

RESEARCH REPORT SERIES no. 121-2011

SILBURY HILL, WILTSHIRE LUMINESCENCE SAMPLING

SCIENTIFIC DATING REPORT

Helen Roberts and Geoff Duller



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WILTSHIRE

LUMINESCENCE SAMPLING

Helen Roberts and Geoff Duller

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SUMMARY

Five locations which may potentially be suitable for luminescence dating in the future were sampled within Silbury Hill during the remediation and preservation works which took place at the site in July 2007. This report describes the samples taken, their locations within the mound, and reports the field gamma spectrometry and water content measurements.

CONTRIBUTORS

Helen Roberts and Geoff Duller

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Wiltshire and Swindon Historic Environment Record
Wiltshire Archaeology Service
The Wiltshire and Swindon History Centre
Cocklebury Road
Chippenham
Wiltshire SN15 3QN

DATE OF SAMPLING

2007

CONTACT DETAILS

Helen Roberts
Aberystwyth Luminescence Research Laboratory
Institute of Geography and Earth Sciences
Aberystwyth University
Aberystwyth
Ceredigion
Wales SY23 3DB
hmr@aber.ac.uk

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INTRODUCTION

During the remediation and preservation works which took place at Silbury Hill, Wiltshire in July 2007, the opportunity was taken to take samples suitable for luminescence dating from within the mound whilst this material was accessible. At the time of sampling, 23rd July 2007, the intention was not to date the material sampled, but rather to take material suitable for consideration for luminescence dating or dating by some other techniques in the future. The material was sampled in such a way as to make it suitable for luminescence dating, but the immediate intention was for the material to be archived by English Heritage. Five locations were sampled from within Silbury Hill, under conditions suitable for future luminescence dating work. This report describes the samples taken, their locations within the mound, and reports the field gamma spectrometry and water content measurements.

SAMPLE COLLECTION AND DOSIMETRY

Five locations ("OSL 1–5") were sampled inside the mound, in a manner suitable for future luminescence work to be conducted (Table 1). Three luminescence samples were taken at each of the five sample sites (see Table 1 and 2 for EH-assigned names); in addition, at 'OSL' site 5 a fourth sample suitable for luminescence dating was also taken (shown in Table 2, but not assigned an EH sample name). Samples were collected either by inserting an opaque plastic tube of 50mm diameter and ~ 0.2m length into the section, or where this was not possible by directly placing sediment into a double-thickness black plastic bag under black-out conditions within the tunnel. During removal of sample tubes or collection of sediment into black bags, the white lighting within the tunnel was switched off and sampling was conducted under subdued red-lighting conditions from a head-torch (Fig 1).

Table 1: List of locations within Silbury Hill sampled for luminescence dating archive, July 2007.

'OSL' Sample Site #	EH Sample Numbers	SDD	Context	Description
1	9134-9136	5.36	4041	From old ground surface underneath bank 5
2	9146-9148	75.57/58	3024	From bank 1
3	9143-9145	5.64	4041	From old ground surface below upper organic mound
4	9140-9142	5.62	4103	From interface of organic upper mound with capping clays
5	9137-9139	5.44	4041	From old ground surface underneath bank 4

Table 2: List of luminescence samples taken during July 2007 sampling exercise

'OSL' Sample Site #	'OSL' Sample number (EH)	Context	Bay	Sample type	Field gamma spectrometry location	Sampling notes
1	9134	4041	36	Tube	✓	Taken at boundary of clay and chalk units, sampling clay unit; innermost end of tube ridden up into chalk unit
1	9135	4041	36	Bag		Preferential sampling of clay layer
1	9136	4041	36	Bag		Preferential sampling of clay layer
2	9146	3024	55	Tube	✓	Sampled 'Silbury Bank' unit below chalk
2	9147	3024	55	Bag		
2	9148	3024	55	Bag		
3	9143	4041	64	Bag	✓	Turf mound, underneath 'Silbury I': clay and flint unit sampled
3	9144	4041	63	Bagged block		Chalk cap, organic horizon and clays, overlying clay and flint layer sampled
3	9145	4041	63	Bagged block		Chalk cap, organic horizon and clays, overlying clay and flint layer sampled
4	9140	4103	62	Bag	✓	Turf stack sampled above 'Silbury I'
4	9141	4103	62	Tube		
4	9142	4103	62	Tube		
5	9137	4041	44	Bag	✓	Sample taken through clay unit lying above clay with flints
5	9138	4041	44	Tube		
5	9139	4041	44	Tube		
5	None given	4041	44	Bag		Additional black-bag of material suitable for luminescence; no EH number assigned



Figure 1: Sampling under subdued red-lighting conditions; photograph was taken using flash photography. The light-exposed outer portion of each sample was removed prior to taking the sample from the section (Photo: H M Roberts)

Many of the samples were collected from sediments which could potentially have a heterogeneous dose rate. For this reason, a measurement of the *in situ* radiation dose rate at each of the five sites sampled was made using a MicroNomad™ portable gamma spectrometer with a 2" diameter NaI crystal, which was inserted at least 0.3m into the section (Fig 2). Where possible, the gamma spectrometry measurement was made where a tube sample had been taken, using an auger to slightly extend the sample hole to the appropriate depth for the portable gamma spectrometry probe; at sample sites where continued augering was not possible due to the stony nature of the sediments or where only bag samples were taken, the auger was used at one of the bag-sample locations to create a hole of sufficient length to accommodate the gamma spectrometry probe (Tables 2 and 3 indicate the luminescence sample closest to the gamma spectrometry measurement location at each of the five sites sampled). The Aberystwyth gamma spectrometer was calibrated in the 'Oxford calibration blocks' (Rhodes and Schwenninger, 2007) and is routinely checked within a standard block in Aberystwyth prior to and following use in the field. The potassium, uranium, and thorium measurements derived from the field gamma spectrometry measurements, and the gamma dose rate calculated from these values using the conversion factors of Adamiec and Aitken (1998), are shown in Table 3.

Table 3: Potassium, uranium, and thorium concentrations derived from in situ field gamma spectrometry measurements, and the gamma dose rate calculated from these values using the conversion factors of Adamiec and Aitken (1998). The EH sample number shown is that which relates most closely to the gamma spectrometry measurements made at each of the five sample sites

Luminescence Sample Site #	EH Sample Number	In-situ gamma spectrometry			Gamma Dose Rate (Gy/ka)
		K (%)	U (ppm)	Th (ppm)	
OSL 1	9134	0.45 ± 0.02	1.32 ± 0.06	3.93 ± 0.17	0.446 ± 0.012
OSL 2	9146	0.14 ± 0.01	0.46 ± 0.04	0.89 ± 0.07	0.128 ± 0.006
OSL 3	9143	0.69 ± 0.03	1.91 ± 0.07	4.58 ± 0.18	0.602 ± 0.014
OSL 4	9140	0.52 ± 0.02	1.36 ± 0.06	3.73 ± 0.16	0.458 ± 0.011
OSL 5	9137	0.50 ± 0.02	1.50 ± 0.06	4.51 ± 0.18	0.506 ± 0.012



Figure 2: Taking in situ field gamma spectrometry measurements (Photo: G A T. Duller)

In addition to the sediments taken and wrapped in light-safe wrappings described thus far, a small amount (between ~60 – 150g) of the material sampled at each of the five sites was placed into a clear plastic bag to allow easy examination under white-light conditions in future. A further small sample was taken from the deepest part of each gamma spectrometry auger hole to allow for assessment of the field water content. The water content samples were dried to a constant mass at 50°C, and the water content shown in Table 4 is calculated as the mass of water divided by the mass of dry sediment. All other samples were sealed in the field and stored under refrigerated conditions at Aberystwyth University since collection.

Table 4: Field water content values (%) at the time of sampling, calculated as mass water divided by the mass of dry sediment

Luminescence Sample Site #	EH Sample Number	Field water content (%)
OSL 1	9134	15
OSL 2	9146	12
OSL 3	9143	22
OSL 4	9140	26
OSL 5	9137	21

Detailed sedimentological and archaeological descriptions of the units sampled are given in English Heritage reports describing the excavation work. Photographs of each 'OSL' sample site are shown in Figures 3-7.



Fig 3a



Fig 3b

Figure 3: a) In-situ field gamma spectrometry measurement at 'OSL site 1', EH sample location 9134, and b) close-up photograph of same (Photos: H M Roberts)



Fig 4a



Fig 4b

Figure 4: a) In situ field gamma spectrometry measurement at 'OSL site 2', EH sample location 9146, and b) close-up photograph of same (Photos: H M Roberts)



Fig 5a



Fig 5b

Figure 5: a) 'OSL site 3', and b) close-up photograph of in situ field gamma spectrometry measurement at EH sample location 9143 (Photos: G.A.T. Duller)



Fig 6a



Fig 6b

Figure 6: a) In situ field gamma spectrometry measurement at 'OSL site 4', EH sample location 9140, and b) close-up photograph of 'OSL' site 4 showing (L-R) sample tubes 9141 and 9142 for scale (23cm in length) (Photos: H M Roberts)



Fig 7a



Fig 7b

Figure 7: a) 'OSL site 5', EH sample location 9137, and b) close-up photograph of sample holes remaining after taking EH samples 9137, 9138, 9139 and the additional un-coded sample (listed in Table 2) (Photos: H M Roberts)

CONCLUDING REMARKS

Samples suitable for a potential future luminescence dating campaign were taken in July 2007 whilst the opportunity arose to enter Silbury Hill during renovation and remediation works. These samples were sealed in the field and stored under refrigerated conditions at Aberystwyth University between July 2007 and January 2012. They were then packaged for long-term storage and desposited in cold storage at the British Ocean Sediment Core Research Facility, National Marine Facilities Division, National Oceanography Centre, Empress Dock, Southampton, SO14 3ZH. Recent and ongoing (2011) work taking place at the 'Water Meadows' site adjacent to Silbury Hill, under the English Heritage 'Silbury Romano-British Settlement' project, has revealed sedimentary deposits which appear to be similar to many of those sampled within Silbury Hill itself as described in this report. Initial optically stimulated luminescence (OSL) work at the Water Meadows site has revealed that although coarse-grained (i.e. sand-sized, 63–300 µm diameter) quartz is scarce in the deposits (0.02% of the initial sample mass), the luminescence characteristics of this quartz were found to be suitable for dating using OSL. This suggests that in future, if sufficient coarse-grained quartz can be isolated, it might be possible to date the material sampled from within Silbury Hill itself using a similar OSL approach to that used at the adjacent Water Meadows site.

REFERENCES

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