THE LOWER PALAEOLITHIC SITE OF BROOM:
GEOARCHAEOLOGICAL IMPLICATIONS OF OPTICAL DATING

R.T. Hosfield & J.C. Chambers

INTRODUCTION

This report presents the results of three seasons' fieldwork and an initial optical dating programme at the Lower Palaeolithic site of Broom (ST 328025 and ST 326020). The site is located in the River Axe valley on the Devon/Dorset border (Hosfield & Terry 2000) and has yielded the largest Acheulean artefact assemblage in southwest Britain. Up to 1800 artefacts, predominantly handaxes, were recovered during the commercial excavation of the Broom gravel pits from the late 19th century onwards (Green 1988). Chert artefacts are dominant in the extant assemblages, reflecting the Foxmould Chert Beds of Upper Greensand that are incised by the modern River Axe upstream of Broom (Shakesby & Stephens 1984).

Despite the long history of the site and several independent studies (Reid Moir 1936; Stephens 1970, 1974, 1977; Green 1974, 1988; Shakesby & Stephens 1984; Marshall 2001), the exact age of the assemblage has remained unknown. The difficulties in dating are further complicated by the low elevation of the artefact-bearing deposits relative to the modern River Axe (Figure 1), the absence of other terrace landforms in the vicinity of the Broom deposits, the unsubstantiated claims for Levallois artefacts, and the conflicting accounts of the stratigraphic origins of the artefacts within the Broom fluvial sequence (Reid Moir 1936; Shakesby & Stephens 1984; Green 1988).

Figure 1: Schematic section of the Broom site by C.E. Bean (after Green 1988: Fig. 2). Note the low-lying elevation of the sediments relative to the height of the modern River Axe.

1 Dept. of Archaeology, University of Southampton, Southampton SO17 5BJ

Fifteen sections were excavated at Broom between September 2000 and September 2002, in the Railway Ballast Pit (sections 1–7), Pratt’s New Pit (sections 8–13) and Pratt’s Old Pit (sections 14–15). The sections exposed the three principal sedimentary units at Broom: the lower gravels, middle beds and upper gravels (Figure 2), which follow the Bridgland (1996) ‘sandwich’ model of terrace formation. The key observations from the field seasons were:

- The presence of fine-grained sediments (bedded and massive sands) within the upper gravel deposits exposed in the Railway Ballast Pit (section 1) and Pratt’s New Pit (sections 9, 10 and 13 — Figure 3).
- Laminated sands, silts and clays associated with the middle beds in Pratt’s Old Pit (section 14 — Figure 4).
- The presence of iron/manganese horizons throughout the sequence, most commonly in the lower gravels of the Railway Ballast Pit.
- Frequent vertical variations in the composition of the coarse-grained sediments, with respect to grain size, sorting, bedding and matrix colour.
- Sharp, erosive contacts separating sedimentary units throughout the sequence.

The excavations over the course of three field seasons produced only five flakes. This paucity of finds in comparison with the extant assemblages from the site not only reflects the relatively small sections that have been exposed but may also be indicative of the distribution of artefacts within the surviving deposits.

INTERPRETATION

The existing models of the Broom sediments (a tripartite sequence of lower gravels–middle beds–upper gravels) had indicated long-term variation in the fluvial regime, which can be related to the Bridgland models of climatically-driven terrace formation (Bridgland 1994, 1996, 2000, 2001; Maddy et al. 2001). However, the current excavations have also provided extensive evidence of shorter-term fluctuations. This is best illustrated by the occurrence of fine-grained sediments within the coarse-grained upper gravel deposits (e.g. sections 1, 9, 10 and 13), but it is also evident in the variations within the coarse-grained sediments (Figure 5). It is suggested that the Axe Valley rivers were responding to relatively brief, sub-MIS climatic oscillations (ranging from stadial/interstadial events to seasonal variations in discharge). However, the small size of the excavated sections do provide potential for apparently temporal (vertical) variation to be a result of migrating river channels and the exposure of a different sub-environment of the floodplain (e.g. laminated, fine-grained sediments suggesting still-water depositional conditions in an abandoned channel or pond were only exposed in section 14 at Broom).

The correlation of aggradational events with climatic oscillations implies that there are significant periods of inactivity (associated with phases of climatic stability) in the development of fluvial sedimentary sequences. This proposition is supported at Broom by the iron/manganese
Heights refer to heights above and below site datum. Widths of enlarged sections not to scale.

Key:
- Quarry backfill & collapse, and topsoil
- Sands
- Upper gravels
- Middle Beds (clays, silts & sands)
- Lower gravels
- Undifferentiated gravels
- Optical dating samples

Pratt's Old Pit & Pratt's New Pit

Railway Ballast Pit

Sections 14, 10, 11, 13 & 9

Sections 4, 6 & 1

Sections 2 & 3 Section 5

Sections 11 +7.46m
+5.99m
+10.74m
+10.12m
+9.05m
+8.74m
+8.46m
+8.68m
+8.26m
+5.59m
+2.82m
+1.92m
+7.39m
+5.57m
+4.39m
+0.10m
+0.50m
+0.25m
+0.10m
+10.27m
+9.51m
+6.25m
+0.69m
+0.96m
-0.49m
-1.70m
-1.68m
+0.69m
+0.30m
+0.51m
-0.28m
-0.69m
-1.00m
-1.68m
-0.28m
-0.69m
-1.00m
-1.68m
-0.28m
-0.69m
-1.00m
-1.68m

Figure 2: Selected Broom sections (2000–2002). The locations of the optical dating samples (2001) are indicated.
Figure 3: massive, fine-grained sands (sampled for optical dating), section 13 (Pratt’s New Pit)

Figure 4: laminated sands, silts and clays, section 14 (Pratt’s Old Pit)
horizon evidence for temporary landsurface development within the fluvial sediments. The presence of the landsurfaces suggests significant hiatus and periods of relative fluvial stability, although the lack of weathering evidence and cryoturbation features indicates that the breaks in fluvial activity were not of considerable length.

The current interpretation of the Broom sequence therefore emphasises both long-term (lower gravels–middle beds–upper gravels) and short-term (coarse-grained–fine-grained) fluctuations in river activity, which is tentatively related to MIS and sub-MIS climatic variations. Optical dating techniques were therefore applied to the site, in an attempt to identify the MIS cycle and investigate whether there was evidence for sub-MIS fluctuations within the sedimentary sequence.

**OPTICAL DATING**

Four optical dating samples were collected in September 2001 (Figure 2). Two samples (GL02083 and GL02084) were collected from the middle beds (sands, clays and silts), exposed in section 2 (the Railway Ballast Pit). One sample (GL02082) was collected from a sand lens within the upper gravels of section 1 (also the Railway Ballast Pit). The final sample (GL02085) was collected from a sand lens within the upper gravels of section 9 (Pratt’s New Pit — Figure 6). Gamma spectra were recorded in situ and quartz was used as the minerogenic dosimeter, reflecting the stability of its datable signal over the Quaternary period. Equivalent dose values were obtained using a single-aliquot regenerative-dose (SAR) protocol, while increased age accuracy was achieved by the detection of aliquots primarily composed of partially bleached grains. Further details of the optical dating methodology are available in Hosfield et al. (in prep) and the estimated ages are listed below (Table 1).

<table>
<thead>
<tr>
<th>Sample</th>
<th>Section</th>
<th>Height (m) (relative to site datum)</th>
<th>Age (kya)</th>
</tr>
</thead>
<tbody>
<tr>
<td>GL02082</td>
<td>1</td>
<td>+5.23</td>
<td>248±19</td>
</tr>
<tr>
<td>GL02085</td>
<td>9</td>
<td>+4.57</td>
<td>273±22</td>
</tr>
<tr>
<td>GL02083</td>
<td>2</td>
<td>+0.42</td>
<td>253±16</td>
</tr>
<tr>
<td>GL02084</td>
<td>2</td>
<td>-0.36</td>
<td>250±15</td>
</tr>
</tbody>
</table>

*Table 1: optical dating sample estimated ages (and sample heights)*
Eight new samples were collected in January 2003. Four further samples were collected from the section 9 sand lens, two further samples from the section 2 middle beds, and two samples from a sand lens within the upper gravels of section 13 (Pratt's New Pit — Figure 4). Analysis of these samples is currently ongoing.

**Figure 6: bedded, fine-grained sands (sampled for optical dating) and upper gravels, section 9 (Pratt’s New Pit)**

**GEOARCHAEOLOGICAL IMPLICATIONS**

The optical dating samples indicate a mid–late MIS-8 age for the deposition of the middle beds and upper gravels at Broom. The age of the lower gravels is currently unknown, due to the inaccessibility of the sediments, although the likeliest age is probably early MIS-8 or late MIS-9. There are clear stratigraphic reversals in the dating sequence (Table 1), although this is unsurprising given the magnitude of the error ranges associated with the optical dates.

Recent research has begun to demonstrate high resolution links between fluvial activity and short-term climatic fluctuations in the Late Pleistocene and Holocene (e.g. Rose et al. 1980; Vandenbergh 1993, 1995, 2001, 2002; Collins et al. 1996; Maddy et al. 2001). The Broom data has suggested some possible links during a short phase of the Middle Pleistocene between 270,000 and 250,000 kya. The Vostok ice-core indicates a sub-MIS warm–cold transition at c. 280–270,000 kya and two sub-MIS warming ‘spikes’ at c. 255–250,000 kya (Petit et al. 1999: Fig. 2). A preliminary correlation with two of the dated sedimentation events (the fine-grained sands within the upper gravels of section 1 (273±22 kya) and the mid–middle beds of section 2 (250±15 and 253±16)
respectively) is therefore suggested here.

It is emphasised that the fine-grained/coarse-grained sedimentary variations (represented by the middle beds and within the upper gravels) are not considered to be evidence for continuous accumulation over the time periods associated with the sub-MIS interstadial events and short-term climatic oscillations (lasting 100s and 1,000s of years). They are rather suggested to be evidence of one or more extremely short-term variations in discharge (seasonal or even single storm events). The key point is that the frequency and magnitude of the storm events (and the magnitude of seasonal variations) are proposed to have been significantly greater during periods of climatic change and oscillation (Vandenberghe 1995). Consequently, some (although not all) of these seasonal variations and storm discharges are represented by sedimentary variations within fluvial terrace sequences.

It is noted however, that vertical sedimentary variations within predominantly coarse-grained deposits (e.g. the Broom upper gravels) may represent channel migrations and changing floodplain morphology, rather than major shifts in fluvial activity associated with climatic oscillations.

The time span associated with the accumulation of the Broom sediments is fundamental for the interpretation of morphological patterns within the artefact assemblage. Charles Bean (Green 1988) observed that the majority of the Broom handaxes are associated with the middle beds, which would suggest a relatively short depositional period for the artefacts. Bean also identified a strong morphological trend within the assemblage towards the amygdaloid form (approximately half of the 1,000 handaxes, although current work suggests that the dominance of the amygdaloid form was exaggerated). Explanations for this morphological patterning may include some or all of the following: raw material constraints; artefact function; and cultural/stylistic groupings. While a cultural/stylistic argument is tenable for relatively short time spans (e.g. through the mechanism of knowledge transmission over a handful of generations), the impacts and constraints of raw material quality and artefact function are suggested to be durable manufacturing considerations, independent of the cultural transmission of knowledge. Unfortunately, the current optical dating resolution at Broom is unable to accurately date the duration of the middle beds' depositional phase. Further resolution of this issue therefore awaits the second series of optical dates and the results of ongoing analysis of the artefact assemblage.

Nonetheless, the current dates indicate a notable, terminal Lower Palaeolithic (MIS-8) presence in southwest Britain. These dates also highlight the paucity of Levallois material (two flakes and one core were documented by Wessex Archaeology (1993) in the extant assemblages). Given the quality of the Broom chert and the manufactured handaxes, a poor quality raw material hypothesis is not supported here as an explanation for the paucity of Levallois artefacts. It may rather reflect regional preferences in manufacturing techniques, or even the mid–late MIS-8 age of the Broom sediments — in other words, the sands and gravels were deposited slightly too early to contain the first evidence of Levallois technique in south-west Britain.
CONCLUSIONS

The current work at Broom has demonstrated:

1. A substantial terminal Lower Palaeolithic presence in southwest Britain, provisionally dating to c. 250–270,000 years BP.
2. There are potential links between fluvial sedimentary sequences and high-resolution climatic events, although the current magnitudes of error associated with optical dating limit our ability to definitively demonstrate these associations in the Middle Pleistocene.
3. That the apparent absence of Levallois material at Broom is enigmatic, and may be due to a number of different factors which are currently under further investigation.

ACKNOWLEDGEMENTS

RTH would like to take this opportunity to thank Mr and Mrs Lunt and Mrs Jennings for their generous permission to excavate on their lands between 2000 and 2003. This research has been supported by the British Academy, the University of Southampton (Department of Archaeology), and English Heritage (Aggregates Levy Sustainability Fund), all of whose support is gratefully acknowledged. The research was partly carried out while RTH was undertaking a British Academy-funded Postdoctoral Research Fellowship (1999–2002). And finally, thanks to all those who worked at Broom between 2000 and 2002.

BIBLIOGRAPHY


Hosfield, R.T., Toms, P. Chambers, J.C. and Green, C.P. In prep. Late Middle Pleistocene dates from the Broom Palaeolithic sites


