7 Discussion

7.1 The date of the Cnoc Dubh quarry

As briefly touched upon earlier (Section 3), it has not been possible to date the events at Cnoc Dubh more precisely than to the 'period of flaked lithic reduction' in general. On Lewis, this means within a time-frame encompassing the Neolithic and Bronze Age periods, possibly including the Early Iron Age.

At present, the worked vein cannot be dated directly, for example via diagnostic attributes associated with the quarrying process, as no other Scottish quartz quarries have been analysed and published. Indirect dating via diagnostic core or tool types would require excavation of the area in front of the rock face and vein, but due to the construction of a sheep pen in this area, the potential tailing pile is today inaccessible.

It is possible that future examination of the various structures around the knoll, for example the oval structure north of Cnoc Dubh, or investigation of the area around the beehive structure (as indicated by James Crawford's excavation; Section 2) may indicate a date of the quarry, as it is likely that the worked vein is associated with a nearby activity area or settlement. As argued in Section 7.3, the distance between quartz sources and prehistoric settlement is generally expected to be relatively short.

7.2 Quarrying of quartz compared to the quarrying of other lithic raw materials

When comparing quartz quarrying to the mining of other lithic raw materials a number of distinctions may be helpful. Firstly, the procurement of raw materials from different types of locations may require different approaches, and the following distinctions are suggested:

- Open pebble sources (river banks / beaches / erratics)
- Covered pebble sources (glacial till, fossil river-beds and fossil sea-shores)
- Intermediary sources (mainly chalk sources)
- Bedrock outcrops (veins, dykes, and sills)

Material from open pebble sources is usually collected directly from the surface, whereas material from covered pebble sources may demand some degree of digging or mining. These sources frequently result in the creation of pits or even pitted landscapes (eg, Saville 1995). It is proposed to class material from Cretaceous chalk and some soft limestone/dolomite locations (mainly flint and chert) as intermediary sources, as the parent rock is noticeably softer than other igneous, sedimentary and metamorphous rocks, but considerably harder than, for example, glacial till. The acquisition of material from these sources varies from collection of loose material in front of chalk cliffs, over teasing out nodules of the cliff face, to actual horizontal or vertical underground operations (Saville 1981; Weisgerber 1987; Rudebeck 1987; Schild 1987; Herne 1991).

Raw material from bedrock sources (eg, granite, gneiss, sandstone) usually takes the form of veins, dykes or sills (eg, jasper, pitchstone/obsidian, rhyolite, dolerite). It is possible to further sub-divide vein sources into vertically exposed seams and horizontally exposed seams. Whether a vein represents a vertical source or a horizontal source has apparent implications for the distribution pattern of the individual site, as an associated artefact scatter (tailing pile, activity area) may be either in front of the vein (Cnoc Dubh) or on top of it (Richburgh Quarry [Cantley 2000] and Gummark Loc. III-IV [Broadbent 1973; Broadbent 1979]).

In most cases, these sources are noticed because they reach the surface, from where they are then initially exploited. At a later stage, when the superficial parts of the outcrops have been exhausted, the sources may be followed underground, first as simple undermining of a rock face (eg Negrino 1998, 103) or the creation of pits (Torrence 1984, 54) and, later, actual adits (Gramly 1984, 12) or shafts (Stocker & Cobean 1984, 85) may be formed. The latter occurred relatively rarely in prehistoric times, due to the hardness of the rock. Quartz was acquired from all but intermediary sources. Quarrying of quartz from pebble sources, though probably one of the more frequent forms of quartz procurement, has rarely been described in the archaeological literature, though Brockington 1992 presents a number of quartz pebble quarries from Virginia.

In connection with the above discussion of raw material sources, various mining forms were briefly mentioned. They may be listed in the following, logical fashion (cf. Weisgerber 1987):

- Surface quarrying: simple surface collection
- Surface quarrying (horizontal): pitting
- Surface quarrying (vertical): the formation of overhangs
- Underground quarrying (horizontal): adit mining
- Underground quarrying (vertical): shaft mining

Table 1 A number of Neolithic and Bronze Age settlement and ritual sites along the west coast of Lewis, their individual distances, and dominant quartz types

Assemblage	Reference	Approximate distance	Dominant quartz variety
Barvas 2	Ballin in prep. f		Fine-grained and milky quartz, pebble source
		14.5 km	
Dalmore	Ballin in prep. b		Coarse-grained quartz, pebble source
		10.0 km	
Olcote	Warren forthcoming		Fine-grained and milky quartz, vein and pebble sources
		2.0 km	
Calanais	Ballin in prep. a		Milky quartz, vein source
		3.5 km	
Cnoc Dubh	[this report]		Milky quartz, vein (quarry)
		16.0 km	
Berie Sands	Lacaille 1937		Fine-grained quartz, vein source

A third distinction may be relevant to the present discussion, namely that of minerals and rocks. A mineral is composed of an orderly arrangement of certain elements which makes it possible to present it in the form of a representative chemical formula (in the case of quartz and related silica: SiO^2), and a specific internal (crystal) structure. Flint and chert (crypto-crystalline varieties of quartz) are technically classified as chemical sediments, that is, types of rock, but their general properties are very much similar to those of minerals, and in the present context they ought to be grouped with mineral raw materials of the silica group (cf. Luedke 1992). A rock, on the other hand, is a mountain-building aggregate of minerals (Pellant 1992, 16). In the present context, the main difference between the two types of stone is that minerals are usually solid, whereas rocks are more or less grainy. This means that, in many instances, mineral raw materials from bedrock sources have to be pounded out of the parent rock by the use of hammerstones (as, for example, the quartz at Cnoc Dubh) whereas, in many cases, it is possible to detach blocks of rock raw materials from their matrix by the use of fire (eg greenstone, rhyolite and Cumbrian tuff; Alsaker 1987, 76–7; Bradley & Edmonds 1993, 95). This process works by heating an area of, for example, a dyke, followed by rapid cooling, thereby creating cracks and fissures allowing the detachment of relatively large blocks or plates of material.

Two of the most important sources to prehistoric Scottish axe-makers, the Cumbrian tuff (from the Great Langdale 'axe factories') and the Perthshire hornfels (from Creag na Caillich, near Killin), were exploited in ways differing noticeably from the approach witnessed at Cnoc Dubh. First of all, the operational schema of the quarrying of tuff and hornfels was not based on the detachment of successive layers of raw material as these sources are essentially massive. Consequently, the two rock types were mainly 'flaked' off the walls of the quarries, leaving huge conchoidal flake scars (Bradley & Edmonds 1993, plate 5.1).

The main reports on the two source areas (Bradley & Edmonds 1993; Edmonds *et al*. 1992) both refer to the mined products as 'large blocks' and 'massive flakes', with the 'blocks' probably owing their more irregular shape to 'pre-existing lines of weakness' (Edmonds *et al*. 1992, 92). Due to the different technological approach, the tuff and hornfels quarries did not acquire a stepped appearance, but have quarry walls characterized by large concave areas, as illustrated in the Creag na Caillich report (Edmonds *et al*. 1992, illus 14). The use of fire played a major role in the procurement of Cumbrian tuff (Bradley & Edmonds 1993, 95), whereas the Perthshire hornfels appears to have been acquired without fire-setting (Edmonds *et al*. 1992, 92).

The choice of approach must have been generally determined by the combination of the factors 1) source type (hardness of matrix and source location in relation to the ground surface), 2) type of material (mineral or rock), and 3) the presence or absence of inherent layers parallel to the exposed surface (described in Section 5.1 in connection with the presentation of the Cnoc Dubh vein). It appears that quartz extraction from vein sources is carried out in more or less the same fashion as the extraction of related silica, such as jasper and novaculite (a form of chert: Luedke 1992, 125), that is, by the use of hammerstones and the successive detachment of raw material layers (resulting in the stepped appearance demonstrated by Illus 6 & 7). The matrix is too hard to allow the use of antler picks (as in the procurement of flint from Cretaceous chalk; Barber *et al*. 1999; Russell 2000), and the raw material is too solid to allow the use of fire (as in the procurement of greenstone and rhyolite; Alsaker 1987, 76–7), or the raw material would be damaged by the use of fire (quartz would disintegrate).

7.3 Quartz sources and settlements

Usually, quartz sources are divided into vein and pebble locations, with the former being quartz veins fixed in a rock matrix, whereas the latter constitute beach and river sources of loose, rounded quartz pebbles (typically including gravel and cobble-sized pieces). The two forms of quartz do not represent inherently different quartz types, as pebble quartz is only vein quartz which has been detached from its original matrix and subsequently abraded and rounded by one of a variety of water media.

Comparison of assemblages from neighbouring prehistoric sites along the Lewisian west coast suggests that quartz sources were fairly local in relation to the Neolithic and Bronze Age settlements. As shown in Table 1, the dominant quartz type of each assemblage usually differs from the dominant quartz types of the assemblages from adjacent sites. All the sites in Table 1 are situated close to the coast, and the pebble sources of Barvas 2, Dalmore and Olcote are most likely the beaches immediately next to these sites. The exact distance between settlement and quarry, in the cases of the vein quartz dominated sites of Calanais, Cnoc Dubh (quarry) and Berie Sands, is unknown, but the distances between the individual locations suggests that it may be as much as 10 km (though the author expects it to be much less).

The relative closeness of quartz sources and prehistoric settlements was discussed by Broadbent who suggested that, due to the amounts of quartz needed by prehistoric man to cover the daily replenishment of lithic tools, as well as the considerable weight of the required lithic raw material, most quartz sources were probably situated within a traditional catchment area (Broadbent 1979, 190) as defined by Vita-Finzi & Higgs 1970, that is, an area with a radius of no more than 10 km.

In northern Sweden, Broadbent examined a complex of settlement sites (Lundfors) and quartz quarries (Gummark), where the settlements were separated from a cluster of quarries by approximately 7 km (Broadbent 1979, 190). Recent re-examination of the quartz from the Scord of Brouster settlement site on Shetland (Ballin in prep. d) demonstrated that, in this case, a number of veins were exploited; the main vein(s) were probably situated within a catchment area with a radius of *c* 5 km (quartz with adhering sandstone), and supplementary quartz supplies were transported across distances of no less than *c* 6 km (quartz with adhering feldspar from granite or gneiss) (Johnstone & Mykura 1989). As the dominant quartz type of the Calanais assemblage is milky quartz, like the quartz of the Cnoc Dubh quartz outcrop, it is plausible that the worked quartz from Calanais was procured from the Cnoc Dubh vein, approximately 3 km away.

7.4 Ownership of / access to quartz sources, and quartz exchange

The generally close proximity of settlements and quartz sources in the Neolithic and Bronze Age of Lewis suggests that, most likely, these raw material sources were in the ownership of individual families, and the families' *main* quartz resources were probably not, or rarely, accessed by other people, or exchanged. This does not mean that quartz was not exchanged at all, but just that the geological resolution of most quartz analyses has been too low to allow more detailed studies. In the present paper, the author has distinguished between a number of quartz sub-types (Table 1) but, generally, lithics analysts tend to lump all quartz sub-types into one main category. As Abbott states, this is '. . . like a faunal analyst putting all furry animal remains into a 'mammal' category without separating them by specific name, genus and/or species' (Abbott 2003, 106). In doing so, a great deal of valuable information is lost.

On Lewis, one form of quartz appears to have been preferred for, for example, arrowheads, namely the so-called 'greasy' quartz (probably an ultra fine-grained form of this material). As shown in Table 1, the Calanais ritual complex, and its central megalithic tomb, is dominated by homogeneous milky quartz (Ballin in prep. a), but the site's barbed-and-tanged arrowheads are mainly in quartz with a greasy lustre. At Dalmore, further to the north, seven out of 15 quartz arrowheads are in 'greasy' quartz, though the dominating variety of that site is coarse-grained quartz (Ballin in prep. b). It is quite possible that this preferred arrowhead material was imported, but presently it is not possible to say from where. No Lewisian sites are dominated by 'greasy' quartz, and only one site on mainland Scotland is known for the presence of greater quantities of this material – Shieldaig in Wester Ross (Ballin *et al.* in prep.). Given the distances across which pitchstone, for example, was traded (Williams Thorpe & Thorpe 1984; Ness & Ward 2001), it is not impossible that Shieldaig, or other sites or quarries in that general area, is the main source of 'greasy' quartz, particularly if it had some symbolic, for example totemic, connotation. As the crow flies, the distance from Shieldaig to the Lewisian west coast sites is approximately 100 km.

At the present time, Shieldaig is the only known assemblage where 'greasy' quartz has been employed in the production of the full range of lithic tools whereas, in assemblages dominated by other quartz varieties, this quartz form was mainly used to manufacture arrowheads and, in some cases, more sophisticated knives. It is quite possible that this state of affairs purely reflects the fact that 'greasy' quartz has better flaking properties and, as a consequence, was saved for the production of more complex, invasively retouched lithic tools (a mainly functional view is favoured by McNiven in his analysis of the technological organization and settlement pattern of prehistoric Tasmania; McNiven 1994), but it is just as likely that this quartz type had some inherent symbolic meaning to prehistoric people in Scotland (totemic association between people and raw materials has been demonstrated in anthropological research by, *inter alia*, Gould 1980, 141–59 and Clemmer 1990).

When a lithic raw material is accessed or exchanged in primitive societies, whether this resource has mainly functional (eg White & Modjeska 1978) or symbolic (eg Gould 1980) connotations, access/exchange is mostly restricted to kinship-related individuals (Sassaman *et al.* 1988, 80), but non-kinship based access/exchange does also take place, creating, or re-inforcing, alliances (Gould 1980, 155). In cases, where the use of a lithic resource is associated with symbolic values or style (Ballin forthcoming: according to Polly Wiessner, style is '. . . formal variation in material culture that transmits information about personal and social identity' [Wiessner 1983, 256]), the frequency of that raw material usually drops abruptly at the borders of that specific social territory, but quantification of the lithic raw material distribution across Scotland (raw material composition of the various assemblages, region by region) is still to be carried out. The analysis of raw-material fall-off curves throughout northern Britain may allow the construction of an, at least rudimentary, territorial structure of early prehistoric Scotland.

However, in the investigation of the use and exchange of quartz and lithic materials throughout Scotland, it is probably necessary to distinguish between sites and assemblages from different periods, as symbolic values and access/exchange patterns are likely to have varied over time. The rules of access and exchange ought to vary between, for example, highly mobile hunter-gatherer communities with relatively loosely defined and, occasionally, overlapping territories, and sedentary farming communities with more precisely defined territories and stricter perceptions of land-rights and ownership of quarries and other resources. Exceptions are, nevertheless, known, and in nineteenth century Australia the Kalkadoons, a hunter-gatherer tribe, were fiercely territorial about their homeland and its quarries (Hiscock 2001). However, it is uncertain whether the well-organised and militaristic Kalkadoon society arose as a result of their prehistoric mining activities, and the associated complex trading patterns, or whether the socio-economic structure of this Australian tribe was a response to European expansion.

In this light, one probably ought to distinguish between the Mesolithic sites and assemblages of Scotland on one hand, and Neolithic/Bronze Age sites and assemblages on the other. The distribution patterns witnessed in connection with the post-Mesolithic lithic material from the Western Isles are most likely an expression of ideas about landrights typical of farming communities, such as the tendencies of quartz sources to almost exclusively supply individual families or farms. In the Neolithic/Bronze Age period, the exchange of the better quartz variety with a 'greasy' lustre may mainly have been linked to lineages, or the tribe (in geographical terms: the social territory), though some inter-lineage or inter-tribal trade may have occurred (as possibly in the case of Scottish pitchstone exchange). The Scottish pitchstone distribution, in particular, paints a picture of generally more complex, regulated exchange, possibly even in the form of 'proper' trade.

In the more egalitarian hunter-gatherer societies, ownership to lithic resources was probably less formalised and quarry access more open, as suggested in Bruen Olsen and Alsaker's analysis of West Norwegian rhyolite, greenstone and diabase sources (Bruen Olsen & Alsaker 1984; Alsaker 1987). They suggest that, in the Norwegian hunter-gatherer period (*c* 10,000 – 3,800 C-14 years uncal BP), lithic resources may have been 'exploited directly, and on open terms' by the people populating a social territory (Bruen Olsen & Alsaker 1984, 96). This assumed difference between Mesolithic and post-Mesolithic access/exchange signals a change in emphasis, from generalized reciprocity to balanced reciprocity (Sahlins 1972, 199).