

A WELTER OF FLINT CHIPS: EXPERIMENTAL KNAPPING TO INVESTIGATE LOCAL FLINT FROM LUCE SANDS, WIGTOWNSHIRE

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ABSTRACT

As part of PhD research into lithic material from Luce Sands, Wigtownshire, experimental work was carried out on local beach pebble flint. John Lord was commissioned to carry out this work using pebbles collected by the author from the beaches abutting the dune area. This work demonstrated that much of the archaeological material could have derived from local sources. However, in order to be able to produce the fine knapping of some of the artefacts it was necessary first to heat-treat the flint.

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INTRODUCTION

This paper represents one element of PhD research carried out on lithic assemblages of the dune sites at Luce Bay and Culbin Sands (Coles 2009). Luce Sands, Wigtownshire, (Figure 1) have long been known for producing large quantities of lithics. The assemblages comprise a wide range of flint artefacts from the Mesolithic, Neolithic and Bronze Age periods including a large number of finely worked leaf-shaped arrowheads, together with large quantities of axe fragments, mainly from Group VI axes and around 2000 pieces of worked pitchstone. The National Museum in Scotland alone has 203 entire or almost entire arrowheads as well as numerous fragments in its antiquarian collections; there are a considerable number in the Kelvingrove

Museum in Glasgow and in the local museums at Stranraer, Dumfries and Kirkcudbright. Four leaf-shaped arrowheads were found in a pit with sherds of early Neolithic pottery and finely worked flint knives probably of Antrim flint (Cowie 1996).

Analysis of the leaf-shaped arrowheads from Luce Sands in the National Museum of Scotland indicated that, while it was impossible to identify a group of ‘ceremonial’ arrowheads larger and more finely made than the rest, as discussed by Devaney (2005), many of the small arrowheads had been extremely carefully worked, far more finely than seemed necessary from a purely utilitarian standpoint (Coles 2009).

A major part of the research work was to ascertain whether the raw material for these

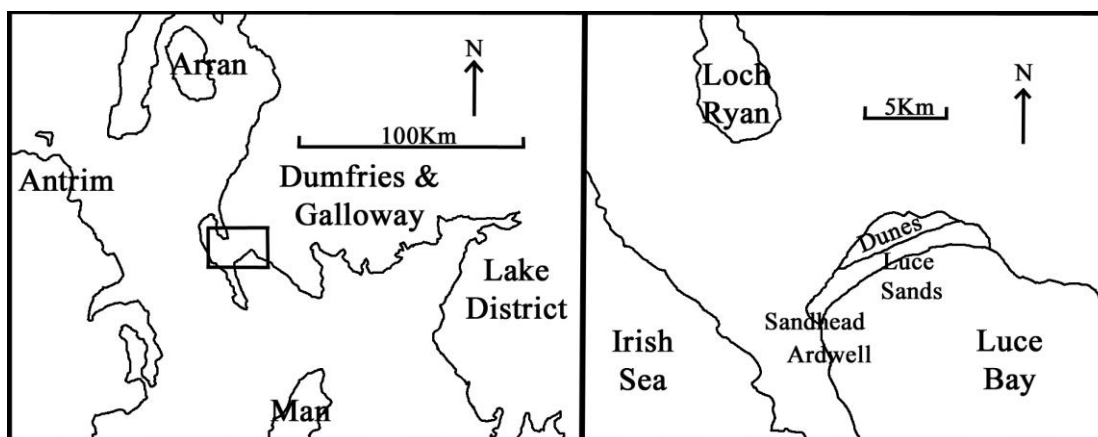


Figure 1. Location of Luce Sands.

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arrowheads was locally sourced or imported. To test the suitability of the local flint for producing finely worked, bifacially knapped leaf-shaped arrowheads, a programme of knapping was instigated to attempt to reproduce similar arrowheads. John Lord kindly agreed to undertake this work which was carried out over about eighteen months on six separate days

LOCATION OF PEBBLE FLINT IN LUCE BAY

There are about 65 kilometres of shoreline encircling Luce Bay. Wilson (1876, 580) reported finding flints along the western part of the bay close to Sandhead (Figure 1). As part of the research, searches for flint were carried out around much of the bay. These investigations established that quantities of flint pebbles of a workable size are indeed found on this comparatively short stretch of this shoreline. Here the beach is covered with pebbles, among them a small but significant proportion of flints, suggesting the erosion of an underwater deposit.

The area of sand directly abutting the dunes was devoid of any surface stones or pebbles. Small pieces of flint are found further to the north at the bay head closer to Glenluce and on the beaches to the eastward side of the bay. Some small fragments were also to be found on beaches around the Rhinns. Generally, however, these are far too small to be workable.

The possibility that the presence of flint is due to the dumping of ships' ballast was considered by Wickham-Jones & Collins (1978). One such dump is clearly identifiable on the west bank of the Piltanton Burn where it meets the beach. However, ballast flint is easily distinguishable from the naturally occurring local flint. It consists of irregular lumps of black nodular flint, typical of that found in the chalk of southern Britain. The beach pebble flint is generally lighter in colour, water worn and chattermarked.

Wilson (1878, 4–5) also noted finding water worn nodules of flint in the glacial gravels close to Dunragit railway station and at Genoch amongst other sites. Two disused gravel pits exist by Dunragit which conform to Wilson's description. On investigation only two tiny flint fragments were found, too small

to be of any practical use. Both pits have been largely quarried away, possibly removing any deposits of workable flint pebbles.

Maxwell (1885) suggested that the flint source lay in the deposits underlying the dunes themselves which were exposed by wind blow during the prehistoric period allowing access to the flint. None of these deposits is currently exposed for this hypothesis to be investigated but it seems likely that the glacially deposited gravels from which the beach flint derives today would have been undergoing the same erosion and redeposition processes at the time of the formation of the raised beaches. It has also been noted that flint is present in the glacial gravels that make up the drumlins which are omnipresent in the area (William Cormack cited in Saville 2003, 14).

It was firmly established through these investigations, that Luce Bay is a source for flint similar to that found in the archaeological record. It remained to establish whether this flint could be utilised to produce the range of artefacts found.

EXPERIMENTAL WORK

First, flint pebbles suitable for knapping were collected from the stretch of Luce Bay between Sandhead and Ardwel, just to the south of Luce Sands. John Lord was asked to split some of these pebbles and to ascertain the suitability of each for making fairly crude tools such as scrapers and whether it could be worked more intensively to produce an arrowhead.

Splitting the pebbles revealed a wide range of colours. Brown and grey predominate, but within these categories there are great variations of shades with some of the browns, particularly when knapped as thin flakes, appearing almost yellow, while the paler grey flakes were virtually white. However exact matches to the flint from the archaeological assemblages could not be obtained. This was in part due to the effects of polishing by wind blown sand which has given much of the prehistoric material a high lustre lacking from the freshly knapped material. Moreover, within the archaeological samples there were some colours, predominantly pinks and purplish tinges, which were not present in the modern sample. It was found that both grey and brown flint could be knapped successfully. Internal thermal fractures causing pebbles to fragment

on being struck or else inclusions of fossils which affected how they knapped were not related to colour.

The greatest proportion of the debitage produced by knapping was split pebbles. These could be subdivided into different categories.

1. Some pebbles when split proved to be of too poor quality to be knapped and both parts were discarded.
2. When a pebble had been split to make a tool, the most promising piece was utilised and the other discarded. The unused part could have either a positive or negative scar.
3. In some instances a flake or two was removed from a pebble and then a series of hinge fractures rendered the pebble unworkable

The larger pebbles could be knapped using a hammerstone. However, pebbles weighing less than 30g could be more efficiently split using an anvil. A few larger pebbles which did not respond to being struck with the hammerstone were also split using an anvil. It was not possible to use a soft hammer technique to rough out tools –the flint would only respond to a hard hammer.

A comparison of the waste material produced during this stage of the experimental knapping with an archaeological collection of flint debitage collected from Luce Sands and currently held in the museum at Dumfries, demonstrated a close resemblance between the two.

Around 80 % of the pebbles could be utilised to make a range of tools. One pebble alone yielded one large scraper, four medium scrapers, two small scrapers, one notched tool, two backed blades and two small arrowheads. Around 50% of the pebble by weight could be utilised.

THE PRODUCTION OF INVASIVELY BIFACIALLY RETOUCED ARROWHEADS

The tough quality of the flint made pressure flaking difficult. Only very short removals of three to four mm could be effected. Thus it was possible to make edge retouched arrowheads but not to reproduce the finely worked arrowheads with invasive retouch across both faces which were found in the archaeological

collections. These latter commonly had flake scars of 12mm or more across their faces.

An arrowhead that has only edge retouch can be produced fairly simply by striking a suitably thin flake and retouching both edges to create the size and shape required. These could be produced in around ten minutes from the first selection of the flint nodule. On the other hand, to produce a finely knapped arrowhead with invasive retouch across both faces it is necessary to strike a fairly thick, large blank from the core. The arrowhead is then produced as a core tool with the blank being reduced on both its faces (John Lord pers. comm.). The initial reduction can be achieved by either hard or soft hammer. Once the blank has been suitably shaped and thinned pressure flaking is used to finish the piece. This process took about 30 minutes. However the pebble flint was too unyielding to allow invasive retouching. Using an antler point the maximum length of flakes that could be removed by pressure flaking was around four mm. This left the arrowhead with a plump profile well in excess of four mm thick with large unretouched areas on both faces.

It seemed that, although it appeared that local pebble flint had been extensively used to make scrapers, awls, serrated edge tools and so on, it was impossible to produce an arrowhead analogous to the archaeological examples using locally obtained pebble flint and the knapping tools that would have been available to the prehistoric knappers. At this point it was necessary to consider a number of alternative explanations.

It was possible that the prehistoric knappers were using particular flint pebbles of a finer flint than had so far been discovered. Alternatively, in the Neolithic the people may have been utilising imported flint which was more amenable to the thinning process. Antrim flint was one obvious candidate for this and Yorkshire flint another. However, the range of colours seen in the archaeological arrowheads did not fit either profile. It was decided to test a further hypothesis that the flint had been rendered more suitable for fine working by being subjected to heat treatment.

HEAT TREATMENT

In order to do this, a sample of 50 beach pebbles of suitable size was worked. Of these

11 pebbles, (22%) were found on being split open to be either thermally damaged or of too poor quality flint to be worked and were consequently rejected. Ten of the smaller pebbles, (20%) although of good quality flint, proved very difficult to work because of the toughness of the flint. It was particularly hard to remove thick flakes for use as blanks for leaf shaped arrowheads. It was decided that it would be useful to see whether the treatment was effective on more complete pebbles. The eight largest of these split pebbles were selected and half of each included for heat treatment to ascertain whether this made the flint easier to work. The remaining 29 pebbles (58%) yielded two or more flakes suitable to act as blanks.

Method of Heat Treating the Pebble Flint

All the flints were clearly marked with a unique identifier. Half the blanks were heat treated while the other half were kept as a control to be worked into bifacially flaked arrowheads without heat treatment. Lee (2001) has demonstrated that the most successful heat treatment using early technology involved placing the flint within a good conductive medium and using a low wide fire kept well fed to provide a concentrated heat. The experiment followed these broad guidelines.

A circular pit about a metre in diameter and approximately 15cm deep was prepared and a bed of sand three or four cm in depth was laid in the base of the pit onto which the blanks and split pebbles were placed. The flints were then covered over with a layer of sand 10 – 12cm deep. A fire of wood lit over the top of the pit which burned for over 12 hours and then went out overnight. It was re-lit and burned for a further day. It was then allowed to cool naturally. A fortnight later the ashes were cleared away and the flint dug up. Sand provides a good medium for spreading the heat evenly. Moreover, within the dunes any hole dug would have been into a predominantly sandy soil or into pure sand so this reproduced as nearly as possible the conditions available on the Sands in prehistory.

Knapping the Heat Treated Flint

The heat treatment worked far more effectively on the blanks than on the split pebbles. Of the eight split pebbles that were heated, one

shattered in the fire and four shattered when they were struck. It was not clear if this was due to existing thermal fractures or solely as a consequence of the heat treatment. One of the split pebbles proved still too tough to work well while only two had been altered by the process so that they produced good easily workable flakes. Of the blanks, however, over 75% were rendered more workable. A few however remained too tough to be worked easily. These were identified as flakes that had been placed at the edge of the pit, and presumably the differential intensity of the exposure to the heat that this caused produced the different results. Much of the flint showed much paler in colour as well as lustrous when the surface was removed, with several of the grey pieces appearing opalescent.

Use of a Vice

An innovation that was employed at this stage of the experimental work was the use of a vice to hold the arrowhead while it was being worked. There had been earlier discussion about the very small size of some of the finely worked specimens and of how difficult it would have been to maintain a grip on such small pieces while applying the necessary force to effect removals. John Lord solved this problem by devising a simple vice to hold the arrowheads during the knapping process. This was a split stick into which the blank was inserted. It was then held firmly, retaining the flint in place (Figure 2). This considerably improved the knapping, allowing long flakes to be produced that did not truncate in the way in which flakes do from an arrowhead held directly in the hand during working. Further, when held in the hand there was a tendency for the flint to twist in a way which made it impossible to maintain the correct angle for knapping, a problem obviated by the use of the vice. It was noted that this simple device would have been part of the Neolithic technological repertoire, as the technique of using a split stick was a necessary part of the process of hafting tools.

Outcomes

The outcomes for one specific pebble are given in detail. This was an ovoid pebble of mottled brownish flint beneath the white cortex. The pebble was initially struck with a hard hammer and a thick primary flake



Figure 2. John Lord using a split twig vice to knap an arrowhead.

removed. This was discarded. Four secondary flakes were next removed from the pebble.

These four flakes were effectively 'slices' of pebble, having cortex around the edges but none on any of the faces. They were examined for flaws and inclusions. None were found so they were identified using a permanent marker. Three of the flakes were placed within the heating pit and the fourth retained to be worked in its natural state. The initial removals of the corticated edges were made using a hard hammer and the subsequent shaping and retouching was done with the use of an antler billet and an antler point. The point needed frequent resharpening during working. The blanks were held in the 'vice' during the thinning process.

The unheated arrowhead blank was almost impossible to thin. Only short removals of up to about 4 mm could be effected, many of which showed hinge or step fractures and after thirty minutes work the arrowhead had been roughed out but exhibited step fractures across its entire surface which made further thinning impossible. At this point work was abandoned.

Work was then carried out on the portions of the same pebble that had undergone heat-treatment. The heat treatment had changed the

colouring of the flakes to a pale mushroom. The first heat treated blank responded far more easily to working. As soon as the flakes were struck it became immediately apparent that the heat process had significantly altered the knapping properties of the flint. It was far easier to set up platforms and the flint responded easily to flaking with an antler point. The flakes also responded well to percussion with an antler billet. As flakes were removed, the scars had the 'greasy' lustre associated with heat treatment. It was possible to remove flakes of up to 12mm in length, all of which showed feather terminations, and some flakes were detached which spanned the arrowhead and removed the opposing platform. However, at an early stage of manufacture the flake broke, proving the flint to be far more brittle than in the untreated state. A second blank was used and within 30 minutes an arrowhead was produced with bifacial flaking across both faces.

OBSERVATIONS

As a result of this experiment a number of observations could be made.

- Pebble flints from Luce Bay comparable in size and colour to worked

pebbles from archaeological contexts could not be knapped to produce arrowheads of the fineness of archaeological examples prior to heat treatment. After heat treatment the flint was far more malleable and allowed the removal of long retouch flakes, rendering the reproduction of fine Neolithic flint work possible. There was, however, a far greater percentage of wastage from heat-shattered pebbles and broken blanks.

- The heat treatment as well as altering the behaviour of the raw material also changed its physical appearance, making it more translucent and altering the colour. The colour changes which were produced as a consequence of the heat treatment corresponded to those detailed by Lee (2001, 43) with pink and purple shades being produced which were not found in the untreated flint.
- It is not generally possible to ascertain by eye whether the archaeological examples from the Sands have been heat treated. The most obvious visual clue, particularly for flint which is naturally rather dull, is the lustre that heat treatment imparts. Cowie noted that flint from Luce Sands which was derived from a sealed context and had not been subjected to sand polishing showed 'the colour and texture changes characteristic of thermally treated flint' (Cowie 1996) However, these cannot be detected when the flint has been sand polished to a high sheen as is the case with the surface collections from Luce Sands.
- None of the heat treated flint showed the white calcification typical of burnt flint and it is highly doubtful whether any kind of treatment that involved the flint coming into direct contact with the heat source would have been effective. As has been seen, over heating resulted in the flint shattering, even when the flint was shielded from direct contact with the fire by several centimetres of sand.

The outcome of this experiment seemed to provide a confirmation that heat treatment was in use at Luce Sands. The arguments for its use are fairly compelling. The process is relatively simple and does not require much expenditure of effort. Even if no tradition of heat treatment existed it could easily have been discovered

accidentally and it is extremely effective. Furthermore there is, at present, no alternative explanation for the method by which obdurate pebble flint was rendered compliant enough to produce the large number of finely made arrowheads that have been recovered from the Sands. If heat treatment was being used, the flint users of Luce Sands would have had access to a source of attractive and highly workable material from which to produce highly accomplished examples of the knapper's craft.

However, even with the use of heat treatment, the production of finely worked arrowheads involved a considerable expenditure of time and energy. Experiment demonstrated that simple edge retouched arrowheads could be produced quickly and easily from the pebble flint and these were not prone to breakage during manufacture. The production of flakes suitable for use as blanks meant an increased amount of wastage. More flint was lost during the actual heat treating process. The final stage of invasive retouch across both faces was the most high risk part of the operation with frequent breakages likely. Some of these could be made good, such as the loss of a tip, but others resulted in the total loss of the arrowhead.

It seems very likely that a large number of the arrowhead fragments from Luce Sands derive from breakages during manufacture. Snapped tips are present in some quantities. During our experiments on a number of occasions during the thinning process a tip was broken off. Usually the arrowhead could be recovered and a new tip worked. At other times the arrowhead split in half. It must be emphasised that during experiment this only happened when heat treated flint which had been rendered more brittle by the treatment was being worked.

Although no systematic programme of experiment has been carried out, it seems probable that the invasive flaking would not particularly have enhanced the performance capability of the arrowhead and that this was rather carried out in order to enhance the aesthetic properties of the artefacts. Much the same has been supposed for the all over polish of stone axes and, like the stone axes, it seems likely that arrowheads had a cultural significance that extended well beyond their

functional use, a likelihood further attested to by the frequent occurrence of leaf shaped arrowheads within chambered tomb and ritual pit deposits.

CONCLUSIONS

From this research it was possible to draw the following conclusions.

1. That local pebble flint from the beaches of Luce Bay was analogous to that in the archaeological record and could have been used during prehistory to manufacture the majority of prehistoric flint artefacts, recovered from the dunes.
2. That there were sufficient flint pebbles of workable size available on the beaches immediately to the south of the dunes and that this area is the likely source.
3. This raw material could not, however, account for all the colours present in the assemblages nor was it possible to reproduce the invasive pressure flaking seen on finer pieces such as the earlier Neolithic arrowheads. A programme of experimental work has, however, demonstrated that these qualities can be reproduced in the local material using heat treatment.

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