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# The Stotfield silcrete (or 'Stotfield Cherty Rock'), Moray, eastern Scotland

**Characterization and discussion of an archaeologically important lithic raw material**

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ABSTRACT
We describe and discuss a lithic raw material new to Scottish prehistoric research: the Stotfield silcrete or Stotfield Cherty Rock. This material was well-known to Scottish geologists, but it was only recently realized that it had been used by prehistoric people in Moray, eastern Scotland. We describe our examination of archaeological Stotfield silcrete, as well as field information relating to its geological occurrence. The purpose of this work is to shed light on 1) the distribution of this material in the Scottish landscape and thereby also the availability to prehistoric people; 2) the general properties of this raw material and thereby its usefulness to prehistoric groups; 3) the characteristics and variability within what is referred to as Stotfield Cherty Rock or silcrete, guiding identification of samples in archaeological and geological collections; 4) the date of archaeological artefacts in Stotfield silcrete, indicating whether this raw material was used throughout Scottish prehistory or only during some prehistoric periods; and 5) the geographical distribution within Scotland of archaeological Stotfield silcrete, indicating whether this raw material was considered precious and widely exchanged or whether it was perceived as as a low value raw material and only used locally. and/or on an ad hoc basis – or something in between. In addtion we suggest that fluorescence excited by short-wave ultra-violet light may be a useful routine tool for archaeological lithic work.

KEYWORDS: Stotfield, silcrete, calcrete, chert, cherty rock, Moray, Scotland, lithic raw material, procurement, exchange network, territory, UV, ultra-violet, fluorescence

## INTRODUCTION

In connection with the examination, cataloguing, and analysis of early prehistoric lithic assemblages from Dr Fraser Hunter's (National Museums Scotland) Clarkly Hill and Birnie excavations, Moray, one of the present project's participants (TBB) also examined and catalogued thousands of lithic artefacts in the county's two main museums, Elgin Museum, Elgin, and the Falconer Museum, Forres. This work took place in 2014. As expected, the vast majority of the lithic finds from Moray turned out to be local brown flint, with small amounts identified as probably being local quartz or quartzite.

However, an additional raw material was also present, in the excavated assemblages, as well as in the museum collections. It was difficult to identify this material immediately, as much of the lithic material had been exposed to 'sand-blasting', that is, abrasion by exposure to Aeolian activity in the region's coastal dunes or adjacent areas. Consequently, these finds were initially defined as 'either flint/chert, quartz or chalcedony', due to varying degrees of similarity with these three raw materials. However, subsequent studies of relevant geological literature suggested that this material might be Stotfield Cherty Rock or, as some recent literature has referred to it, silcrete from the Stotfield Calcrete/Silcrete Formation. Some of these sources were mapped as chert in Wickham-Jones & Collins (1978).

To investigate the – in an archaeological context – poorly understood Stotfield silcrete, the authors of the present paper therefore organized a field trip to Moray (23-25 June 2014), supported by National Museums Scotland, Edinburgh, and The Hunterian, University of Glasgow. We carried out a limited survey of areas likely to have natural or quarried outcrops of Stotfield silcrete, including outcrops on the shore at Stotfield/Lossiemouth (NGR: NJ 227 708), quarried rock faces within Lossiemouth town (Lossiemouth East Quarry; NGR: NJ 236707), Inverugie Quarry (NGR: NJ 149 686), as well as Spynie Quarry (NGR: NJ 222 656). We also examined outcrop extent, availability of loose and fragmental material in adjacent soil and beach deposits, and collected samples to record variability, and provide a reference suite for detailed characterisation. Discarded silcrete pebbles from Clarkly Hill also form part of our reference collection; these small natural pebbles may represent the beach wall of a fossil shoreline. In Moray, Post-Glacial beaches may be found up to *c*. 10m above O.D. (Peacock *et al.* 1968, 110). The known distribution of Moray silcrete is indicated in Fig. 28, in which the distribution of archaeological silcrete is compared with that of worked Rhum bloodstone and Arran pitchstone (≈ obsidian). Our findings have been briefly summarized in a number of preliminary reports (Ballin 2014a-c; Ballin & Faithfull 2014; 2015) and they will be included in Hunter (in prep a; in prep b).

The main aim of the present paper is to present the findings of our examination of archaeological Stotfield silcrete, as well as findings relating to our geological fieldwork. The purpose of this work is to shed light on 1) the distribution of this material in the landscape and thereby also the availability to prehistoric people; 2) the general properties of this raw material and thereby its usefulness to prehistoric groups; 3) the physical variability within what is referred to as Stotfield Cherty Rock or silcrete, guiding identification of samples in archaeological and geological collections; 4) the date of archaeological artefacts in Stotfield silcrete, indicating whether this raw material was used throughout Scottish prehistory or only during some prehistoric periods; and 5) the geographical distribution of archaeological Stotfield silcrete within Scotland, indicating whether this raw material was considered precious and widely exchanged or whether it was perceived as as a low value raw material and only used locally and/or on an *ad hoc* basis – or something in between.

## STOTFIELD CHERTY ROCK OR SILCRETE – BRIEF RESEARCH HISTORY

What is now called the Stotfield Cherty Rock Formation (British Geological Survey 2015; hereafter SCRF) has been recognised as a distinctive feature in the geological sequence in Moray since the early 19th century. The unit is rather variable, and in places it is very calcite-rich, rather than chert-rich, and this caused some confusion initially. The term 'cherty rock' seems to have been first used by Gordon (1859). A good summary of older work on the geology of the area, and in particular, on the history of views on the SCRF is given in Judd (1873).

The SCRF outcrops in a few places in the Lossiemouth-Elgin area, on the south coast of the Moray Firth, and it is also exposed in a few beach and inland exposures around Golspie, on the east coast of Sutherland (Judd 1873; Batten *et al* 1986). Offshore borehole and geophysical records show that the SCRF is also widely developed offshore in the Moray Basin (Naylor *et al* 1989). Within the SCRF, silica-rich, cherty lithologies are recorded from the Lossiemouth-Elgin area, as well as from Golspie, and are reported to be similar (Judd 1873), but we have so far only examined the southern area in detail. The cherty lithologies are quite distinctive, and cherty varieties have been reported as ice-transported boulders in glacial drift at Clackmarras and Fochabers, south-east of Elgin (Hinxman & Grant-Wilson 1902, 66).

The SCRF consists of a rather variable assemblage of calcite- and chert-rich rocks developed on the upper surfaces of the Triassic sandstones around the Moray Firth. It represents one or more pedogenic (fossil soil) units developed on these sandstone units during late Triassic terrestrial weathering (Naylor *et al.* 1989). In arid and semi-arid climates, and especially under hot conditions, evaporation of rain water and groundwater within soils can produce hard layers known as duricrusts just below the soil surface. Depending on the nature of the rocks, soils, vegetation and climate, different duricrust minerals can grow, including calcite (producing calcrete duricrust) and opal/quartz (producing silcrete). Many modern duricrusts are mineralogically complex, with closely associated calcrete and silcrete (e.g., Nash & Shaw 1998). Similar complexity is seen within the SCRF, although Naylor *et al.* (1989) suggest that the silica in the SCRF is generally later than the calcite, and that at least some of the silica in the SCRF (the late drusy quartz) is not pedogenic silcrete, but formed by later hydrothermal activity.

Naylor *et al*. (ibid.) concentrated mainly on the calcite-rich calcrete lithologies within the SCRF, but it is clear from samples collected during the current project that the silica-rich lithologies also preserve a very variable and complex geological history.

Onshore exposures of the SCRF are extremely hard, causing problems for construction and quarrying, and often requiring blasting to break up. It seems unlikely that it could have been worked at a larger scale using stone or organic tool materials, and eroded pebbles and cobbles are most likely to have been the main source of material for working.

## METHODOLOGY

To allow samples of Moray Cherty Rock to be identified unequivocally, partly in themselves but also in contrast to other forms of chert or flint, we chose an approach which included the exposure of the samples to ultra-violet light (below).

We used a 230V, ~50Hz, UK-mains powered, UVP UVS-28 series, 8-watt shortwave ultraviolet lamp, with a peak emission at 254nm to examine the fluorescent behaviour of chert/silcrete samples. This unit is small and light enough for easy hand-held use, while giving excellent UV intensity. We also investigated longwave fluorescence using a high-intensity mains-powered 365nm UV lamp, but this gave much dimmer fluorescence in almost all chert/silcrete samples. We suggest that shortwave (254nm) UV lamps with a power of at least 8 watts should be the preferred tool for the examination of fluorescence in cherts and silcretes. Although some intense fluorescence can sometime be seen in ambient light, we used a totally dark room for close examination and photography.

Samples were placed on a non-fluorescent dark grey polythene background, and photographed using a Canon G16 compact camera on a copy stand. The white balance was set for the visible light source, and the same setting used for UV photography. The UV lamp was held as close as practicable to the specimens (generally < 30cm), to give the strongest fluorescence, while avoiding obvious gradients in illumination intensity across the field of view. Shortwave UV light is dangerous to skin and eyes, so we took care to always direct the lamp away from users, and to manually move or adjust specimens only when the lamp was off.

## THE CHERTY ROCK

Duricrust rocks such as silcretes develop over very long timescales: typically thousands to tens of thousands of years at the Earth's surface. Over such long timescales, there are almost always variations in climatic conditions, from seasonal changes, to long-term changes. Accordingly, such rocks tend to preserve a lot of small-scale complexity reflecting these variations, and the variability of local environments and vegetation across their outcrop ranges. Banding, brecciation, veining, colour variation, and variations in grain-size caused by recrystallization are all common in silcrete cherts. This textural heterogeneity is often visible on a mm to cm scale within the silcrete, and may allow easy discrimination of silcrete chert from nodular diagenetic cherts, such as flint, or hydrothermal cherts, which tend to have simpler textures.

Examination under ultra-violet light is a simple, quick and non-destructive tool which can be very helpful in making quick assessments of some geological materials. This non-destructive technique is not routinely used, but has been shown to be very useful in distinguishing chert-like lithic materials (e.g. Lyons *et al.* 2003; Huckell *et al*. 2011; Gonzalez *et al.* 2014).

Many common minerals, such as quartz or calcite may sometimes emit visible fluorescent colours under UV excitation. These colours are usually the result of trace chemical components substituting in the crystal lattice of the host mineral, and accordingly they may provide a powerful tool in revealing subtle variations in chemistry during the growth of minerals. Detailed visible-light and ultra-violet fluorescence imaging of the SCRF shows a very wide range of complex textures recording complex micro-stratigraphy within the rocks (Table 1, Figs 1-8).

*Fig. 1. (below) Sandstone, partially cemented by chert: field sample 27A1. Topmost sandstone (probably just below the Stotfield Cherty Rock Formation) at east end of Spynie Quarry, Elgin (NJ222 657) Cream fluorescent chert may be infilling former roots or burrows (photo JF).*

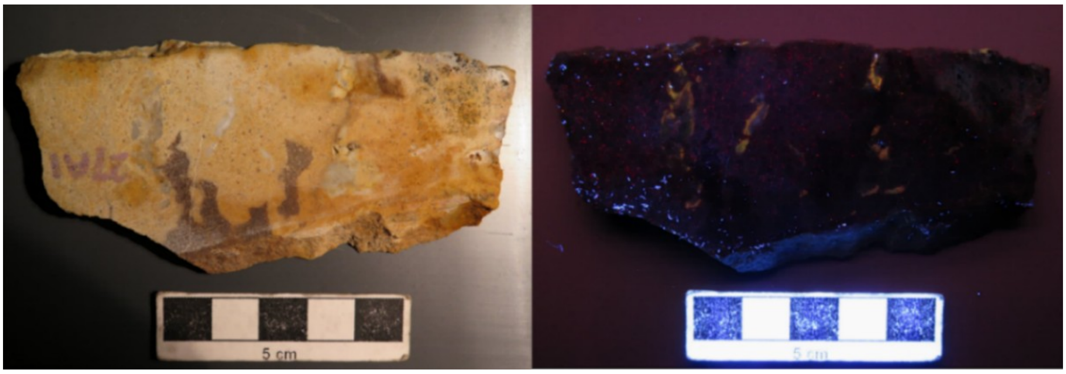



*Fig. 2. (below) Black chert veins in sandstone, cutting, and replacing earlier complex pink-fluorescent calcite cementation: field sample 25A. Boulder on Stotfield beach, Lossiemouth (NJ 230 712) (photo JF).*

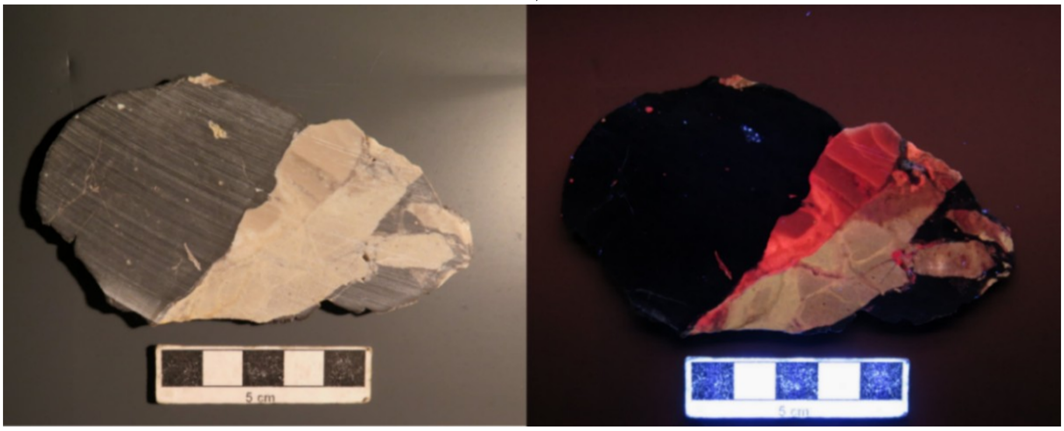



*Fig. 3. (below) Pale buff chert with good conchoidal fracture: field sample 26A3. In situ SCRF exposures at Gallow Hill, Inverugie (NJ1468 6844). Strong green fluorescence (probably due to uranyl ion activator), with later cream fluorescent chert infilling voids (photo JF).*

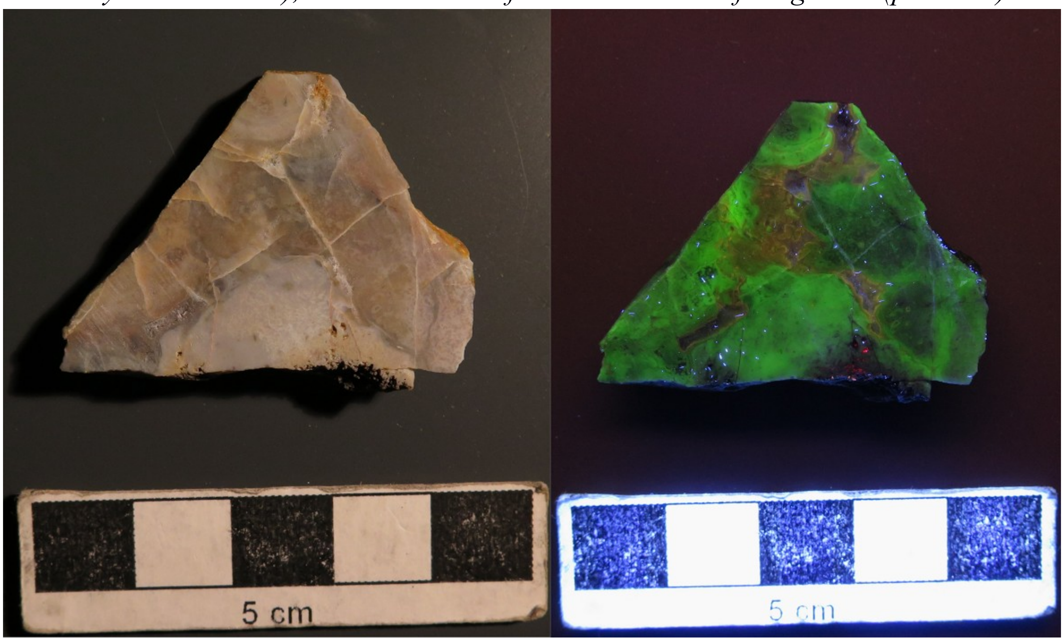



*Fig. 4. (below) Pale buff, laminated and brecciated chert: field sample 27A3. Collected loose from rock surface cleared at east end of Spynie Quarry, Elgin (NJ222 657). Interbanded cream- and green-*

*fluorescent chert, brecciated, and cemented by later brown- and non-fluorescent chert and coarse quartz (photo JF).*

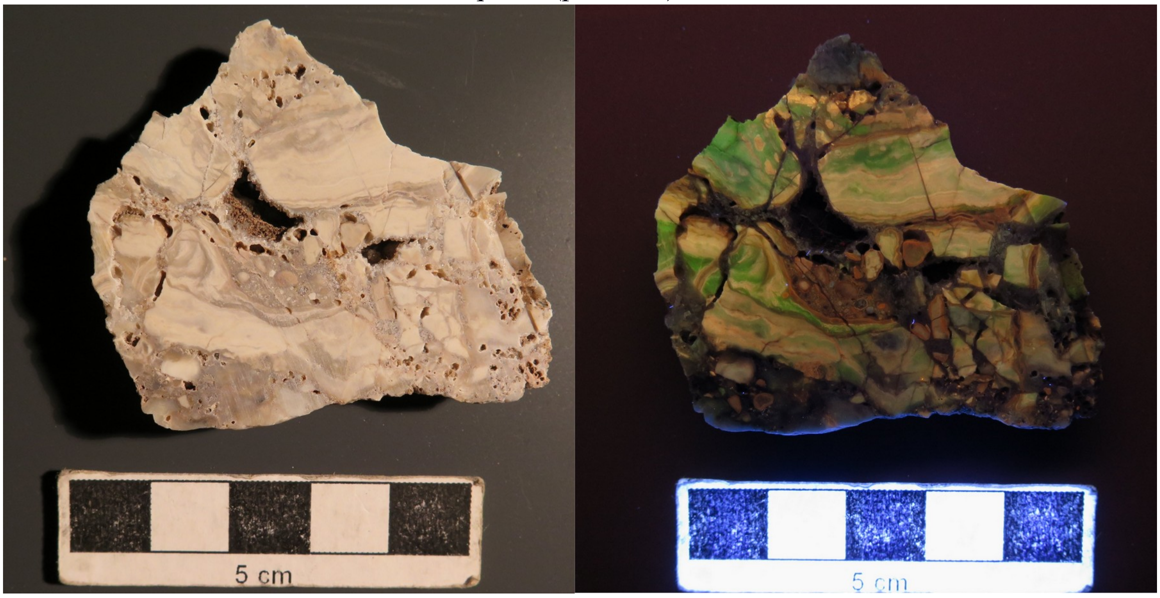



*Fig. 5. (below) Brecciated chert: field sample 25D1, from outcrop on Stotfield beach, Lossiemouth (NJ2293 7106). Shows complex stratigraphy of non-fluorescent, brown-, cream- and green-fluorescent cherts, with non-fluorescent quartz, and pink-fluorescent calcite and chert with abundant calcite inclusions (photo JF).*

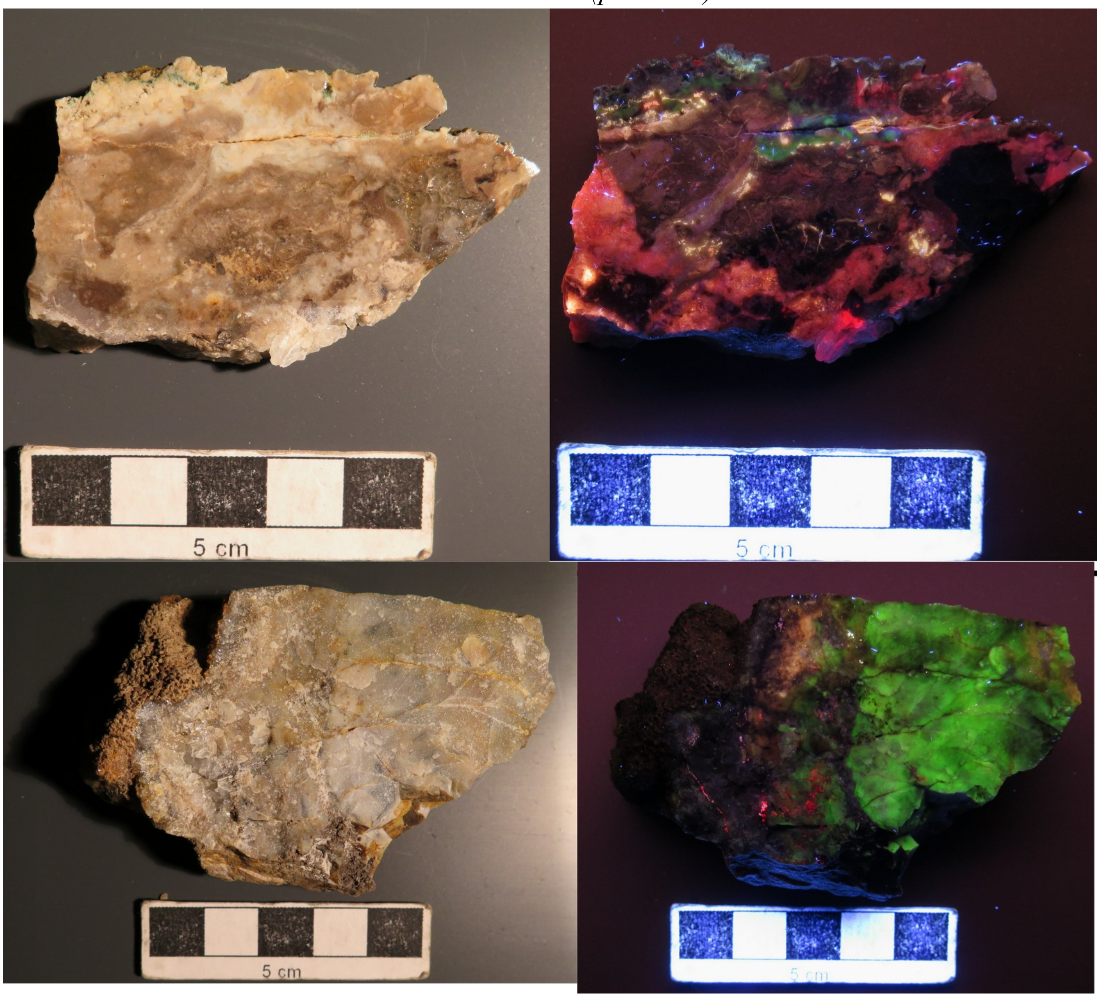


*Fig. 6. (below) Randomly broken fragments, showing good flaking behaviour, from pebbles and boulders on Stotfield beach, Lossiemouth, showing green-, cream- and non-fluorescent chert varieties, plus small pink-fluorescent calcite inclusions (photo JF).*

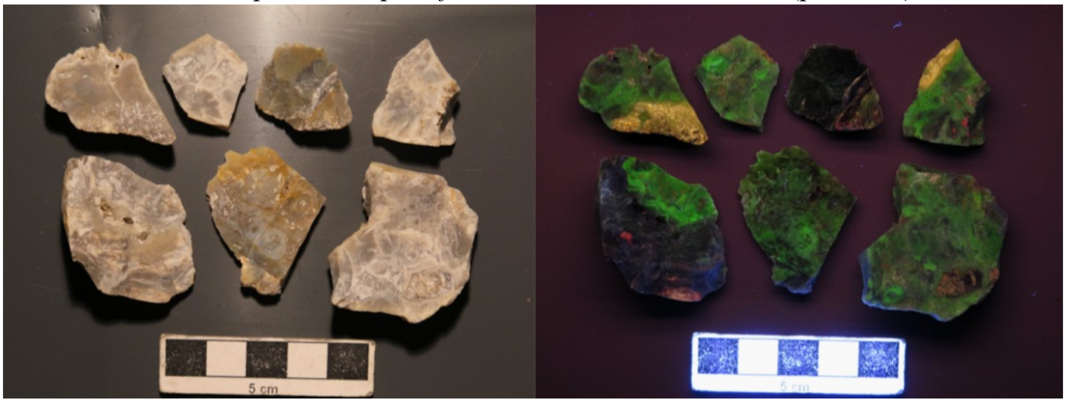



*Fig. 7. (below) Brown saccharoidal (recrystallized?) chert, with late drusy quartz lining cavities: field sample 26A2. In situ SCRF exposures at Gallow Hill, Inverugie (NJ1468 6844). Although most of this chert is non-fluorescent, there is a thin cream-fluorescent zone under the coarsely-crystalline quartz on the right (photo JF).*

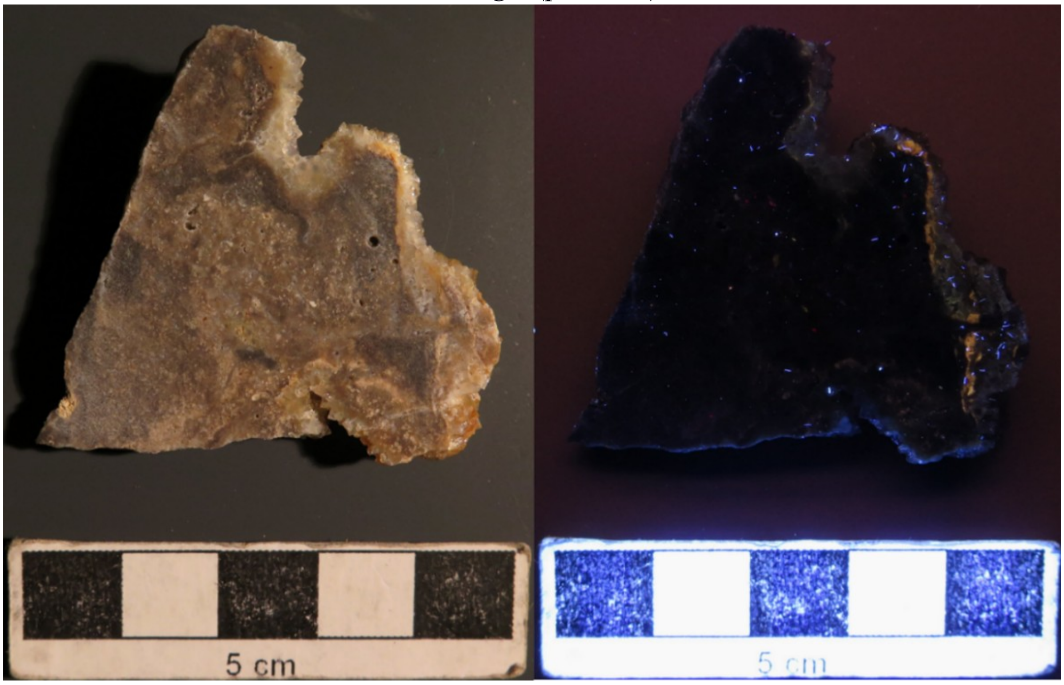


*Fig. 8. (below) A selection of microcrystalline quartz materials, illustrating the distinctive fluorescence of the SCRF silcrete cherts. Top row (left to right) bloodstone, brown chert/chalcedony, white chert, white chert (all from Guirdil, Isle of Rum, NW Scotland); second row down: agate (Guirdil), agate (Blue Hole, Montrose, Scotland), agate (Heads of Ayr, Scotland), agate/chert vein (Carlops, Scotland). Third row down: three specimens of SCRF cherts from Lossiemouth/Elgin area, plus agate (Ardownie Quarry, Angus, Scotland). Bottom row: four excavated flint artefacts from Craigsfordmains, Earlston, Scotland, modern leaf arrowhead knapped from Norfolk flint, large piece of flint from Stevns Klint, Denmark, broken flint beach pebble from Iona, Scotland (photo JF).*

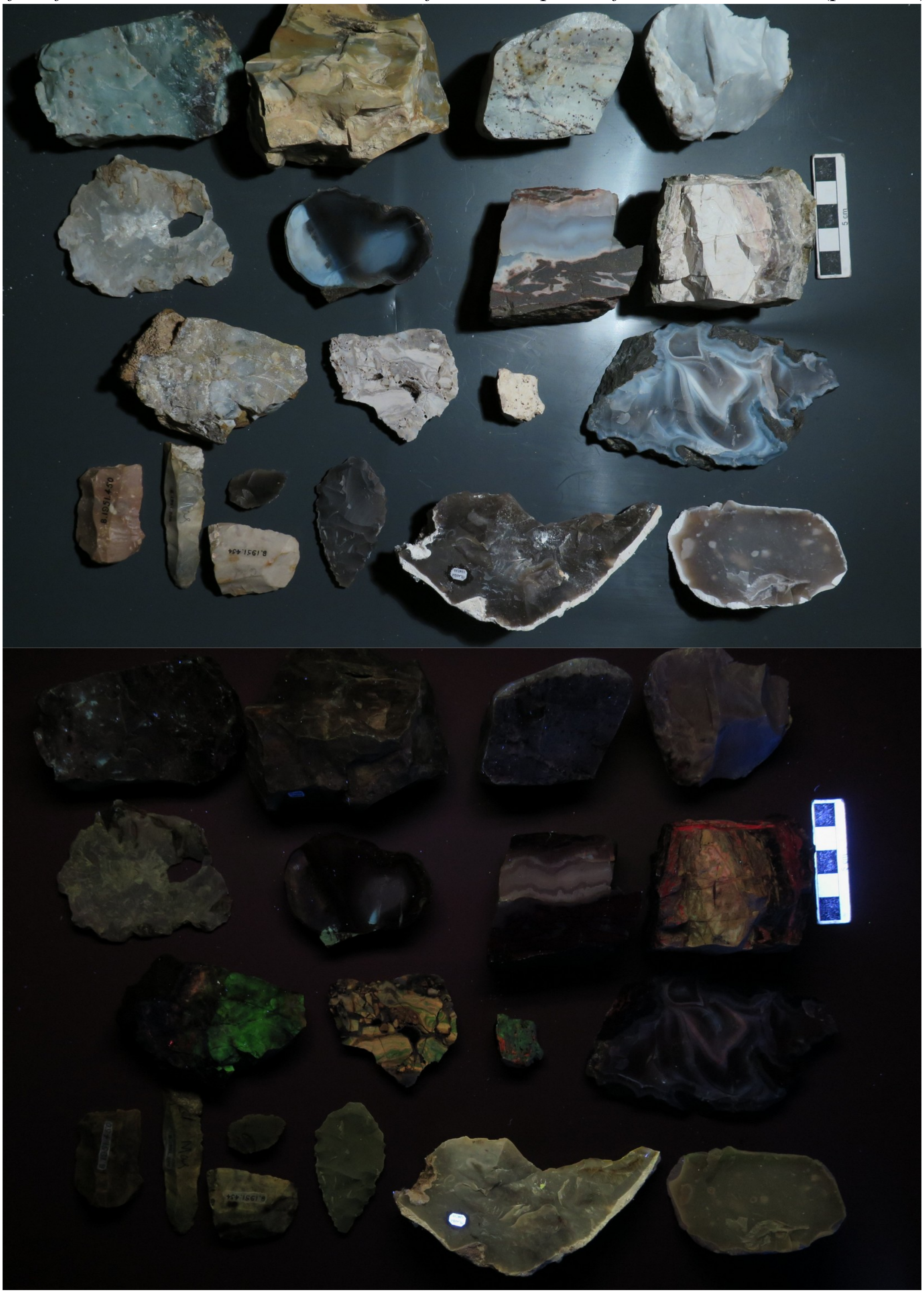


*Fig. 9. (below) Unworked chert fragments from Clarkly Hill, Cummingstown, Moray. The fluorescence behaviour indicates that these fragments are SCRF lithologies (photo JF).*

We have found that the many of the SCRF varieties most suitable for lithic tool manufacture have very distinctive UV fluorescence under short-wave (254nm) UV light, and this may be very helpful in identifying this material in excavated assemblages. Much of the calcite associated with the SCRF fluoresces pink (due to Mn2+ activation), but the intensity is very variable, indicating changes in the chemistry of the groundwater from which different generations of calcite grew.

*Table 1. SCRF chert varieties distinguishable by colour and UV fluorescence criteria.*

| Colour | SW UV fluorescence (254nm) | Occurrence |
|---|---|---|
| 1. Pale buff chert (Fig. 1). | Cream to yellowish. | Patchily developed within sandstone below SCRF, sometimes preferentially developed in vertical zones, perhaps reflecting former presence of plant roots, or burrows within unconsolidated sand. |
| 2. Homogeneous clean black, (weathering greyish), slightly saccharoidal texture on conchoidal fracture surfaces (Fig. 2). | Non-fluorescent. | Post-calcrete replacement masses within sandstone (not seen *in situ*, but probably below main Cherty Rock outcrop?). |
| 3. Cream to pale brown chert with little obvious macroscopic internal structure (Figs 3-6). | Green fluorescence (UO2 2+ activated : Goetze *et al* (2015) . | Pre-dating, or interbanded with cream-yellow fluorescent chert (Type 4). |
| 4. Cream to pale brown finely banded or brecciated chert, smooth on fracture surfaces (Figs 4-6). | Pale cream to yellow, or brown fluorescence. | Interbanded with green fluorescent chert. (Type 3). Often later veins or overgrowths on green fluorescent chert, but may also be early in places. |
| 5. Patchy brown to greyish translucent chert; saccharoidal | Non-fluorescent. | Abundant at Stotfield. |

| | | |
|---|---|---|
| texture on broken surfaces (Fig. 7). | | |
| 6. Coarsely crystalline colourless, to white or faintly amethystine quartz. | Non-fluorescent. | Late hydrothermal overprint and recrystallization of earlier microcrystalline chert. |

ARCHAEOLOGICAL FINDS

In connection with the investigation into the SCRF, a number of lithic assemblages from sites in Moray were examined, namely those from Clarkly Hill, Birnie, and Sculptor's Cave. In addition, the entire collections of lithic artefacts in Elgin Museum, Elgin, and the Falconer Museum, Forres, were inspected.

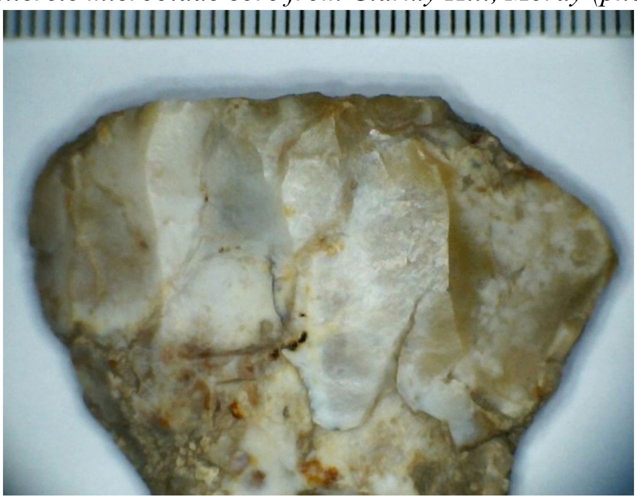
**Clarkly Hill, Moray**

The excavations at Clarkly Hill (NGR: NJ 13 67), were directed by Dr Fraser Hunter, National Museums Scotland, and they focused mainly on remains from the later prehistoric period, as well as from Roman and medieval times. However, a relatively numerous lithic assemblage (379 pieces) was also recovered, including residual finds from the Mesolithic, Neolithic and Early Bronze Age periods.

Clarkly Hill is located immediately south-east of Burghead, 1-2km from the present coast. At the time of the Main Holocene Transgression, Clarkly Hill would have been an Island, and the presence of many small silcrete pebbles amongst the artefacts from the excavation suggests that this island would have had shingle beaches, or pebble beach walls, from which this raw material could be procured.

The artefactual assemblage (Ballin 2014b) is dominated by flint, supplemented by a few pieces of quartz, and 15 pieces of worked silcrete. This translates into a silcrete ratio of only 4%. Most of the silcrete artefacts are simple waste, but one piece is a regular microblade core (Fig. 10). Microblades are popularly associated with the Late Mesolithic period, but a notable proportion of the blades from Scottish Early Neolithic sites are also microblades (Ballin 2006; 2015a; 2016), and the Microblade core from Clarkly Hill can therefore only be dated to the Late Mesolithic / Early Neolithic period *sensu largo*.

*Fig. 10. Silcrete microblade core from Clarkly Hill, Moray (photo TBB).*

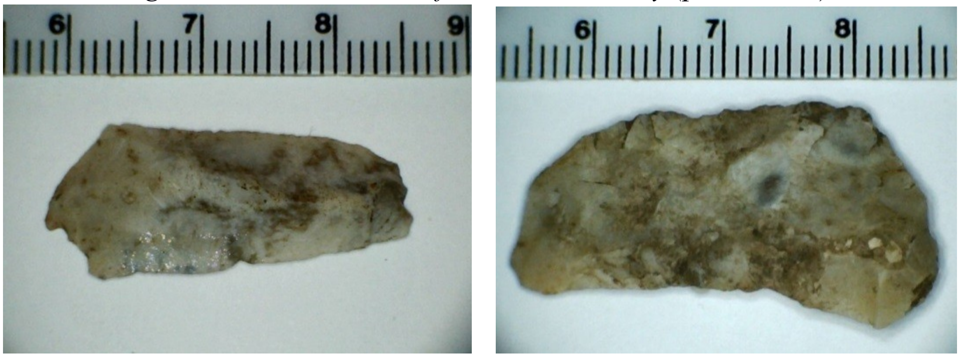


**Birnie, Moray**

The site at Birnie (NGR: NJ 210 585) was also excavated by Dr Fraser Hunter, and this work resulted in the discovery of two hoards of Roman coins as well as a number of Iron Age roundhouses and Neolithic and Bronze Age features. In addition to the mainly later prehistoric finds, an assemblage of earlier prehistoric lithic artefacts (703 pieces) was also recovered from the site.

The site is located on a hill further inland, *c*. 12km from the present coast, and it would also have been an inland site in prehistory, even at the time of the Main Holocene Transgression. However, the river Lossie runs less than one km west of the location, and silcrete procured from coastal outcrops could easily have been canoed to the site when it was settled.

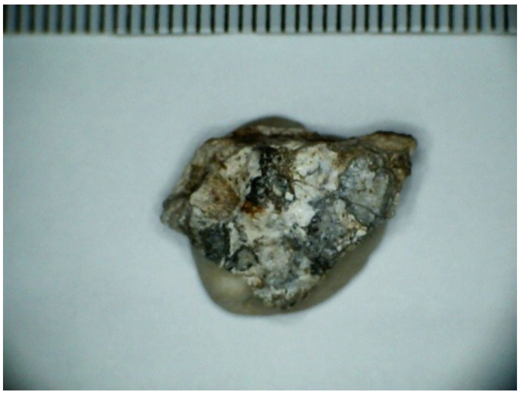
*Fig. 11-12. Silcrete blades from Birnie, Moray (photos TBB).*

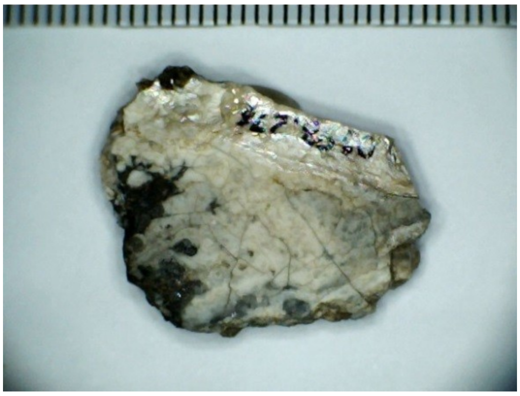


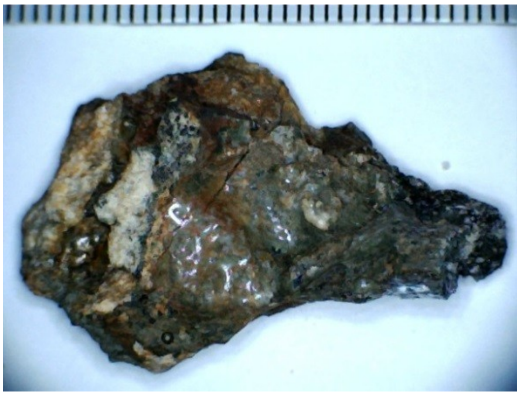
The artefactual assemblage (Ballin 2014a) is dominated by flint, supplemented by a substantial proportion of quartz and rock crystal (one-third of the collection), and 45 pieces of worked or burnt silcrete (6% of the assemblage). Like the assemblage from Clarkly Hill, this collection also includes Mesolithic, Neolithic and Early Bronze Age lithic artefacts. The silcrete artefacts include some broad blades (Figs 11-12), which are likely to date to pre-early Bronze Age times, as in Scotland blade production was abandoned prior to the Neolithic/Bronze Age transition (e.g. Ballin 2014c). However, many of the site's silcrete objects are heavily vitrified indeterminate pieces with notably glassy and, in some cases, slaggy surfaces (Figs 13-17).

As silcrete is commonly found with calcrete in the SCRF (Peacock *et al.* 1968; Naylor *et al.* 1989), the vitrified silcrete may have been burnt accidentally in connection with the burning of SCRF as a fertilizer, and subsequently scattered across the region's fields, most likely in Post Medieval times. Practically all the vitrified silcrete derives from spoilheaps – probably originally topsoil – indicating a late date.

*Figs 13-17. Vitrified silcrete 'lumps'. Fig. 17 is a piece of actual silcrete slag (photos TBB).*



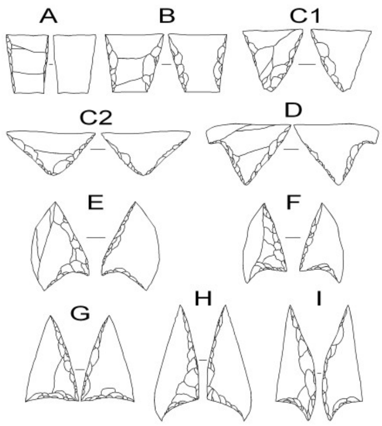


**Sculptor's Cave, Covesea, Moray**

In connection with Ian and Alexandra Shepherd's excavations in Sculptor's Cave (NGR: NJ 1750 7072) in the late 1970s (Shepherd 1995), a small lithic assemblage was recovered. These artefacts, as well as two lithics from the site donated to National Museums Scotland separately (Benton 1931), were briefly characterized and discussed in a report by Ballin (2015b).

These finds embrace objects in flint (11 pieces), silcrete (seven pieces), flint or silcrete (five pieces), quartz and rock crystal (nine pieces), and one piece in agate. In contrast to many other lithic assemblages from Moray, the finds from the cave are generally not sand-blasted (that is, abraded by Aeolian activity). The flints include one bifacial knife and one scale-flaked knife, whereas the silcrete and the potential silcrete artefacts are chips, flakes and indeterminate pieces. The site and its lithic finds are generally thought to date to the Early Bronze Age period.

*Figs 18-19. Fig. 18. Silcrete oblique ('lop-sided') arrowhead from Elgin Museum (photo Heather Townsend/courtesy of Elgin Museum). Due to notable sandblasting, it was difficult to define the piece as to formal type, but closer inspection of the implement as shown in this photo reveals that it has retouch around its base and along the entire right lateral side, whereas its left lateral side, its cutting-edge, has been left unmodified and sharp. Fig. 19. Although it has a rounded corner rather than an acutely pointed barb, it most closely resembles Clark's squat Types E-F (1934b, Figs 1-2; in Ballin 2011).*

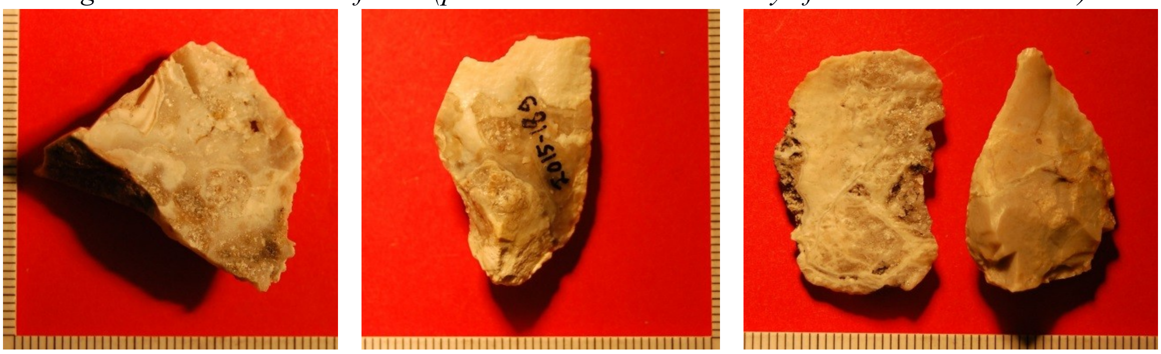

**Museum collections**

In connection with one of the authors' (TBB's) assessment of the lithic finds from Clarkly Hill and Birnie in 2014, he was also asked to to assist with the production of an inventory of the lithic artefacts in Elgin Museum (Elgin) and the Falconer Museum (Forres) in Moray. Both museums have in their care thousands of local lithic artefacts, most of which are flint. However, both museum collections also include tens of artefacts in silcrete. Most of these artefacts are simple flakes, but some platform and bipolar cores, as well as tools, were also recognized, the latter including one oblique arrowhead, one barbed-and-tanged arrowhead, knives and scrapers. Many, if not most, of these pieces have been recovered from sites in, or near, the county's dune systems, such as Culbin Sands, and they are generally notably sand-blasted, that is, affected by Aeolian activity. Chronologically, these pieces seem to span the entire early prehistoric period, although mostly the Neolithic and Early Bronze Age (Ballin 2014c). Figs 20-26 show a selection of these finds.

*Figs 20-21. Barbed-and-tanged arrowhead and bifacial knife in silcrete (photos John Barrett/courtesy of the Falconer Museum).*

*Figs 22-23. Single-platform core and irregular core in silcrete (photos John Barrett/courtesy of the Falconer Museum).*

*Figs 24-26. Four silcrete flakes (photos John Barrett/courtesy of the Falconer Museum).*



**DISCUSSION**

Many of the SCRF silcrete lithologies are relatively easily identified by their distinctive textures, and by their short-wave UV fluorescence behaviour, and we suggest that UV fluorescence may be a cheap, quick and useful tool in the examination and characterisation of lithic materials. Complex, heterogenous textures visible under UV light, combined with frequent green and/or cream fluorescence are characteristic of many of the SCTF lithologies most widely used as tools. Although flint usually displays a cream fluorescence, it has a low-intensity, even fluorescence unlike SCRF silcretes (Fig. 8).

Stotfield silcrete forms part of the bedrock of the Elgin area, Moray, from Burghead to Lossiemouth, and as far inland as Spynie (Pea cock *et al.* 1968, Fig. 14). However, although silcrete may today be collected from a number of locations in this area (modern quarries), it is likely that, in prehistory, it was only available from primary and secondary coastal deposits. Primary deposits may have been available at Stotfield, Lossiemouth, like today, but would probably have been very difficult to work due to the general hardness of the material. Secondary coastal deposits may have included shingle beaches or pebble beach walls along the shores of the time, with Post-Glacial fossil beaches being located topographically at levels up to 10m above OD, with some Late-Glacial beaches being located at levels up to 15m+ above OD (ibid., 107, 110).

Although most Stotfield silcrete appears to be a potentially poor lithic raw material, with its inhomogeneity and inclusions (quartz druses, carbonate and sulphide inclusions, etc.), inspection of prehistoric artefacts from excavations and museums in the Moray council area shows that it was clearly used. Processing of the collected samples included splitting the many recovered cobbles and pebbles to allow them to be geologically characterized, and as part of the hammering of these pieces a number of acceptable flakes were (unintentionally) produced (Fig. 27). In prehistory, flakes like these could easily have been used as blanks for simpler lithic artefacts like scrapers, piercers, etc., but that more sophisticated bifacial pieces were manufactured in this material is demonstrated by the illustrated oblique arrowhead (Fig. 18) and barbed-and-tanged arrowhead (Fig. 20). These arrowheads may not be of the regularity and quality experienced in connection with prehistoric burial and ritual depositions (see for example the oblique arrowheads from the chambered tomb at Ormiegill, Caithness in northern Scotland [Clarke *et al.* 1985, Fig. 2.8], or the barbed-and-tanged arrowheads from the chambered cairn at Calanais, Western Isles [Ballin 2005, Illus 19]), but they may have been acceptable in functional terms. However, it is presently uncertain how many varieties of silcrete were exploited by prehistoric people in eastern Scotland (as the present investigation focused on artefacts in more chalcedonic and agate-like/brecciated forms of the material) and further examination of museum and excavation collections is needed to clarify this point.

*Fig. 27. Flakes unintentionally produced in connection with the splitting of geological samples from Stotfield, Lossiemouth (photo JF).*

The Stotfield silcrete artefacts presently known include a number of diagnostic elements, such as narrow and broad blades, one microblade core, one oblique ('lop-sided') arrowhead, and one barbed-and-tanged point. As microblades were produced not only during the Late Mesolithic, but also during the Early Neolithic (Ballin 2006; 2015a; 2016), it is uncertain exactly when the use of Stotfield silcrete as a lithic raw material started. The silcrete microblade core from Clarkly Hill, for example, can only be dated to the Late Mesolithic/Early Neolithic period *sensu largo*. The silcrete oblique arrowhead is clearly Late Neolithic, and the silcrete barbed-and-tanged arrowhead is of an Early Bronze Age date. In summary, silcrete seems to have been exploited as a toolstone from the Late Mesolithic or Early Neolithic period to (and including) the Early Bronze Age.

The Mesolithic period in general is slightly poorer represented in the region, which further complicates the definition of the earliest use of Stotfield silcrete. The low number of Mesolithic artefacts in Moray's museums may be due to the fact that the region's Mesolithic settlements may mainly have been located along the coast and the region's water-courses, and the extensive dune systems of Moray now cover many of these sites (Peacock *et al.* 1968; Stephenson & Gould 1995).

Geographically, Stotfield silcrete seems to only have been used in Moray, that is the area in the immediate vicinity of the primary and secondary deposits of this raw material, possibly an area with a radius of *c*. 25km (although collections from sites further away from the sources should be examined to test this). The small area covered by the archaeological use of this type of stone (Fig. 28) supports the impression given by the execution of the silcrete artefacts, namely that the raw material was considered a functional resource and that it was not considered precious and subsequently widely traded. It would be useful in connection with future work to examine the potential occurrences and use of SCRF silcretes on the other side of the Moray Firth, around Golspie.

Examination of toolstones used in Scottish prehistory suggests that the different lithic raw materials may have been perceived in very different ways, and that exchange networks of different geographical size and complexity were organised for their distribution. Table 2 gives an overview of the most important of these exchange or procurement networks.

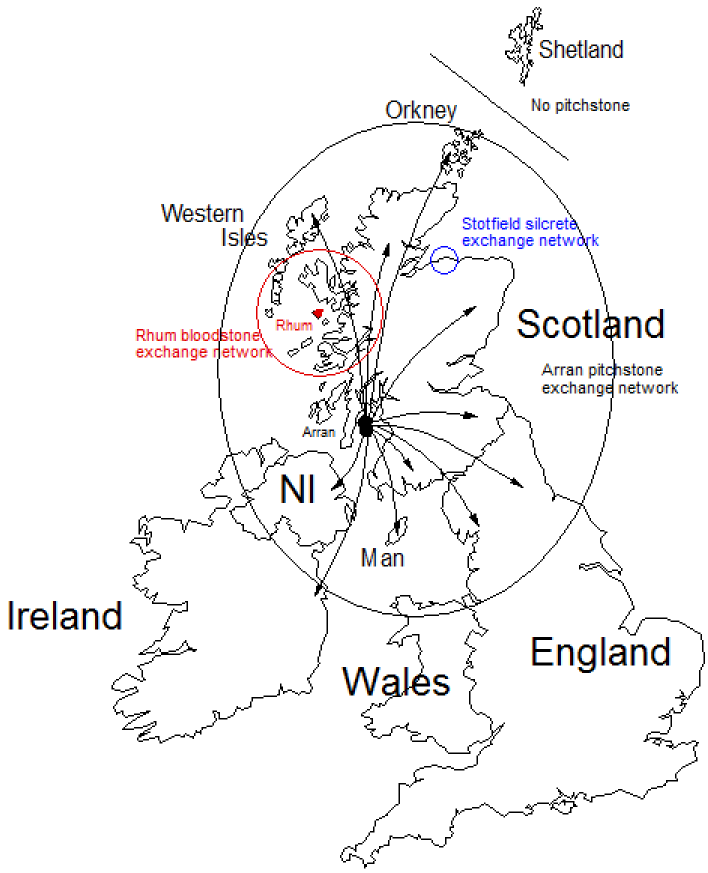
*Table 2. Lithic toolstones and their exchange/procurement networks in Scottish prehistory.*

1. <u>Techno-complexes</u> – coastal flint, quartz, Southern Uplands (and similar) chert;
2. <u>Inter-regional social networks</u> – Arran pitchstone, Yorkshire flint; Antrim flint;
3. <u>Social territories</u> – Staffin baked mudstone, Rhum bloodstone, Lewisian mylonite;
4. <u>Local importance</u> –agate/chalcedony/carnelian, Durness chert, quartzite;
5. <u>Local *ad hoc* supplements</u> – Stotfield Cherty Rock, jasper, basalt/dolerite.

When discussing prehistoric exchange networks and territories, the authors suggest that Clark's hierarchical structure and terminology is followed (Clark 1975: 1. the catchment territory, 2. the annual territory, 3. the social territory, and 4. the techno-complex; also see Ballin 2009, Ch. 7.4.3: Tribal Territories). Categories 4 and 5 in Table 1 may relate to Clarke's annual territory, and in this case we may be talking about one band or tribe procuring lithic raw material for its own use, with no actual between-group exchange taking place.

Fig. 28 gives an impression of the different geographical size of a number of types of exchange networks. The Early Neolithic Arran pitchstone (≈ obsidian) network (Ballin 2009; Ballin & Faithfull 2011) has a radius of approximately 600km and is thought to embrace a number of prehistoric social territories with pitchstone possibly having been perceived and traded differently in different parts of the network (Ballin 2009). The Rhum bloodstone network (Mesolithic to Early Bronze Age; Ballin forthcoming) has a radius of *c*. 80km, with a few bloodstone-bearing sites beyond this distance. Rhum bloodstone may have had a symbolic value ('emblematic style'; Wiessner 1983; 1984) throughout this territory, with possession of bloodstone artefacts indicating that the bearer belonged to a particular kinship-based group or territory. And the Stotfield silcrete network had a radius of only *c*. 25km, and this fact, in conjunction with the flawed character of the raw material (see above), may indicate that this raw material was not perceived as precious, and that it was perceived entirely in a functional light, that is, as a useful lithic supplement within the immediate vicinity of the sources.

*Fig. 28. The geographical size of three lithic exchange networks, the Arran pitchstone network (black), the Rhum bloodstone network (red), and the Stotfield silcrete network (blue).*




CONCLUSION AND FUTURE PERSPECTIVES

As shown above, Stotfield silcrete was clearly used by prehistoric people in the Moray area for a variety of tool forms, and it is highly likely that it was used throughout the prehistoric period. However, it appears to have been perceived entirely as a functional resource, where other lithic raw materials may have been perceived in a combined functional/symbolic light, which may explain why it was only used within a very small geographical area, possibly by people living within walking distance from the SCRF sources, whereas other Scottish raw materials may have been used in an emblematic manner and traded within a larger social territory (Rhum bloodstone), or traded across vast distances and possibly – near the periphery of the exchange network – perceived as something exotic, if not mysterious (Arran pitchstone).

Although our work has dealt with many archaeological and geological aspects of prehistoric exploitation of the SCRF, and shown how examination under ultra-violet light is a simple, quick and non-destructive tool in terms of identifying this raw material, there is still much work to be done, such as the examination of archaeological collections beyond Moray and the investigation of silcrete outcrops near Golspie, on the western shores of the Moray Firth. It should, in particular, be tested whether Moray silcrete was used for other tool forms than those identified so far; whether other forms of SCRF material than the more chalcedonic and agate-like/brecciated forms were exploited; whether Stotfield silcrete may be found in archaeological contexts further afield than the presently known silcrete-bearing sites; and whether the silcrete of the Golspie area is similar to that of the Moray area and associated with a similarly small exchange network.

In a broader perspective, this approach may be useful to lithics specialist throughout the world, as silcrete was used as a toolstone by a variety of different industries, from the earliest to more recent stone-using periods (Nash & Ullyott 2007), and the reduction of silcrete has been reported most notably from Australia and Oceania (eg, Webb *et al.* 2013) and South Africa (eg, Nash *et al.* 2013).

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