, Mid-Devensian, age for landscape incision (Whiteman and Haggart, this volume).

Calcium carbonate-dominated sequences are also seen in tufa sequences at Wateringbury in Kent and Blashenwell Farm in Dorset (Briant et al., this volume a). When pieced together these provide a remarkably complete record of vegetation and landscape change during the Early- to Mid-Holocene based on the contained molluscan assemblages and radiocarbon dating. Both also contain plant remains, ostracods and vertebrates and at Wateringbury oxygen isotopic analysis of the ostracods indicates changes in air temperature and woodland development (Garnett et al., 2004). At Blashenwell Farm early- to mid-Holocene sequences trace the development of woodland followed by open ground conditions and provide context for local important Mesolithic sites (Preece, 1980). At Wateringbury, early Holocene landscape change shows increasing woodland cover as first birch then hazel, oak and elm returned to south east England. Stable isotope and trace elements suggest the early Holocene warming of about 2.6°C to a thermal maximum at about 8900 cal. BP was interrupted by two colder events at 11300 and 8200 cal. BP, the latter of which may also have been dry (Garnett et al., 2004).

A few rare mire sites are also present in this GCR regions. These form a network of three sites in the New Forest along with two separate sites, one in Oxfordshire and one in Dorset (Briant et al., this volume a). The three New Forest sites together give a full picture of vegetation changes in the region. Cranes Moor is rare for southern England having become largely or solely ombrogenous from the early Holocene, enabling dry and wet phases to be reconstructed alongside charcoal and pollen records, but is truncated by peat cutting of the surface (Grant et al., 2014). Mark Ash Wood (Church Moor) contains evidence from the Late Glacial Windermere (Bølling-Allerød; Greenland Interstadial 1) Interstadial and Loch Lomond (Younger Dryas; Greenland Stadial 1) Stadial onwards into the middle Holocene (Grant et al., 2009). The recently proposed extension to Mark Ash Wood at Barrow Moor continues this high-resolution record, covering the last c. 4000 years, including evidence of past woodland management (Grant et al., 2009). Cothill Fen in Oxfordshire is another early- to mid-Holocene sequence, notable for its rarity due to its location within an area of calcareous soils in central southern England (Day, 1991), and Rimsmoor is a uniquely long (18 m) peat sequence in a subsiding doline immediately south of the chalk Dorset Downs, with significant potential for modern high resolution studies because it has not been studied in detail since the 1980s (Waton, 1982, Waton and Barber, 1987).

Thus, the GCR sites in the South-East and South-Central Regions record a landscape that spans the Quaternary period, relatively quiescent in the earlier Pleistocene, but later shaped by alternating periglacially dominated and high sea level phases, which have left distinctive features on the landscape, depending on the underlying bedrock and created the internationally important periglacial sites at Allington Quarry and Fyfield Down (Whiteman, this volume) and the archaeologically spectacular raised beach sequence at Eartham's Pit, Boxgrove (Briant et al., this volume b). Archaeological artefacts and vertebrate and other fossils are also preserved, allowing environmental history to be reconstructed through parts of the later Pleistocene. Since the start of the Holocene, limited organic accumulation has occurred, much of it calcareous, which has nonetheless enabled reconstruction of Holocene vegetation change.

Whilst some sites are still interpreted as when they were originally selected, many have been subject to significant additional research which has changed their statements of interest. This is particularly due to the provision of age estimates using optically-stimulated luminescence (OSL) and amino-acid racemisation (AAR) dating on fluvial and marine sequences, as described in Briant et al. (this volume a and b). This has significantly improved understanding of the rates and timing of deposition within the river system networks of the Solent and Stour, both of which are currently subject to significant ongoing research which should clarify the stratigraphy and ages further. It has also provided valuable age context for the rich archaeological and vertebrate assemblages at many selected sites, for example Aylesford and Selsey West and East Beaches. Additional research has also resulted in the selection of new sites. One example is at Wear Farm Pit Chislet, where a previously unprotected terrace of the Kentish Stour has yielded rich fossil and archaeological assemblages, with robust age estimates. A further example is at Mark Ash Wood, where GCR selection prompted more detailed research. This research uncovered a second sequence at Barrow Moor which increased the time depth of the vegetation record and has thus prompted an extension to the site boundaries (Briant et al., this volume a).

It is entirely likely that future research will extend our understanding of these sites still further. For example, there is still significant future research potential in applying any suitable new geochronological techniques to sites either dating beyond the *c.* 500 ka limit of the OSL technique or those which are predominantly geomorphological features. Further site extensions may also be necessary in the future, for example as new research discovers the full extent of where sediment bodies are preserved (e.g. ongoing research at Fordwich Pit). A site extension may also be needed to protect Eartham's Pit, Boxgrove, where the tibia and incisors that show direct evidence of hominin presence were found in Quarry 1, which falls outside the boundaries of the GCR site (overview in Briant et al., this volume b). Further archaeologically and fossil rich sites in the Hampshire Avon (e.g. Harnham and Fisherton – Bates et al., 2014; Delair and Shackley, 1978) should also be considered for selection despite the uncertainty over their stratigraphic positions in the sequence.

The papers included in this volume are as follows, with sites listed in Table 1 as coded below:

CL – chalk landscapes: Whiteman, C.A., Haggart, B.A., this volume. Chalk Landforms of Southern England and Quaternary Landscape Development. Proceedings of the Geologists' Association

PG – periglacial landforms: Whiteman, C.A., this volume. Periglacial landforms and landscape development in southern England. Proceedings of the Geologists' Association

RTM – rivers, tufas, mires: Briant, R.M., Whiteman, C.A., Haggart, B.A., Bridgland, D.R., Egberts, E., Grant, M.J., Hatch, M., Knowles, P.G., Schreve, D.C., Toms, P.S., Wenban-Smith, F.F., White, M.J., this volume a. Quaternary Rivers, Tufas and Mires of Southern England: description of Geological Conservation Review sites. Proceedings of the Geologists' Association.

SL – sea level evidence: Briant, R.M., Haggart, B.A., Whiteman, C.A., this volume b. Quaternary sea-level landforms and sediments in southern England – Geological Conservation Review of Sites of Special Scientific Interest. Proceedings of the Geologist's Association.

Acknowledgements

The authors would like to thank the Quaternary Research Association through their Geoconservation Award for supporting creation of figures by Ed Oliver (Queen Mary University of London) and Chris

Orton (University of Durham) for Briant et al., this volume a and b, covering rivers, tufas and mires (RTM) and sea level changes (SL) respectively. We further thank Malcolm Hart and Eleanor Brown for their diligent and detailed review of these papers.

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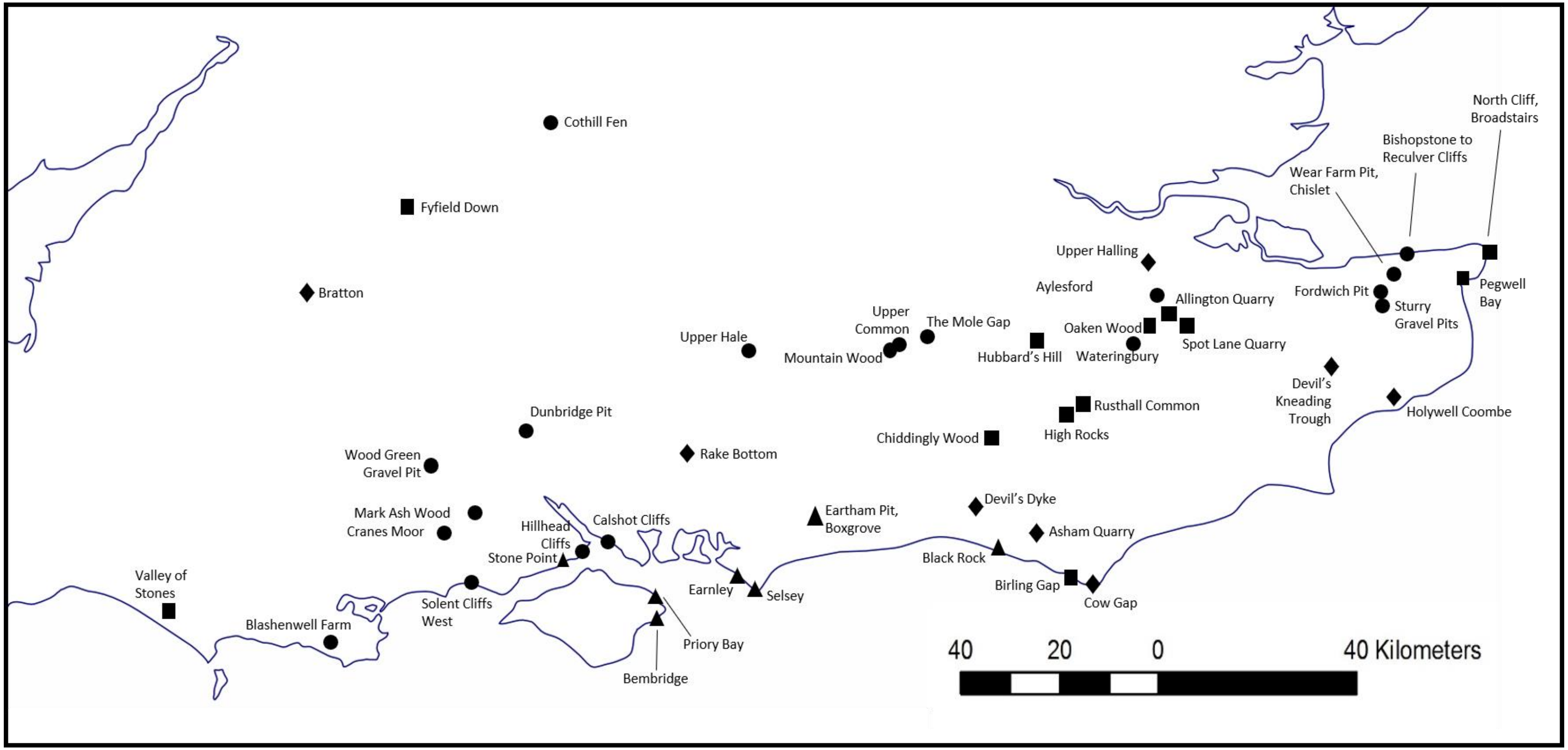

Figure 1. Location of GCR sites from blocks 80 and 81. Base map © d-maps.com. Used under a creative commons licence. Available at: https://d-maps.com/m/europa/uk/angleterre/angleterre02.pdf [accessed 30/6/24]. Diamonds = CL paper; squares = PG paper; circles = RTM paper; triangles = SL paper.

GCR number	GCR name	GCR block code	Grid reference	Publication code	Reason for selection

1729	Allington Quarry	PN/QA SE E	TQ743576	PG	Exceptional development of loess-filled gulls containing rich fossil faunas.
1907	Asham Quarry	PN/QA SE E	TQ440060	CL	Unusually long calcareous colluvial sequence rich in mollusc shells, providing a detailed and radiocarbon dated record of late Holocene environmental change and molluscan biostratigraphy
991	Aylesford	PN/QA SE E	TQ727596	RTM	Rich mammalian fauna and artefacts in the second terrace of the Medway, Kent
1895	Bembridge	PN/QA SC E	SZ870650	SL	Two fine-grained sequences with fossil assemblages and critical evidence of sea level history at both c. 40 m OD and c. 5 m OD, the lower one associated with a former cliffline
790	Birling Gap	PN/QA SE E	TV553960	PG	Probably the best cross-section through a chalk dry-valley-fill in Britain with a complex series of sediments, including undeformed and fragmented and contorted Seaford Chalk Formation bedrock, and a range of Pleistocene deposits.
tbc	Bishopstone to Reculver Cliffs	PN/QA SE E	TR205686 to TR222691	RTM	Section displaying multiple levels of terrace deposits of the Stour system, yielding significant archaeological artefacts and allowing correlation with upstream GCR sites
789	Black Rock	PN/QA SE E	TQ339033	SL	Only exposure in the region of a wave-cut platform and raised beach from the penultimate interglacial, overlain by one of the finest exposures of cold climate deposits in Britain
2249	Blashenwell Farm	PN/QA SC E	SY952805	RTM	Long and continuous early and mid Holocene environmental record from a tufa with associated archaeological remains
1908	Bratton	PN/QA SC E	ST920515	CL	Complex of multiple chalk landforms including multiple coombes, flutes and chutes
2339	Calshot Cliffs	PN/QA SC E	SU473003	RTM	One of a network of sites chosen to represent the sedimentology and stratigraphy of key gravel bodies of the former Solent River – here in the Stanswood Bay Gravel
781	Chiddingly Wood	PN/QA SE E	TQ349322	PG	Sandstone cliffs exhibiting a comprehensive suite of weathering features: cliffs, isolated blocks, including the remarkable 'Great-upon-Little', well-developed gulls and undercut faces, including a cave; also surface crusts, polygonal cracking and honeycomb weathering
2884	Cothill Fen	PN/QA SC E	SU463999	RTM	Mire sequence yielding a detailed picture of early and mid Holocene vegetation change, in a region where such sequences are rare
792	Cow Gap	PN/QA SE E	TV594959	CL	Coombe with an infill of colluvial deposits containing a land molluscan fauna of Late Devensian and Holocene ages

1905	Cranes Moor	PN/QA SC E	SU194028	RTM	Rare Late-glacial to Early Holocene vegetation record from an ombrotrophic mire allowing study of both the early immigration and expansion of flora in post-glacial times and changes in summer water balance
791	Devil`s Dyke	PN/QA SE E	TQ265112	CL	Largest and most famous of the dry valleys ('coombes') incised into the scarp slopes of the Chalk
784	Devil`s Kneading Trough	PN/QA SE E	TR063448	CL	Classic scarp-face dry valley and associated scarp-foot fan, with associated thick radiocarbon dated sequence in a coombe. The fan provides evidence for dramatic landscape change, notably large-scale erosion of the chalk escarpment during the Loch Lomond Stadial. Fossils (snails and plant macrofossils) provide a record from the Late glacial into the late Holocene.
2291	Devil`s Kneading Trough	PN/QA SE E	TR076451	CL	
1941	Dunbridge Pit	PN/QA SC E	SU316257	RTM	Terrace gravels of the Test yielding two different very rich Palaeolithic artefact assemblages within a single sequence, demonstrating superposition
2016	Earnley	PN/QA SC E	SZ827947	SL	Fossil-rich estuarine channel fill, one of only a very few sites in Britain yielding evidence of Middle Pleistocene sea levels
2158	Eartham Pit, Boxgrove	PN/QA SC E	SU923087	SL	Internationally important Middle Pleistocene site, comprising a fossil cliffline, sequences from multiple nearshore environments, extremely abundant vertebrate fossil material and Lower Palaeolithic Acheulian archaeology, including hominin remains
992	Fordwich Pit	PN/QA SE E	TR179587	RTM	One of a network of sites characterising river gravels of the Kentish Stour, here from a high terrace and yielding a rich Early Acheulian archaeological assemblage
1350	Fyfield Down	PN/QA SC E	SU135710	PG	Dry valleys with classic examples of sarsen “valley trains” or “streams” and for other important geomorphological features: exceptional importance as a ‘periglacial relict landscape’
788	High Rocks	PN/QA SE E	TQ560384	PG	Imposing series of 15 m high inland cliffs displaying evidence of multiple sandstone micro-weathering processes
2046	Hillhead Cliffs	PN/QA SC E	SU522030	RTM	One of a network of sites chosen to represent the sedimentology and stratigraphy of key gravel bodies of the former Solent River – here in the tributary gravels of the Test
782	Holywell Coombe	PN/QA SE E	TR221381	CL	Coombe with a significant thickness of waterlogged sediments where it has been possible to compare in detail molluscan, plant and insect records and responses from a single site between 13,000 and 7500 yr B.P. The pollen record is the longest yet recorded for south east England.
2286	Holywell Coombe	PN/QA SE E	TR221381	CL	

786	Hubbard`s Hill	PN/QA SE E	TQ535520	PG	Multiple large and well-preserved solifluction lobes on the greensand escarpment, an organic clay ('buried soil') within which has been radiocarbon dated. Representative of a wider landscape where such lobes have been dissected. Construction of the Sevenoaks bypass in the 1960s/70s caused slip planes to be reactivated
1900	Mark Ash Wood	PN/QA SC E	SU247069 and SU250076	RTM	The two valley mire sites that form Mark Ash Wood GCR (Church Moor and Barrow Moor) together provide an almost complete record of vegetation development starting in the Late-glacial Windermere Interstadial (Church Moor) and a valuable high-resolution record of late Holocene woodland dynamics and changing management strategies that is missing from other New Forest sequences
845	Mountain Wood	PN/QA SE E	TQ093509	RTM	One of a network of ancient high-level gravels - here with the potential to illuminate long-term landscape denudation and evolution of the Weald
2017	North Cliff, Broadstairs	PN/QA SE E	TR399684	PG	Complex sequence of sediments overlying frost-disturbed Chalk and comprising Middle Devensian solifluction deposits, Late Devensian loess and brickearths, late-glacial solifluction deposits separated by fossil soil horizons and post-glacial hillwash
785	Oaken Wood	PN/QA SE E	TQ701548	PG	The best example in Britain of ridge and trough topography produced by intense cambering and gulling. This unusual type of topography is confined to the Maidstone area and the north Cotswolds.
783	Pegwell Bay	PN/QA SE E	TR348641	PG	The most important British locality for loess, a relatively rare sediment type in Britain, here found in thicknesses up to 4 m
1938	Priory Bay	PN/QA SC E	SZ635900	SL	Pleistocene gravels of debated depositional origin with a rich Palaeolithic Acheulian handaxe industry
780	Rake Bottom	PN/QA SC E	SU710207	CL	Spectacular, steep-sided, chalk dry valley with two right-angle bends, underlain by various Pleistocene slope deposits and adjacent to the important archaeological complex on Butser Hill
1903	Rimsmoor	PN/QA SC E	SY814922	RTM	An exceptionally thick peat accumulation in a doline feature that provides evidence of chalkland vegetation change from the Middle Holocene to the present
787	Rusthall Common	PN/QA SE E	TQ568395	PG	Provides excellent evidence of cambering in the Ardingly Sandstone and sandstone weathering features. Location of 'Toad Rock', a spectacular, isolated block of sandstone formed by periglacial weathering / erosion and resting on a narrow pedestal in front of the main sandstone outcrop

2021	Selsey West and East Beaches	PN/QA SC E	SZ843931 and SZ860925	SL	Two estuarine / freshwater / marine channel fills of seemingly different ages with abundant fossils including vertebrate fossils and the ‘Selsey mammoth’ in the East Beach Channel which is ascribed to the penultimate interglacial. Both are overlain by beach gravels of last interglacial age. Selsey East Beach is a GCR Pleistocene Vertebrate Site: 1201 - Selsey East Beach - SZ 860 925
2045	Solent Cliffs West	PN/QA SC E	SZ200930	RTM	One of a network of sites chosen to represent the sedimentology and stratigraphy of key gravel bodies of the former Solent River – here comprising 3 or 4 gravel bodies depending on interpretation, also including the rich Palaeolithic assemblages found at Barton on Sea
1206	Spot Lane Quarry	PN/QA SE E	TQ793542	PG	Complete section through a series of cambered Hythe Formation blocks and associated fossiliferous, loess-filled gulls in Britain dated using thermoluminescence and yielding a land snail fauna
1870	Stone Point	PN/QA SC E	SZ459985	SL	The only fossil-rich estuarine channel fill preserved in the west of the region, thought to be of last interglacial age and over and underlain by gravels of the former Solent River
1171	Sturry Gravel Pits	PN/QA SE E	TR174607	RTM	One of a network of sites characterising river gravels of the Kentish Stour, here from the third terrace and yielding Middle Acheulian handaxes and Levallois artefacts
1234	The Mole Gap	PN/QA SE E	TQ165531 and TQ175516	RTM	Classic geomorphological locality with multiple well-developed landforms including periglacial debris fans, river cliffs (e.g. at the Whites) and swallow holes
454	Upper Common	PN/QA SE E	TQ084499	RTM	One of a network of ancient high-level gravels - here containing numerous marine fossils with Red Crag affinities
1172	Upper Hale	PN/QA SC E	SU823494	RTM	One of a network of ancient high-level gravels - here of the Caesar’s Camp Gravel whose origin has been widely disputed
2036	Upper Halling	PN/QA SE E	TQ689635	CL	Sequence of Holocene hillwash overlying lighter-coloured Devensian and Late Devensian deposits containing a prominent grey rendsina soil radiocarbon dated and ascribed to the Allerød. The molluscan fauna and lithological changes provide a valuable record of Late Devensian to Holocene environmental history.
1904	Valley of Stones	PN/QA SC E	SY598875	PG	Individual sarsens in a Chalk dry valley with particularly fine sarsen breccia types.
2260	Wateringbury	PN/QA SE E	TQ688534	RTM	Tufa deposit containing a detailed record of early Holocene mollusc biostratigraphy

tbc	Wear Farm Pit, Chislet	PN/QA SE E	TR 224650	RTM	One of a network of sites characterising river gravels of the Kentish Stour, here from a low terrace and yielding a wealth of vertebrate and molluscan fossils and some Palaeolithic artefacts
1940	Wood Green Gravel Pit	PN/QA SC E	SU172170	RTM	Terrace gravel of Hampshire Avon 7th terrace with an extremely abundant Palaeolithic artefact assemblage containing twisted ovate type handaxes

Table 1. GCR sites from blocks 80 and 81, with codes, showing where their site descriptions are published. Since the original designation, Corfe Castle (1899) has been deselected, Mark Ash Wood (1900) boundaries have been enlarged to include Barrow Moor and Bishopstone to Reculver Cliffs (tbc) Wear Farm Pit, Chislet (tbc) have been proposed. Site 1643 (Portland Bill) has already been published by Keen (1998). Sites noted CL are published in Whiteman and Haggart (this volume); sites noted PG are published in Whiteman (this volume); sites noted RTM are published in Briant et al. (this volume a); sites noted SL are published in Briant et al., (this volume b).