
Not All That Glitters is Gold? Rock Crystal in the Early British Neolithic at Dorstone Hill, Herefordshire, and the Wider British and Irish Context

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Evidence for working rock crystal, a rare form of water-clear type of quartz, is occasionally recovered from prehistoric sites in Britain and Ireland, however, very little has been written on the specific methods of working this material, and its potential significance in the past. This paper presents the first synthesis of rock crystal evidence from Britain and Ireland, before examining a new assemblage from the Early Neolithic site of Dorstone Hill, Herefordshire. This outlines a methodology for analysing and interpreting this unusual material, and, through comparison with the flint assemblage, examines the specific uses and treatments of this material. Far from being used to make tools, we argue the distinctive and exotic rock crystal was being used to create distinctive and memorable moments, binding individuals together, forging local identities, and connecting the living and the dead.

Introduction: rock crystal and British prehistory

Rock crystal is a water-clear type of quartz, forming in both veins and as single 'hyaline' or 'automorph' crystals; however, in the UK it only forms as single- or double-ended hyaline crystals, usually with a hexagonal cross section. Whilst quartz is a common component of igneous, metamorphic and sedimentary rocks found across the UK, large water-clear quartz crystals are much rarer, only forming in specific geological conditions (Ballin 2008, 44–5; Cotterell 2011). These are restricted to a number of localized areas, including Snowdonia, St David's Head and the area around Merthyr Tydfil in Wales, the area surrounding Tintagel, Cornwall, the Isle of Jura, locations in Argyle and Bute, Aberdeenshire and East Lothian, Scotland, and the Dingle Peninsula in Ireland (Cotterell 2011; forthcoming; Griffiths 2009; Lewis 1846; National Museum Wales n.d.). On the European mainland, rock crystal

forms in veins, and crystals much larger than in the UK, which has provided raw materials for large and impressive artefacts, such as the enigmatic dagger and projectile points from Valencina de la Concepción in Seville, Spain (Morgado *et al.* 2016).

Owing to the scarcity and size of native crystal material, the evidence for working it in the UK is perhaps less dramatic, but also under-reported; to date, there have been no published syntheses of rock crystal in British prehistory, and many examples are only presented within larger discussions of knapped stone, or other material assemblages. However, humanly worked rock crystal has been recovered from a small number of prehistoric sites across Britain and Ireland, many as single pieces, or very small assemblages (see Supplementary material 1; this is intended to be as comprehensive as current enquiry has permitted. However, the authors acknowledge that finds of this material could be

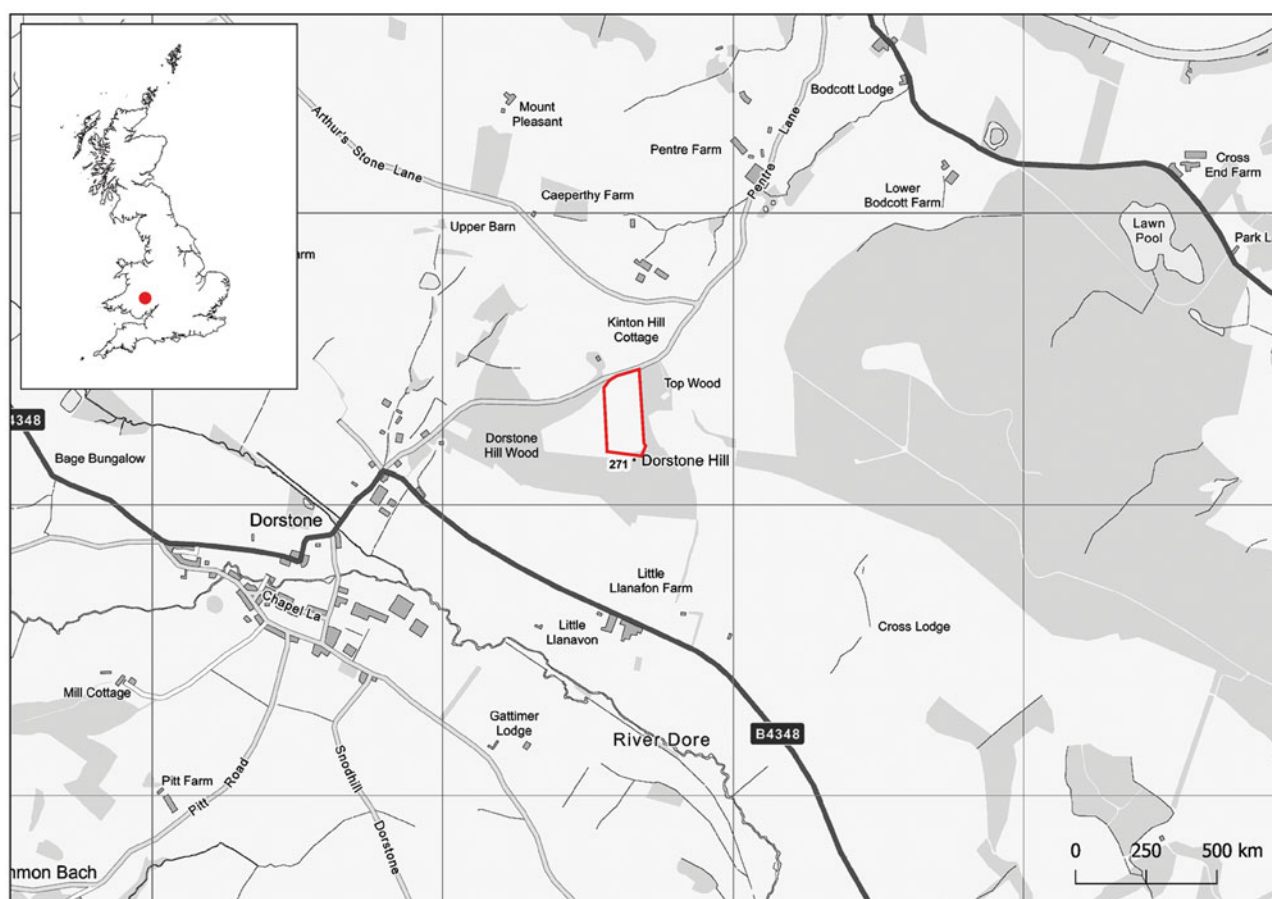


Figure 1. Location of Dorstone Hill, with the field detailed in [Figure 3](#) outlined in red. (Contains OS data © Crown copyright and database right 2020.)

more common than currently appreciated, and welcome reports of other instances which can be added). Aside from the two larger Mesolithic assemblages from the Isle of Jura (consisting of 273 and 146 pieces), the other larger assemblages date to the Neolithic. These focus on mortuary contexts, such as megalithic tombs at Achnacreebeag (Scotland), Parc le Breos (Wales) and Kilnagarns Lower (Ireland), and Early Neolithic timber structures in Ireland, Scotland and England. The association of rock crystal and timber houses is particularly apparent in Ireland, and the inclusion of this material in house foundation trenches has been suggested as potential foundation offerings (Smyth 2011), the most spectacular being a rock crystal leaf-shaped arrowhead being recovered from Ballyglass, Co. Mayo (Driscoll 2010, 40; Smyth 2014).

This paper presents analysis and interpretation of a new assemblage of rock crystal from the Early Neolithic site of Dorstone Hill in Herefordshire. Totalling 337 pieces, this is one of, if not the largest

assemblage of worked rock crystal within Britain and Ireland, offering an important opportunity to examine the working, use and treatment of rock crystal within a British Neolithic context. This analysis will focus on examining the technological process of working rock crystal, providing a detailed reduction sequence, which has been outlined for some continental assemblages (e.g. Fernández-Marchena & Ollé 2016 for Spanish material) but not yet established in British contexts, and a detailed examination of the use and deposition of rock crystal. Comparison to the flint assemblage from this site will highlight a number of differences in the methods of reduction, use and the selective deposition of rock crystal, most notably the apparent lack of tools or utilization, and the selective deposition of pieces with cremated bone deposits within negative features. The paper concludes with a consideration of why rock crystal may have been treated in these specific ways and the role it played within the lives of people at Dorstone Hill,

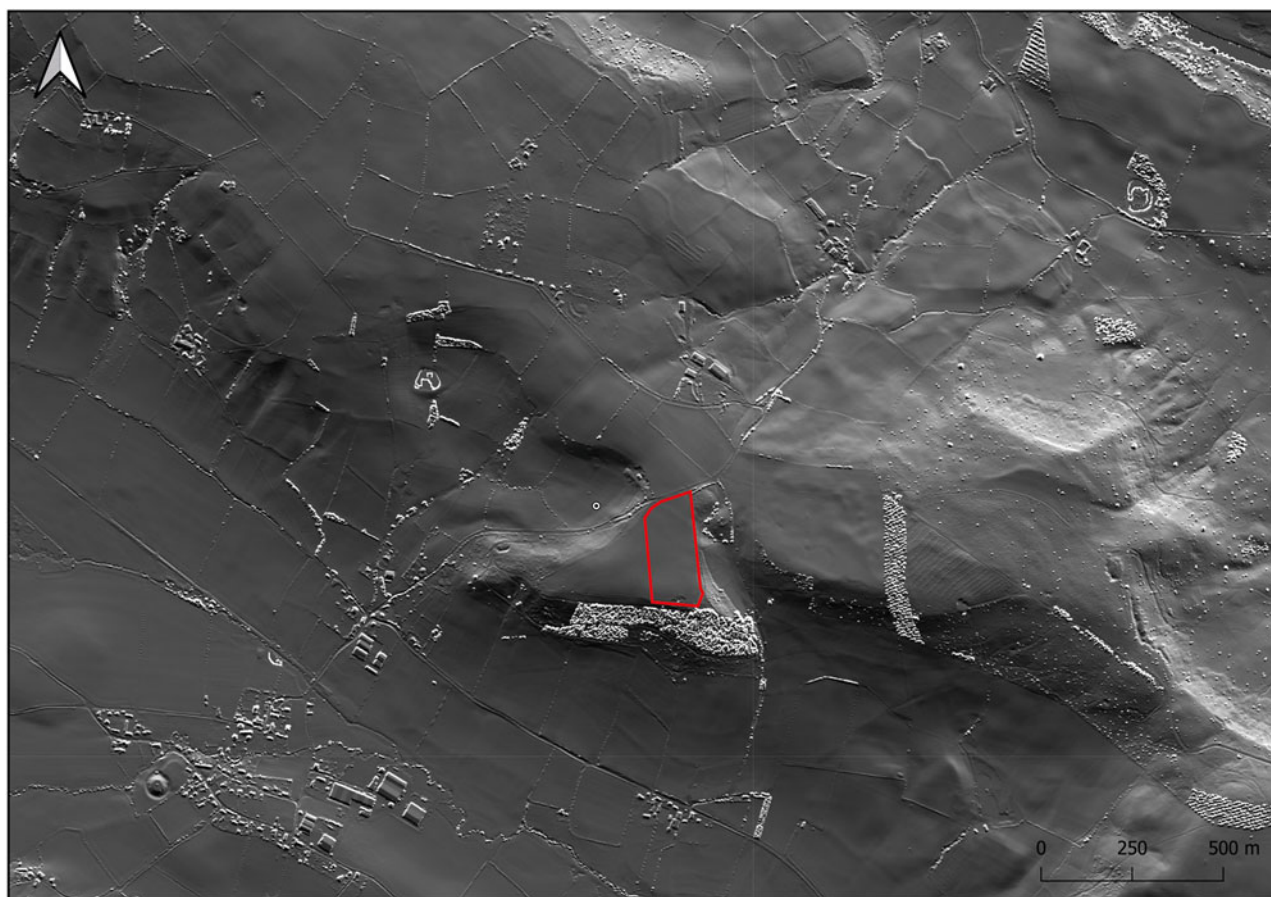


Figure 2. LiDAR survey of Dorstone Hill, with the field detailed in Figure 3 outlined in red. (Contains DEFRA data © Crown copyright 2020.)

and the new lines of enquiry that a focused study of rock crystal can open in the context of the Early Neolithic in Britain and Ireland.

Neolithic rock crystal at Dorstone Hill, Herefordshire

Dorstone Hill is a flat-topped eminence extending southward from the watershed ridge separating the valleys of the rivers Wye and Dore in southwest Herefordshire (Figs 1 & 2). Excavations undertaken here between 2011 and 2019 revealed a monumental Early Neolithic complex, including three timber halls, three long mounds and a causewayed enclosure (cf. Overton *et al.* 2022; Ray & Thomas 2020). The three long mounds (hereafter referred to as the Eastern, Central and Western mounds) were laid end-to-end, and were each constructed of an outer stone cairn deposit, an intermediate earthen and turf deposit and an inner 'core' of intensely burnt daub containing large fragments of carbonized

timber, which had been intentionally gathered into a rectangular shape.

The burnt daub and timber core of the mounds represented parts of the collapsed superstructure of three large wooden buildings, the post-holes of which were uncovered beneath the mounds, again aligned end-to-end. The three buildings have produced a series of radiocarbon dates suggesting that they were constructed in the thirty-eighth or thirty-ninth centuries BC (cf. Ray & Thomas 2020, 109). The Western structure (beneath the Western mound) was comprised of a trapezoidal structure approximately 35×18 m in extent, with a distinct gully running along the axial line, and large load-bearing post-holes along the undisturbed northern side of the structure. The building beneath the central mound was different in construction, using both posts and possible parallel beam slots defining the sides of the building. The eastern building lacked substantial earthfast constructional evidence, having been built on bedrock, but the core of burnt daub

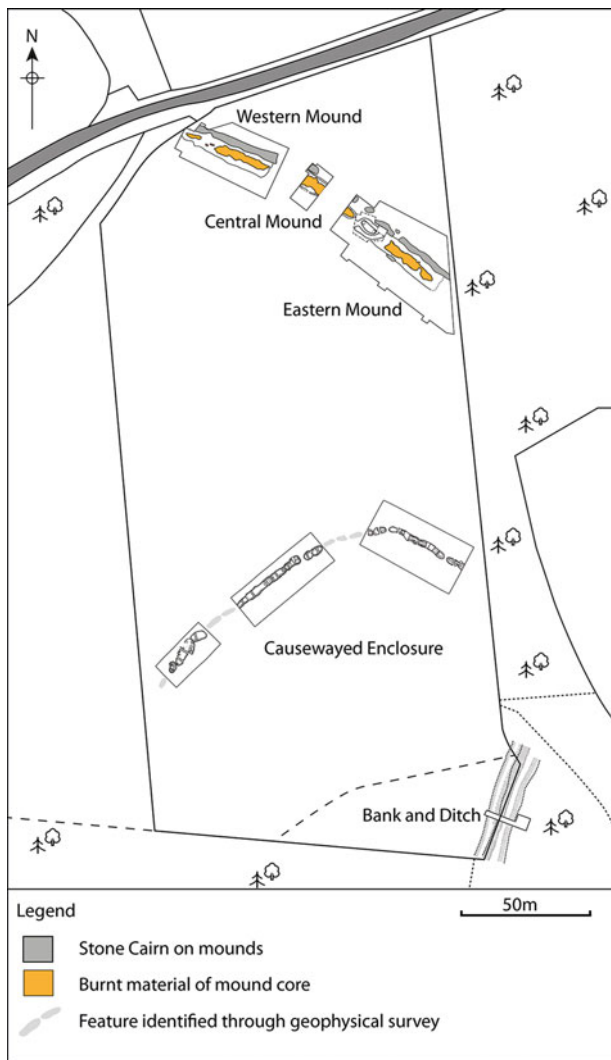


Figure 3. Overall site plan of Dorstone Hill.

was here exceptionally well defined, and contained an area of well-preserved carbonized planks, containing a series of small uprights set in sockets, which may have represented a suspended wooden floor.

Similar to the timber structures, each of the mounds was also architecturally distinct; the turf body of the Central mound was revetted by a wooden palisade set in a cut slot, and later capped by stone cairn material with a number of stone cists being inserted into the northern edge. The Western mound was contained by a stone wall, on to which a number of cellular buttresses were attached, to provide an overall trapezoidal shape in plan, echoing the shape of the structure beneath it. On the northern edge, an orthostatic chamber was set into the wall. Finally, the Eastern mound had no enclosing feature,

but was covered by a cairn that was received by a terrace that had been cut along the northern side of the monument. At the eastern end, this mound covered a trough-like axial chamber that had been bracketed by two massive D-shaped post-holes. This linear mortuary structure had been contained within a U-shaped ditched enclosure and covered by a small mound, suggesting the building and mortuary structure beneath the Eastern mound were standing end-to-end before the long mound was constructed. The Eastern mound later received a series of intrusive features: four large pits that had been lined with sandstone blocks on to which had been placed fragments of cremated human and cattle bone, and a small cylindrical pit close to the site of the mortuary structure, containing a bifacial knife and two polished flint axes.

The remarkable complex of long mounds and buildings on Dorstone Hill was complemented by a single-circuit causewayed enclosure located on the tip of the hilltop overlooking the Golden Valley (Figs 3 & 4). The enclosure was approximately 150×120 m in extent, and its northeast side was flattened in plan, perhaps deliberately to run parallel with the long mounds. Excavations revealed the segmented ditches were subject to extensive re-cutting, including the removal of causeways to create more continuous lengths of ditch, and many small bowl-shaped cuts containing placed objects (including a concentration of large pottery sherds and animal bone). Radiocarbon evidence indicates deposition of one such concentration within the ditch dates to the thirty-seventh/thirty-sixth century BC (Overton *et al.* 2022). Within the eastern edge of the causewayed enclosure a large two-phase bank-and-ditch earthwork divided off the south-east tip of the promontory; based on the artefacts recovered, these appear to date successively to the Iron Age and Roman periods.

The rock crystal assemblage

During excavations at Dorstone Hill between 2011 and 2019, a total of 2686 pieces of chipped stone were recovered. Flint made up the majority of the assemblage (86.8 per cent); rock crystal comprised 12.5 per cent of the assemblage with a total of 337 pieces. There are also 18 examples of polished axes and axe flakes (0.7 per cent of the assemblage), both of flint and stone, which were probably acquired as finished objects. Petrological analysis is on-going; however, the flint axes are made of a type of flint usually associated with flint from primary geological contexts (e.g. mines), while the others of volcanic rock probably originated in north

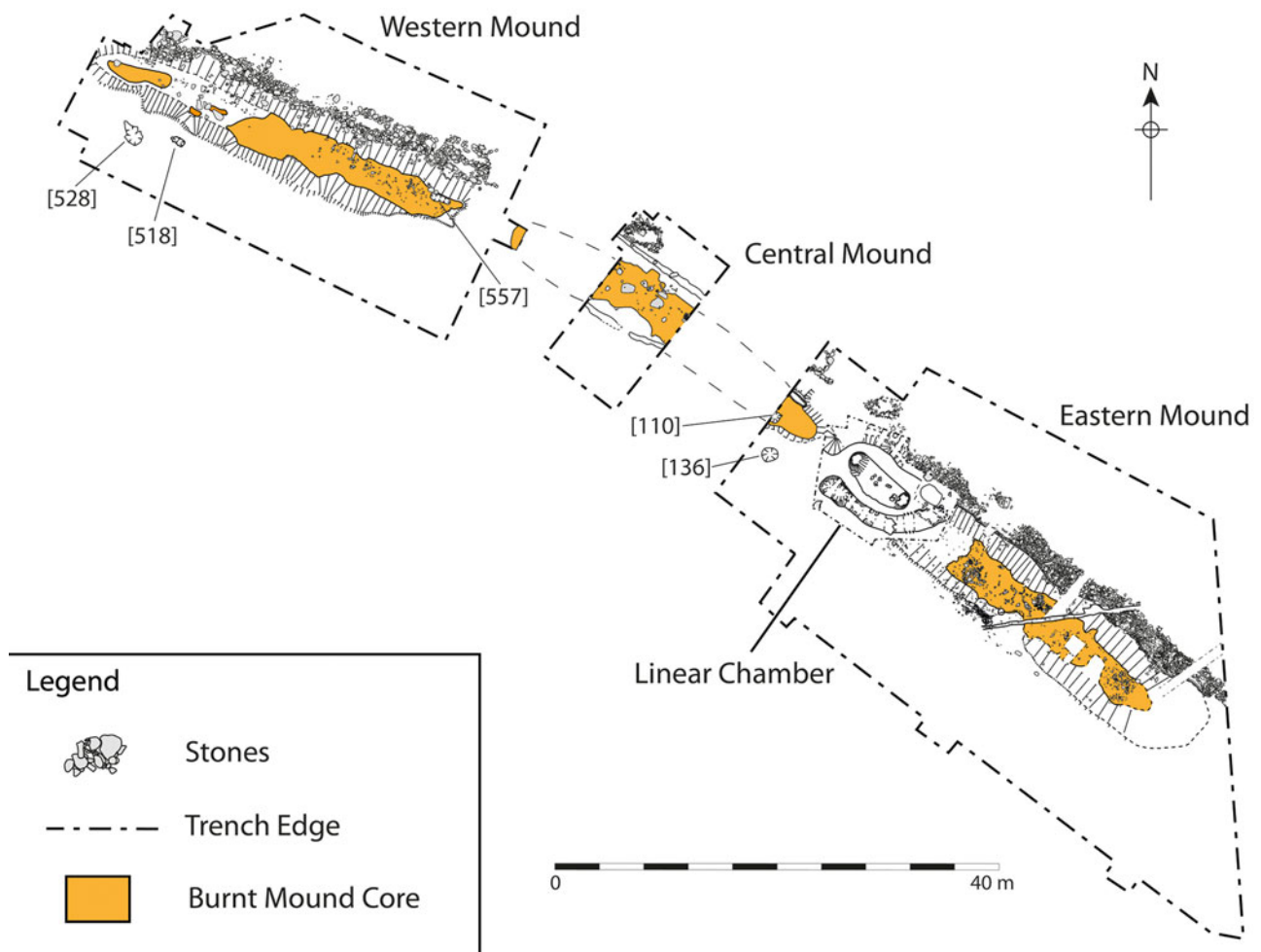


Figure 4. Detailed plan of Eastern, Central and Western mounds. Features discussed in the text are identified with cut numbers.

Wales and Cumbria. Due to local geology, all raw materials used in the chipped-stone assemblage had to be imported to the site; the closest potential sources for flint is *c.* 20 km away (Elliot 2019).

Potential sources of rock crystals large enough to produce the artefacts at Dorstone (the largest removal being 34 mm long) are much further away than those for most of the potential flint sources. Geological specimens measuring in excess of 5 cm in length have been recovered from Ogof Grisial (Crystal Cave) at St David's Head (Pembrokeshire) and multiple sites in Snowdonia, in north Wales (100 miles and 80 miles away from Dorstone Hill respectively, as the crow flies), with larger specimens up to 10 cm in length being recovered from Snowdonia. Both sources represent surface or close to the surface sources, which could feasibly have been accessible during the Neolithic (Cotterell 2011; forthcoming; Griffiths 2009; National Museum

Wales *n.d.*). The South Wales coalfields around Merthyr Tydfil (*c.* 30 miles from Dorstone Hill) may be another potential source; however, known specimens are smaller (a maximum of 4 cm) and have been recovered recently as a result of industrial mining at depth (National Museum Wales *n.d.*), and may not have been a source easily accessible in the Neolithic. High-quality rock crystal has also been recovered from mines surrounding Tintagel, Cornwall (125 miles from Dorstone Hill) (Cotterell forthcoming), although these are subject to the same caveats as for the Merthyr samples. It is also possible the rock crystal originated from Ireland, Scotland or continental Europe (see introduction).

The techno-typological analysis of rock crystal artefacts is challenging, as the fracture characteristics of rock crystal are not identical to those of flint and chert (cf. Fernández-Marchena *et al.* 2020; Tardy *et al.* 2016). Most pertinently, the anisotropic nature

Table 1. Overall quantities of rock crystal recovered from Dorstone Hill, divided by 'type' and area of the site.

	Eastern Mound	Central Mound	Western Mound	Causewayed enclosure	Bank and ditch	Total	%
Blade	1		1			2	0.59
Blade-like flake		3	2			5	1.48
Flake	6	6	7	5		24	7.12
Core			1	1		2	0.59
Chips & fragments	23		268	3	1	295	87.54
Whole crystal				1		1	0.30
Crystal fragment				2		2	0.59
Chunk				6		6	1.78
<i>Total</i>	<i>30</i>	<i>9</i>	<i>279</i>	<i>18</i>	<i>1</i>	<i>337</i>	<i>100.00</i>

Table 2. All pieces exhibiting natural crystal edges, distributed by piece type, number of crystal edges visible for each piece and the position of the edges within the parent crystal structure. Note that all pieces under 10 mm are recorded in the 'Chips & fragments' category.

Type	Pieces with crystal edges (total number of pieces)	% with crystal edge	Number of faces				Position					
			1	2	3	4 +	Point	Body	Base	Point and body	Body and base	Unident.
Blade	1(2)	50		1				1				
Blade-like flake	3(5)	60	1	1	1			1	1	1		
Flake	13(24)	54.17	2	4	4	3	2	3	1	5		2
Core	2(2)	100	1		1				2			
Chips & fragments	33(295)	11.2	27	6				3	2			28
Whole crystal	1(1)	100				1				1		
Partial crystal	2(2)	100				2			1			1
Chunk	5(6)	83.34	2	1		2			4			1
<i>Total</i>	<i>60(337)</i>	<i>16.76</i>	<i>33</i>	<i>13</i>	<i>6</i>	<i>8</i>	<i>2</i>	<i>8</i>	<i>11</i>	<i>7</i>		<i>32</i>

of rock crystal means that the energy from a blow may not travel evenly through the crystal (Fernández-Marchena & Ollé 2016; Rodríguez-Rellán 2016), and the unique shape of the parent crystal also affects the reduction process. Therefore, while our approach is based on established recording systems for other types of lithic materials, some terminology has been adapted for the specific features of the rock crystal assemblage. The technological categorization that follows should be regarded as preliminary, pending experimental replication to understand better how rock crystal behaves when knapped or pressure-flaked.

For the purpose of this study, we recorded attributes of the crystal, included clarity, texture,

inclusions and evidence for heat alteration, the techno-typological category of each artefact (according to conventional definitions with the addition of whole and partial crystal), the presence of visible modifications (e.g. edge retouch), as well as completeness and metric data. For the larger pieces we also recorded technological attributes including bulb type, striking platform type, platform edge treatment, termination type, dorsal scarring pattern, longitudinal profile and the presence of the natural edge of the crystal (where applicable). Those pieces exhibiting one or more crystal edges offered the potential to locate the specimen within the parent crystal. Where possible, specimens were recorded as 'body' faces along the length of the crystal



Figure 5. Examples of larger pieces within the Dorstone Hill assemblage, including cores and pieces exhibiting crystal edges.

(characterized by growth-lines orientated horizontally to the crystals longitudinal axis), 'point' faces at the tip, (lacking growth-lines), or 'base' faces (characterized by more complex formations where the crystal joins other crystals and/or the vein quartz substrate).

The breakdown by category (Table 1) indicates that complete rock crystals were being reduced at Dorstone Hill. A total of 60 pieces retained portions of the natural edge surface of the crystal (see Table 2 and discussion below), which are comparative to pieces retaining cortex in flint assemblages. These, combined with the presence of one complete crystal and two partial crystals, confirm that the material was being introduced to the site as whole crystals, which were then reduced on site. The larger removals (pieces over 10 mm) were divided into the conventional categories of blades, blade-like flakes and flakes, and the smaller removals (under 10 mm) were comprised of chips and flakes. The 31 larger removals represent 8.7 per cent of the total assemblage, or 73.8 per cent if we discount the smallest debitage. These larger removals range from 10 mm

to 34 mm in length, and are mainly knapped from high-quality crystal, although some pieces show pronounced juddering/stepping towards the distal termination, which can be caused by areas of coarser crystal, and the anisotropy of the crystal (Tardy *et al.* 2016, fig. 17). The smaller removals (chips and fragments), some of which are miniature versions of the larger flakes, are almost certainly the by-products of knapping, confirming reduction was being undertaken locally. The pieces comprising the smaller portion of this category are too small to be deliberately struck pieces, and seem to be a knapping by-product. No 'cores' in the traditional sense are present in the assemblage; however, two pieces have only negative scars and exhibit clear signs of multiple removals being taken from two faces in a systematic manner: these are the most convincing parent pieces, and have therefore been classified here as 'cores'. The larger of these cores (#017, see Figure 5) measures 15×20 mm across one of its flaked surfaces, making it smaller than many of the blades/blade-like flakes/flakes, and both cores appear to at the end of their workability. The 'bifacial' nature of the

Table 3. Overall quantities of chipped stone (all materials) from Dorstone Hill.

	Overall		Mounds		Enclosure		Bank and ditch	
	Count	%	Count	%	Count	%	Count	%
Flake and flake fragment	798	34.06	414	33.60	336	35.29	48	30.19
<20 mm flake and flake fragment	1330	56.76	725	58.85	511	53.68	94	59.12
Core	12	0.51	4	0.57	7	0.74	1	0.63
Chunk/possible core	14	0.60	7	0.57	7	0.74	0	0.00
Arrowhead	41	1.75	22	1.79	13	1.37	6	3.77
Scraper	25	1.07	16	1.30	6	0.63	3	1.89
Point or perforator	8	0.34	5	0.41	1	0.11	2	1.26
Retouched piece	1	0.04	1	0.08	0	0.00	0	0.00
Fabricator	3	0.13	2	0.16	1	0.11	0	0.00
Knife	6	0.26	3	0.24	3	0.32	0	0.00
Axes and axe fragments	18	0.77	11	0.89	7	0.74	0	0.00
Hammerstone	2	0.09	2	0.16	0	0.00	0	0.00
Other	16	0.68	6	0.49	10	1.05	0	0.00
Indeterminate	69	2.94	20	1.14	50	5.25	5	3.14
<i>Total</i>	<i>2349</i>		<i>1238</i>		<i>952</i>		<i>159</i>	

Table 4. Comparison of rock crystal and flint and other lithic material assemblages (with smallest debitage category removed).

	Rock crystal overall		Flint and other lithic materials overall	
	Frequency	%	Count	%
Blade/flake and flake fragment	31	73.81	798	78.78
Core	2	4.76	12	1.18
Chunk/possible core	6	14.29	14	1.38
Arrowhead	0	0.00	41	4.05
Scraper	0	0.00	25	2.47
Point or perforator	0	0.00	8	0.79
retouched piece	0	0.00	1	0.10
Fabricator	0	0.00	3	0.30
Knife	0	0.00	6	0.59
Axes and axe fragments	0	0.00	18	1.78
Whole and partial crystal	3	7.14	n/a	n/a
Hammerstone	0	0.00	2	0.20
Other	0	0.00	16	1.58
Indeterminate	0	0.00	69	6.81
<i>Total</i>	<i>42</i>	<i>100.00</i>	<i>1013</i>	<i>100.00</i>
<i>Total formal tools</i>	<i>0</i>	<i>0</i>	<i>102</i>	<i>10.07</i>

reduction of these pieces could also indicate they were the intended product, especially given the small size and limited utility of the visible removals.

Overall, the assemblage indicates the introduction of whole crystals to Dorstone hill, which were reduced, producing larger blades and flakes, smaller debitage and cores in the form of exhausted crystals.

The flint assemblage, like the rock crystal, was largely dominated by small flakes, which, with the presence of cores, indicate flint was reduced on site, but also modified to create ‘formal’ tools (Table 3). After the removal of the smallest flake/flake fragment category, cores make up 1.8 per cent of the flint assemblage, but 4.7 per cent of the rock crystal assemblage, possibly indicating more on-site knapping of the latter. The two assemblages also contrast in the frequency of formal tools; a total of 102 formal tools were recovered from the Dorstone Hill sites, representing 4.4 per cent of the total assemblage, or 10.1 per cent after the removal of the smallest category of debitage (see Tables 3 & 4). In contrast, the rock crystal assemblage contained no formal tools, retouched pieces, or pieces with macroscopic edge-use, and the crystals continued to be reduced after the point at which the removals would have been a usable size. Among the flint, some of the formal tools, notably the axes, almost certainly arrived at the site as finished pieces; however, the scrapers, perforators, fabricators, knives and some of the arrowheads were made on larger flakes of the same dark grey flint that dominates the assemblage. Furthermore, the arrowheads of a different type of flint appear to be accompanied by debitage to suggest they, too, could have been made, or at least

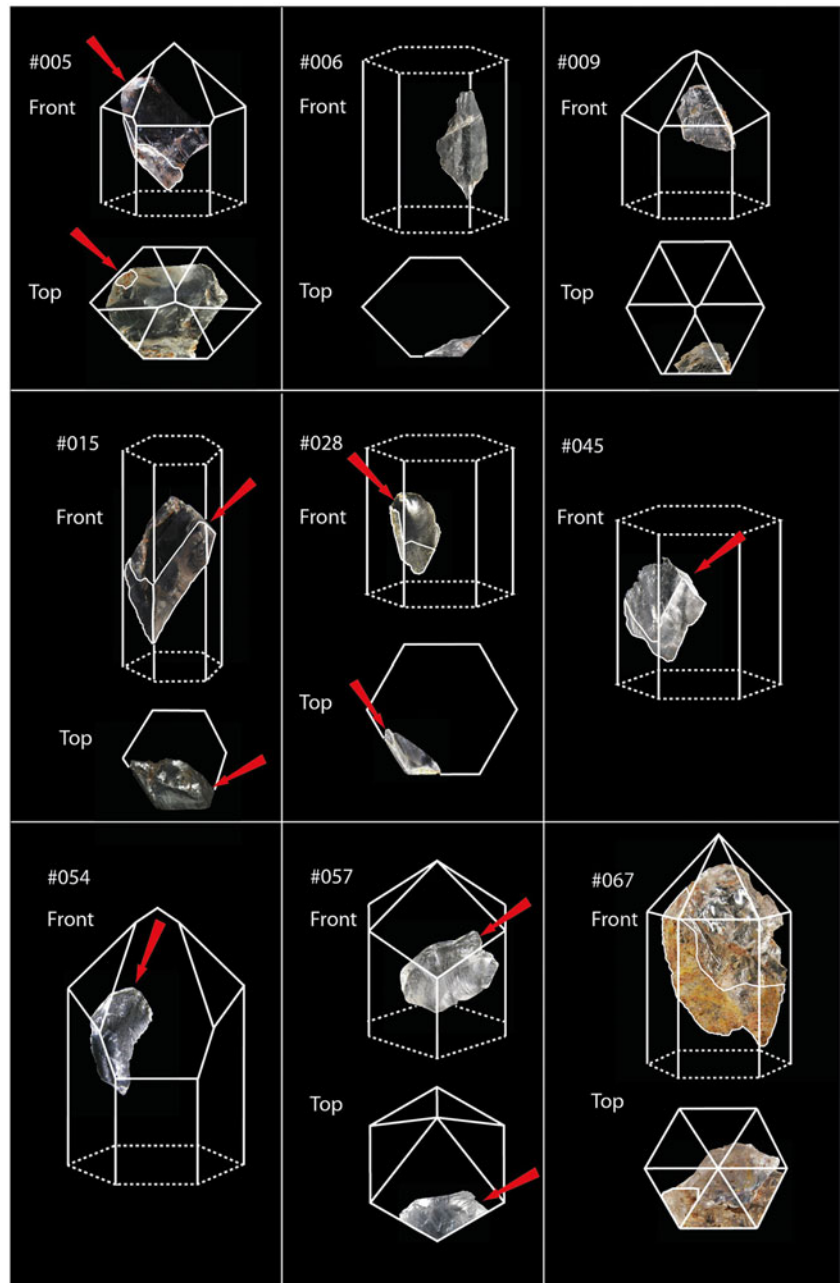


Figure 6. Pieces that evidence position within the crystal and direction of removal.

finished/repared, on site. Therefore, while both flint and rock crystal were being brought to Dorstone Hill and reduced there, the rock crystal, transported from much greater distances, was not being used to make any formal tools, nor were the removals being used in any utilitarian way.

Working rock crystal at Dorstone Hill

The unique six-sided hyaline form of rock crystal affords the opportunity to establish a detailed sequence and directionality of crystal reduction at Dorstone Hill and as such provides the first detailed

account of rock crystal reduction in a British or Irish context. A total of 60 specimens exhibited crystal edges (Table 2), with 33 of these specimens exhibiting only one face, and a further 27 exhibiting 2 or more faces. Given the specific morphology of the tip, body and base crystal faces (see above), it is possible to identify the specific faces in 28 of these pieces (Table 2). In a number of pieces, the crystal face morphology indicated the location of the piece more precisely within the parent crystal, allowing the reduction to be characterized further in a number of ways.

Table 5. Quantification of pieces with direction of removal from the crystal (relative to the parent crystal longitudinal axis), and direction of crystal reduction identified.

Type	Direction of removal			Direction of reduction	
	Diagonal	Horizontal	Longitudinal	Tip first	Base first
Blade	1				
Blade-like flake	1		1	1	
Flake	6	2	2	7	1
Core				2	
Chips & fragments	3			2	
Whole crystal				1	
<i>Total</i>	<i>11</i>	<i>2</i>	<i>3</i>	<i>13</i>	<i>1</i>

Table 6. Character of reduction process, distributed by piece ‘type’. Note that all pieces under 10 mm are recorded in the ‘chips and fragments’ category.

	Indeterminate	Irregular	Systematic	<i>Total</i>
Blade			2	2
Blade-like flake			5	5
Flake	8	3	10	21
Core			2	2
Chips & fragments	4		21	25
Whole crystal	1			1
Chunk	6			6
<i>Total</i>	<i>19</i>	<i>3</i>	<i>40</i>	<i>62</i>

Table 7. Distribution of all rock crystal specimens in primary contexts within the Eastern, Central and Western mounds, divided by construction phase.

Phase	Eastern Mound	Central Mound	Western Mound	<i>Total</i>
Structure			2	2
Pre-earthen mound (mortuary) construction	19			19
Earthen mound construction	27	1		28
Post earthen mound		6	271	277
<i>Total</i>	<i>46</i>	<i>7</i>	<i>273</i>	<i>326</i>

Firstly, a total of 14 pieces could be located precisely within the parent crystal (Table 6), which allowed the direction of crystal reduction to be established. When orientated within the crystal, 13 of these pieces had dorsal surfaces facing the crystal tip end, indicating a reduction sequence that began

at the tip end, while a single specimen evidenced base-first reduction. The clearest examples of the tip-first reduction are two pieces which used platforms on the pyramidon to take a removal down the point faces (#009 and #054). A further three pieces (#005, #057 and #067) had been struck from platforms within the point area of the crystal, with the removals running down through the point-body boundary (see Figure 6). Finally, the larger of the two cores (#017) exhibits natural edge morphology to suggest it may be from the base of a crystal, indicating this is the exhausted remnant of a crystal reduced from the tip.

Secondly, 16 pieces, when orientated within the parent crystal, evidenced the direction of their removal (Table 5, Fig. 6). 11 were removed diagonally to the longitudinal axis of the parent crystal, two were removed horizontally and three were removed longitudinally. The vertical removals had at least one natural crystal surface, and appear to have been attempts to remove the outer edge of the crystal; these pieces exhibited a lower quality of crystal, which is most likely to be a product of the

anisotropic nature of the material, inhibiting fracture along the longitudinal axis of the crystal (cf. Tardy *et al.* 2016).

Thirdly, of the 62 specimens exhibiting evidence of previous removals (Table 6), the majority (40) presented dorsal scarring characteristic of systematic reduction. Of these, 28 pieces exhibited evidence of systematic unidirectional reduction (use of the same platform for multiple previous removals), with lower numbers of pieces showing truncated scarring from other directions. Based on the attributes used to determine reduction strategies relating to flint, the nature of the bulbs of force suggests direct percussion, and their diffuse appearance might indicate the use of a soft hammer (Whittaker 1994, 180, 187ff, fig. 8.8). This contrasts with other assemblages that have undergone detailed technological analysis from Spain and Greece (Rodríguez-Rellán 2016; Tardy *et al.* 2016), where the use of pressure techniques as well as direct percussion in working this material is documented. The striking platforms are narrow, and some have tiny remnants of crystal faces, indicating the use of the natural crystal edge as a platform. Distal terminations tend to be broken, but where surviving they often overshoot, following the inherent properties of the crystal; this tends to corroborate the use of a soft hammer as it is similar to that known to occur on thinning flakes in bifacial reduction (Whittaker 1994).

The evidence indicates a systematic and established process of crystal reduction at Dorstone Hill; the sequence began with whole crystals, which were reduced from the tip using the sub-90° angle of the pyramidon as a suitable platform. Once past the point region of the crystal, the body of the crystal was then reduced systematically by taking multiple removals primarily diagonally across the longitudinal axis of the crystal, with a smaller number of pieces being taken horizontally or vertically, the latter to remove the natural crystal edges. The full reduction sequence ended (in at least some cases), with an 'exhausted' crystal that took the form of a bifacially worked 'core' from the base of the crystal. The predominance of diagonal tip-first removals suggests that the knappers were familiar with the properties of the rock crystal, starting reduction from the isotropic pyramidon, before following the diagonal cleavage planes in the anisotropic body of the crystal (cf. Rodríguez Rellán 2016, fig. 1; Tardy *et al.* 2016, fig. 15). This tip-first approach is generally similar to the method suggested by Fernández-Marchena and Ollé (2016), where the crystal is 'beheaded' to create a platform from which bladelets would be struck by direct percussion using the facets of the

crystal edge as guides; however, the Dorstone material differs in that it demonstrates reduction, as opposed to removal, of the tip, and diagonal reduction, as opposed to more longitudinal reduction for bladelets. The systematic reduction sequence of rock crystal contrasts with the reduction of flint at the site, which is more *ad hoc* in character, using both hard and soft hammer, including changes in orientation of the core during reduction. This more opportunistic approach may be the result of the small size of nodules being worked at the site; however, this too draws contrasts with the rock crystal, which was as small, if not smaller, yet worked in a systematic way.

This systematic approach to working the material at Dorstone Hill is further reinforced by the distribution of the rock crystal across the multi-mound complex. Rock crystal was recovered across all three mounds, and the causewayed enclosure (Table 7), however, these are not all contemporary. The structural phases of the mounds have produced dates indicating construction in the thirty-ninth or thirty-eighth century BC (Ray & Thomas 2020, 109), and a new radiocarbon measurement (Table 8) from a post-mound pit on the southern edge of the western mound, sealed by eroding mound material, indicated the mounds were most likely constructed by the thirty-eighth or mid thirty-seventh century BC. This pit was notable for containing 267 rock crystal specimens from either an *in situ* knapping event, or a deliberate deposition of knapping debris probably from a single event (see discussion below). The causewayed enclosure has returned dates of 3770–3640 cal. BC for the earliest phase, and 3630–3530 cal. BC for the latest phase of activity (Overton *et al.* 2022, 48). Rock crystal was recovered from secure contexts in the pre-mound, mound and post-mound phases (Table 7), and from primary and recut ditches in the causewayed enclosure, indicating a prolonged engagement with this material, potentially spanning the thirty-ninth to thirty-sixth centuries cal. BC.

Given this temporal spread, the character of the assemblages are notably similar; flakes are the most frequent removal type, followed by blade-like flakes across the mounds and enclosure (Table 1). The only notable difference is the presence of whole crystals, partial crystals and 'chunks' at the causewayed enclosure, but not the mounds. These pieces, either complete crystals full of flaws, or small ancillary crystals probably removed from larger crystals prior to working, suggest materials may have been 'tested' at the enclosure prior to working, whereas 'pre-tested' crystals were introduced to the mounds.

Table 8. Radiocarbon measurement from western mound pit [518]. Calibrated using OxCal 4.4 IntCal 20 curve (Reimer *et al.* 2020).

Lab code	Measurement	Error	$\delta^{13}\text{C}$	Sample/context	Calibrated range (95.4%)*
SUERC-77965	4972	±28	-25.3	(short-life) roundwood <i>Alnus/Corylus</i> Pit [518], fill (519)	3895–3881 cal. BC (2.3% probability) or 3799–3652 cal. BC (93.2% probability)

Table 9. Summary of technological process within each monument sub-assembly.

	Eastern Mound	Central Mound	Western Mound	Causewayed enclosure	Bank and ditch	Total
<i>Reduction direction</i>						
Base first	1	0	0	0	0	1
Tip first	3	3	2	5	0	13
<i>Character of reduction</i>						
Systematic	17	6	11	5	1	40
Irregular	1	0	1	1	0	3
Indeterminate	5	2	2	10	0	19
<i>Removal direction</i>						
Diagonal	4	3	2	2	0	11
Horizontal	1	0	1	0	0	2
Longitudinal	0	0	2	1	0	3

Table 10. Frequency of rock crystal and other lithic material from primary, secondary and disturbed contexts in the mounds.

Context type	Rock crystal		Flint and other lithic material	
	Frequency	%	Frequency	%
Primary	308	96.54	607	49.03
Secondary	3	1.26	76	6.14
Disturbed/ unstratified	7	2.20	555	44.83
Totals	318	100.00	1238	100.00

However, the presence of cores and large and small removals at both mounds and enclosure indicate this material was actively knapped at all four monuments. More significantly, when the reduction sequence is examined in more detail (Table 9), the tip-first systematic reduction, primarily focusing on diagonal removals, is present at all three mounds and the enclosure. This helps to confirm that this was an established and specific way of working this material, which persisted at Dorstone Hill for generations, and possibly centuries.

Taken all together, the technological analysis indicates a very specific and distinctive set of practices related to rock crystal at Dorstone Hill. While all knappable material had to be introduced to the site, the rock crystal was a rare exotic, transported

over substantial distances. At the site both rock crystal and flint were reduced; however, in contrast to the *ad hoc* flint reduction, working rock crystal followed a systematic process, informed by knowledge of its material qualities. Furthermore, this approach to rock crystal persisted for many generations, an established way of working this material, which was transmitted across generations as a set of skills, knowledges and practices. The distances involved in moving this material to Dorstone, the skill and knowledge bound into this established and systematic tradition of working and the maintenance of this practice over generations are all the more striking given the fact that this material, in direct contrast to flint, appears not to have been used to make any artefacts or tools. It was the material, and the practice of working it, which was significant; the intention to combine the material, the site, and a particular way of working it, but with no ‘final product’, indicate it was the moment of working itself that was the intended outcome. This can be explored further by examining how the resultant pieces from these events were treated through deposition.

Deposition of rock crystal at Dorstone Hill

Of the 337 rock crystal specimens recovered from Dorstone Hill, the majority (318) were retrieved from within or very close to the three long mounds, while 18 came from the Causewayed Enclosure and a

Table 11. Distribution and frequency of rock crystal and other lithic material from primary contexts in the mounds.

	Rock crystal		Flint and other lithic material					
	Frequency	%	Overall frequency	%	Flakes frequency	%	Tools frequency	%
Cist	0	0.00	27	4.48	26	4.44	1	5.56
Land surface	0	0.00	13	2.16	12	2.05	1	5.56
Mortuary structure	19	6.17	19	3.15	19	3.25	0	0.00
Mound	9	2.92	263	42.95	256	43.76	3	16.67
Pit	278	90.26	238	39.47	227	38.80	11	61.11
Structure	2	0.65	40	6.63	38	6.50	2	11.11
tree-throw	0	0.00	7	1.16	7	1.20	0	0.00
<i>Total</i>	<i>308</i>	<i>100.00</i>	<i>607</i>	<i>100.00</i>	<i>585</i>	<i>100.00</i>	<i>18</i>	<i>100.00</i>

single specimen came from beneath an Iron Age/Roman earthwork (Table 1). In the Causewayed Enclosure, rock crystal was recovered from upper ditch fills, which could not be confidently identified as *in situ*, and most likely represented silting events which incorporated material from surface middens within the enclosure (cf. Overton *et al.* 2022). Within the mounds, 96.54 per cent of the rock crystal recovered was recovered from primary contexts (Table 10), including pits dug along the southern edge and into the body of the Western and Central mounds, the ditch surrounding the mortuary enclosure, and within deposits making up the mound. The remainder were recovered from secondary contexts (1.26 per cent) and topsoil or disturbed contexts (2.20 per cent) relating to the bulldozing of the mounds in the twentieth century. In contrast, 49.03 per cent of the flint and other lithic artefacts were recovered from primary contexts in the mounds, including fills of pits, post-holes and deposits making up the mound structure, with 6.14 per cent from secondary contexts and 44.83 per cent topsoil or disturbed contexts. The higher proportion of flint and other lithic materials recovered from disturbed contexts is probably the result of more of these materials being deposited into the upstanding mound layers, which were later bulldozed.

The distribution of rock crystal and lithics within primary contexts exhibits a number of important patterns relating to the specific depositional contexts of these materials. Both materials were recovered from structural post-holes, pits dug after the initial construction of the Western and Central earthen mounds ([518], [136] and [528]), pits dug into the top of the Western and Central mounds ([557] and [110]), the ditch surrounding the mortuary structure, and deposits forming the body of the

earthen mounds (see Figure 4). Additionally, flint was recovered from buried soil beneath the mound, tree throws and a number of stone-lined cists cut into the mounds. The distribution of this material over the different features shows that rock crystal was overwhelmingly deposited within pits, whereas the majority of flint was deposited relatively equally across pits and mound deposits (Table 11: Overall frequency). Furthermore, when the flint assemblage is split into flakes and formal tools, over 60 per cent of formal tools are recovered from pits. This indicates that, while flakes were present across the site, formal tools were being intentionally selected for deposition in pits, a pattern echoed in the deposition of rock crystal (albeit even more strongly with the latter). It must be noted that while *in situ* contexts were sieved on site, using a 0.8 mm dry sieve, sediment samples from pit [518] were wet-sieved through a 0.05 mm mesh, which recovered large numbers of very small rock crystal and flint fragments (267 rock crystal and 175 flint). This has inflated the frequency of flint and rock crystal flakes/debitage from pits; with the [518] material removed, 60 per cent of the flint flakes are within mound deposits and 46 per cent of rock crystal is from the mortuary structure ditch, with a further 27 per cent from pits. However, even though the lack of wet-sieving across the site has led to a possible under-representation of micro-debitage across the site, it does not affect the recovery of much larger formal tools, indicating the focus of formal tools within pits is a genuine pattern, and not a product of recovery bias.

The deposition of both rock crystal and formal tools made of flint and other lithic material is particularly associated with mortuary contexts, both in the form of graves and more broadly in reference to

the long mounds. In pit [136], a cremation grave, five large flakes of rock crystal, including the largest pieces in the assemblage (#004) and a flake from the crystal tip (#009) (see Figure 5) were deposited alongside cremated bone, beneath a charred plank. The crystal and bone were accompanied by two flint leaf-shaped arrowheads, a transverse arrowhead, one flake from a greenstone polished axe, one scraper, one serrated flake (both flint) and 53 sherds of prehistoric pottery. In pit [518], another deposit of cremated bone was accompanied by a flint perforator, three rock crystal flakes, and 268 pieces of rock crystal and 175 pieces of flint micro-debitage (recovered through wet sieving). Further cremation deposits in pit [110] and within the mortuary structure ditch were also accompanied by rock crystal and a few flint flakes. Pits without cremated bone also contained notable material; pit [528] on the south edge of the Western mound contained a single rock crystal flake and six flint flakes, pit [557], cut through the Western mound into its burnt core, contained the largest rock crystal 'core', a flint scraper and three burnt chips, and pit [102], cut through the Eastern mound over the top of the mortuary structure, contained two polished axes and a bifacially flaked knife and debitage. These pits show the intentional selection of specific materials and artefacts, either as grave goods when associated with cremated bone, or as deposits venerating the mounds. Notably, rock crystal was selected as suitable for these deposits alongside other artefacts, even though it was not used or modified into tools. This further supports the interpretation that the material produced from knapping rock crystal was seen as significant in its own right and was perhaps the intended product from working (in contrast to flint, where the products were transformed into tools).

A number of these pits are also materially tied to moments of transformation. Multiple pits contained cremated remains, the product of dramatic and transformative processes; in the case of the mortuary chamber ditch, the rich charcoal and bone deposit was laid down directly before the chamber and ditch were backfilled and may be made up of the cremated remains of bodies taken out of the chamber before it was decommissioned. In pit [102], the knife was deposited alongside debitage which appears to be related to its production, suggesting this piece was made specifically for deposition. Pit [136] contained the fragments from breaking ceramic vessels and flaking of a polished stone axe. In pit [518], the micro-debitage of flint and rock crystal was the result of either knapping directly into the pit, or the deliberate collection and

deposition of knapping debris, probably from a single event (cf. Kadowaki *et al.* 2013, 154). This was deposited alongside large quantities of charcoal from a range of taxa; *Corylus avellana* (hazel), cf. *Frangula alnus* (alder buckthorn), Maloideae (apple, pear, hawthorn, service tree, rowan, whitebeam), *Populus/Salix* (poplar/willow), *Quercus* sp. (oak) and *Sambucus nigra* (elder). Notably, there was little oak and much of the charcoal derived from roundwood fragments of small diameter. This type of fuelwood would provide a relatively fast heat, typically used for domestic fires, but would not easily provide the high, sustained heat required for human cremation. The general paucity of oak is unusual, given that oak-hazel woodland was prevalent in the Dorstone area in the Neolithic and there is little evidence for significant woodland clearance until the Early Bronze Age (Garwood 2011). The charcoal from [518] came mostly from scrub or hedgerow taxa, which could have been sourced from the immediate environs of the site. Poplar, willow and alder buckthorn, however, favour wet ground habitats and are more likely to have come from the valley bottom. This combination of a range of species from a range of environs again suggests the intentional selection of materials; in later periods, certain woods have special associations: hazel and elder, for instance, have traditionally been used in England to ward off evil (Watts 2007), and it is not inconceivable that the selection of wood for fuel in the Neolithic was neither purely accidental nor solely functional, but may have had symbolic meaning. Smoke and fire are associated with cleansing and purification rituals in many societies, with both the act of burning and the production of the ashes being significant (Chadwick 2012; Kaliff 2011).

Therefore, rock crystal was one of a suite of materials being intentionally selected for deposition in pits and negative features across the mounds; these materials can be understood as votive or venerative 'gifts', but they were also significant as a result of the transformative events they were involved in before deposition. However, rock crystal should not be understood as interchangeable or synonymous with other selected materials and artefacts. In total, 95 per cent of rock crystal pieces were deposited in association with cremated bone deposits, in comparison to 35 per cent of flint flakes and 39 per cent of formal tools. This clearly demonstrates that rock crystal, over other materials, was being intentionally selected and deposited with cremated bone deposits, citing a specific link between this material, the transformative moments of working it, and the cremated remains of the dead.

The significance of rock crystal at Dorstone Hill, and Neolithic Britain and Ireland

At Dorstone Hill, people had a lasting association with rock crystal; it was transported large distances to the site, it was worked in a systematic manner that remained a feature of local practice for generations, yet it was not used in any utilitarian way. Instead, the products of knapping events were intentionally collected and deposited, alongside other notable materials and artefacts, in mortuary contexts. Here, we argue that the material's significance, which led to its specific treatment, related to its origin, its character, and subsequently its role in producing distinctive and memorable events at Dorstone Hill.

The rock crystal at Dorstone Hill could only have originated from a very limited number of sources, all of which are substantial distances away from the site. The most likely sources are Snowdonia in north Wales, or St David's Head in southwest Wales, although Cornwall and sources further afield remain a possibility (see *The rock crystal assemblage* section, above). However, the presence of rock crystal and early Neolithic timber buildings/halls at both Dorstone Hill and the northwest Welsh sites of Llandegai I and II, Parc Cybi and Llanfaethlu (see Supplementary material) suggest Snowdonia may be the most likely source (which can be tested in the future following recent sourcing studies: Hess 2020; Sachanbiński *et al.* 2008); whatever its origin, rock crystal would have been notable as an exotic at Dorstone Hill. However, exotics do not need to be understood as significant simply because of the distance between their source and the site from which they are recovered. Nyland (2020) argues that materials, and in particular certain types of rock, including rock crystal, may have held a certain 'charisma', anchored in the landscape or place from which it was obtained. This is very similar to the idea that the distinctive blue-grey volcanic tuff from Great Langdale in the Lake District used to make Neolithic group VI polished stone axes (also recovered at Dorstone Hill) was perceived as powerful or significant, as a result of the dramatic and awe-inspiring landscape and towering rock faces from which it was quarried (Bradley & Edmonds 1993). Similarly, Fowler and Cummings (2003) suggest white quartz in Neolithic monuments in the Irish Sea region was significant due to its connections with water and its liminal or transformative character. Therefore, the subterranean caves, shimmering veins, mountainous surroundings or dramatic coastal headlands offered by Snowdonia (or perhaps St David's Head) can be thought of as conferring a

dramatic flavour to rare and exotic rock crystal, which was subsequently treated as significant as a result of its association with specific, affective places.

It has previously been noted by several authors that quartz may have been understood in British prehistoric contexts as important or significant in non-utilitarian terms, for its aesthetic, symbolic, totemic, or ontological value (Ballin 2008, 9, 44; Noble *et al.* 2012, 144; Reynolds 2009). As Kenney (2008a: 24) has noted, in a world without glass, water-clear quartz crystals must have seemed like a remarkable material. Whole crystals also have refractive properties, splitting white light into its spectrum of constituent colours. On Jura, Ballin (2008, 60) has suggested that quartz may have been valued for its reflective and refractive qualities over its use as a raw material for tools, while the presence of a quartz crystal at Achnacreebeag in association with ceramics with 'rainbow' motifs is suggested to make a direct reference to the refractive abilities of this material (Sheridan 2020, 179; see also Cassen 2000). At Dorstone Hill, the clarity and transparency would have made this material distinctive from other lithic materials, or solid materials in general. Specimen #017, the larger of the two cores, has a small internal structure within the crystal that, when rocked back and forth in the light, is illuminated by a rainbow flash (see Figure 7). A second piece, (#018), a flake full of micro-cracks, shimmers with dancing lines of rainbow as light hits the internal fracture planes within it. These add an extra dimension to the visually arresting character of this material; it may be no coincidence that both specimens were selected for depositions in pits [110] and [557], which cut through the mound into its burnt core. Furthermore, quartz is also triboluminescent, which means it emits lights when two pieces are rubbed or struck together (Whitley *et al.* 1999, 236), which has been argued to be a significant aspect of its use at other Neolithic sites (Reynolds 2009). Tribological analysis offers a potential avenue to examine this further in future research (Stemp *et al.* 2016, *inter alia*). These characteristics would have made the working of rock crystal a highly distinctive and special event, in turn making the products, the flakes, the cores and the debitage, equally significant, not as 'waste', but as important in their own right.

The distinctive and exotic character of rock crystal at Dorstone Hill would have made moments of working this material significant events; the technological and distribution evidence demonstrates that these events were undertaken in very specific ways, and deposition was almost always in mortuary contexts, with close association to the cremated remains



Figure 7. Specimen #017, exhibiting the refractive qualities of a small internal structure within the crystal.

of the dead. In a number of societies, quartz crystals play significant roles in peoples' lives; Australian aboriginal groups understand rock crystal as 'solidified light', spiritually charged with power and associated with ancestral beings (Eliade 1967b, 177; Taçon 1991, 198). Animist groups in the Amazon consider quartz as 'living rock', with special healing properties (Reynolds 2009, 154) and pre-Columbian groups placed a cosmological significance on it due to its light-capturing qualities (Mökkönen *et al.* 2017; Nyland 2020). More significantly, a number of societies harness the distinctive characteristics of rock crystal within ritualized practices; several indigenous groups in California used quartz tools for rituals such as blood-letting or to cut the umbilical cord of newborns (Hess 2020, 295; Kroeber 1976, 45), while the Luiseño and Chumash affix crystals to shafts to create ceremonial batons (Hess 2020; Hudson & Blackburn 1986, 255; Kroeber 1976, 45). The Hopi and Zuni of North America and the Tukano of South America harness the triboluminescence of quartz in rain ceremonies, banging crystals together to mimic lightning, or making rattles containing crystal fragments, which would flash, and even ignite

their organic container, leading to an understanding of quartz as being alive (Ball 1941, 31; Hess 2020; Reichel-Dolmatoff 1997; Roediger 1941, 146). In Animist and Shamanic societies, such as the Yuman-speaking groups of the Colorado Valley and the Nuuchah-nulth of Vancouver Island, quartz crystals are linked to the transformation and powers of shamans (Drucker 1951, 169; Eliade 1967a, 233; 1967b, 162; Hess 2020; Levi 1978; Reynolds 2009, 159).

This is not to argue that any of these are suitable parallels for Dorstone Hill in the British Neolithic, however, they do foreground the way that the unique properties of rock crystal can be harnessed to create distinctive moments or events. At Dorstone Hill, the working of this material, associated with dramatic places, and affording experiences of its unique transparent, refractive and triboluminescent properties, would act to disrupt everyday life, creating memorable moments for those in attendance (cf. Hamilakis 2014). The close association between rock crystal and cremated bone suggests that the distinctive crystal qualities were being employed by people at Dorstone Hill to mark the passing of individuals, or the transformation of

bodies, binding the people present together through shared experience, and ensuring the deceased remained alive in the memories generated. Furthermore, the continued presence of rock crystal and Dorstone Hill over many generations, from the timber structures through to the causewayed enclosure, and the adherence to a specific way of working it, which became part of local practice or tradition, would have made rock crystal and the practice of working it a key aspect of local identity. The intentional deposition of rock crystal with the remains of the dead can be seen as a recognition of the shared identity that bound the living and the dead together through their knowledge and use of rock crystal at Dorstone Hill. Given the unsecure contexts of the material from the Causewayed Enclosure, it is difficult to gain a clear picture of how it was being used there; however, the technological evidence indicates the methods of working were continued, and the material remained an element of local identity.

The use and role of rock crystal more widely within Neolithic Britain and Ireland is a topic requiring much more research, and the significance of the material at Dorstone Hill is not suggested to be relevant *per se* to material at other sites. However, the distribution of Neolithic sites with rock crystal does show a concentration in northwest England, northwest Wales and Ireland, with a notable association with early Neolithic timber halls (see Supplementary data). While the connection between early Neolithic architecture and material culture has already been made between Irish and north Wales sites (e.g. Rees & Jones 2015), the presence of both rock crystal and timber halls at Dorstone Hill may suggest this is a wider pattern in the west of Britain and Ireland, echoing the significant use of white quartz around the Irish Sea during the Neolithic outlined by Fowler and Cummings (2003). The identification by the authors of another relatively large rock crystal assemblage from a suspected longmound within 20 miles of Dorstone Hill, and the material from Parc le Breos chambered tomb (Whittle & Wysocki 1998, 145) indicate that Dorstone Hill is not an isolated example in this region. Given the rarity of rock crystal, the presence of a network of sites, including a number which are long distances from potential sources, offers a clear opportunity to explore the movements and connections of Neolithic groups in the west of Britain in the first centuries of the Neolithic. Furthermore, given the role that rock crystal played in the mortuary practices and identity at Dorstone Hill, studies of the ways in which rock crystal was worked, used and deposited at other sites

would provide a more detailed understanding of the roles this material played in people's lives, and their local and regional identities during the start of the early Neolithic in Britain and Ireland.

Supplementary materials

Supplementary materials may be found at <https://doi.org/10.1017/S0959774322000142>

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Elizabeth Healey has a long-standing interest in lithic artefacts both in the UK and the Near East. Her research focuses on raw materials and the choices made by the communities who acquired and used them. This involves a holistic approach integrating provenance studies, with the investigation of the technologies and techniques employed in the working of the different raw materials, the products made, and the functional and socio-economic contexts of their use. She also regards the frameworks within which lithic analysts and others interpret them as important. She is currently an Honorary Research Fellow in Archaeology at the University of Manchester.

Irene Garcia Rovira is a project manager at Archaeology Wales/England. She was previously a research associate for the Cuween-Wideford Landscape Project, based at the University of Manchester, and was part of the team excavating the Early Neolithic site at Dorstone Hill, Herefordshire. Her research interests are varied and range from the studies of social change evidenced in prehistoric contexts to the role of archaeology in the planning process. She has a particular interest on the identification of new sites using LiDAR and other mapping tools.

Julian Thomas is Professor of Archaeology at the University of Manchester, UK. His books include *Archaeology and Modernity*, *The Birth of Neolithic Britain* and (with Keith Ray) *Neolithic Britain: The transformation of social worlds*. His research interests include the British Neolithic and the theory, philosophy and history of archaeology.

Julie Birchenall is a researcher at the University of Manchester. Throughout her academic career she has pursued interests in early prehistoric archaeology, lithics and

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Dana Challinor is an archaeobotanist, specialising in wood and charcoal analysis, currently working as an independent researcher. With more than 20 years' experience working on a wide range of projects across the UK and abroad, she has particular expertise in prehistoric and Roman cremation practices and ritual offerings.

Tim Hoverd attended Bournemouth (1988–90) and Sheffield (1990–92) Universities before working in commercial archaeology. He is currently the Archaeological Projects Manager at Herefordshire Council where he manages a small externally funded team, undertaking research and conservation projects within Herefordshire and neighbouring counties.

Keith Ray (PhD Cambridge University 1988; MCIfA 2005; FSA 2006; MBE 2007) is currently an honorary professor in the School of History, Archaeology and Religion at Cardiff University. He was previously County Archaeologist for Herefordshire (1998–2014) and authored *The Archaeology of Herefordshire: An exploration* (2015). He was lead author (with Ian Bapty) of *Offa's Dyke: Landscape and hegemony in eighth-century Britain* and co-author (with Julian Thomas) of *Neolithic Britain: The transformation of social worlds* (Oxford University Press, 2018).