The

Manx

Stone Axe-head

Project

Interconnection or Isolation? The evidence from stone axe-heads for the Manx Neolithic in its Irish Sea context.

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Thank You.

All mistakes, errors and omissions are my own.

TABLE OF CONTENTS

TABLE OF FIGURES

CHAPTER 1

1.1 Introduction

As a small island in the middle of the Irish Sea, the Isle of Man is a distinctive and easily defined geographical unit with an interesting history of development. This thesis evaluates the polished stone axe-heads that have been acquired by the Manx Museum since its foundation in 1922 in an attempt to understand more about the island during later prehistory.

Until recently, these stone axe-heads had only been subjected to a cursory analysis as part of a larger, on-going study of axe-heads undertaken in the United Kingdom, see Section 1.4.1. A more comprehensive review of the Manx collection is therefore overdue. In the following pages, the procurement, manufacture and disposal of axe-heads on the Isle of Man will be discussed. Firstly, in a chapter that explores the morphological features of the axe-heads, the form and function of the various styles in the collection are reviewed (Chapter 3). Then in a chapter reviewing axe-head petrology, the range of source rocks used in axe-head production is examined and proposed local provenances are explored using novel geochemical analysis methods (Chapter 4). Finally, contextual information obtained from the axe-head records in the Manx Museum archives has been utilised to help understand the circumstances of discovery of axe-heads on the Isle of Man (Chapter 5). In all three chapters, when possible, the collection is cursorily compared to contemporaneous collections in neighbouring regions. Methodology is discussed in Chapter 2. However, initially an appreciation of the island's situation, and an understanding of the work that has been completed on similar artefacts elsewhere is essential.

1.2 The Isle of Man in Context

As the Late Glacial Maxima progressed (c. 13,000-10,000 years ago) the Devensian ice caps in the northern hemisphere retreated and sea level changed in the Irish Sea region as a result of a combination of complex glacio-hydro-isostatic corrections in the earth's crust. Models accounting for these corrections are continually being refined by geoscientists (Chiverrell et al., 2013, p. 206). Kettle-hole data from the Jurby ridge in the nineteen seventies suggested the island was ice free by around sixteen thousand years ago (Birm-794, 15150±350 BP) (Tooley, 1977, p. 33; see also Chiverrell, 2002, pp. 3, 210). Several 'land bridges' have been proposed but by approximately eight to ten thousand years ago the Isle of Man had become an island, almost equidistant from Scotland, Ireland, Wales and England (among others see Tooley, 1974, 1977; Robinson et al., 1990; Lambeck, 1995; Gonzalez et al., 2000; Chiverrell et al., 2001; Davey and Innes, 2002, p. 44; Shennan and Horton, 2002; Heathcote and Michie, 2004; Fleming, 2005, p. 15; Roberts et al., 2006; Thomas and Chiverrell, 2007; Chiverrell et al., 2013, p. 206; Thrasher et al., 2009; see also Bradley, 2007 p.11 Fig. 1.4).

The main spine of the island is composed of a series of folded and faulted meta-sedimentary mudstones and sandstones, collectively known as the Manx Group and dated to the Ordovician period, c. 495-470 Ma (Chiverrell and Thomas, 2005, p. 6). The hills in the north and south are bisected by a central valley stretching from the island's capital, Douglas, on the east coast, to the westernmost harbour town of Peel. The island's highest peak, Snaefell (621 m), is located in the north and beyond are the gently undulating northern plains, see Figure 1:1. To the south of the central valley the fertile hills on the eastern side of South Barrule (483 m) gradually slope down to the most sheltered natural harbour on the island at Langness, near Castletown;

where some of the earliest evidence of human activity and occupation has been discovered[1].

Most of the island's rocks are covered by diamicton, gravel, silt or peat, although small exposures appear at the surface along the coast, and in quarries, see Figure 1:2. According to the online World Factbook (Central Intelligence Agency, 2015), arable land comprises 43.86% of the island, with the rest a mixture of permanent pastures, plantation forests, and heathland. Originally, the island would have been largely covered in native oak/hazel woodland (Dubbeldam, 2011, p. 4) comparable to that of Ireland, south-west Scotland and Cumbria as the temperature warmed after de-glaciation. All that remains is a total of 1.27 km^2 of native oak/hazel woodland, scattered mostly between 50 metres and 150 metres altitude, in narrow ravines on the northern and eastern edge of the northern hills; land clearance and excessive harvesting of wood led to the island being almost completely stripped of natural woodland by the sixteenth-century CE (Dubbeldam, 2011, p. 6).

The presence of broad swathes of trees on the island in the Neolithic (c. 4th millennium BCE) would have tempered the climate as presently experienced (Davey and Innes, 2003, p. 121), see Figure 1:3. The relatively flat terrain of the northern coastal plain is underlain by glacial sediments—largely unconsolidated sands and gravels—which were eroding at an average rate calculated by J.C. Brown in the nineteen fifties of 0.7 metre per year at Port Cranstal (Phurt) in Bride, north of Ramsey (@54.397617, -4.3622836) (Brown, 1951; Rouse, 1990, p. 80; see also, Joliffe, 1981, p. 78). This is a ten-fold increase on the 0.07 metres per year rate he estimated for the previous period between 1869-1959. Current estimates of an average of 1 metre per year could remove the entire northern coastal plain in

[1] In 2009 Oxford Archaeology North uncovered a Mesolithic Pit house in the Ronaldsway area (@54.087272, -4.6094513). Named Cass ny Hawin II, it has been radiocarbon dated to c.8200-7950 cal BCE (Quartermaine, 2016), and is perhaps over 1000 years older than the previous oldest date: 7315-6862 cal BCE, obtained by Woodcock and McCartan from hazelnut shells at Ballacregga, Glen Wyllin in Michael (@54.355966, -4.5913782) (Davey and Allwood, 2016, p. 143).

approximately 10,000 years (Chiverrell and Thomas, 2005, p. 4). As such, a considerable reduction in habitable land area over the last 5000 years is highly likely, although at the same time at the Ayres—the northern most point of the island — sediment has accumulated (Rouse, 1990, particularly Table 6.2), creating a lot of land and providing new habitats for life, including people (Davey, P.J. pers. comm.). As can be seen on Figure 1:4, the island's geological history defines its shape and it has been this geology, coupled with the island's setting and climate, that has shape the landscape and its users over the last 10,000 years. The island is littered with small igneous intrusions and many would have originally contained valuable ore minerals; similarly, the Castletown Limestone, as well as providing hard-core rubble and building blocks for the southern Parishes, was an invaluable source of lime for the kilns in the seventeenth-century CE. Peel Sandstone's usefulness as a building stone is well known on the island, exemplified by Peel Castle itself, while, the shape and character of the numerous megaliths, stone walls and buildings still standing today prove that both the Manx Group, and the similar Dalby Group, can make good lintels, binks[2] and uprights, even if they are really not true roofing slates.

But what of the period immediately before the utilisation of metal? How did the populace utilise the natural resources of the island then? What environmental issues and resource limitation did inhabitants have to face? Can a small assemblage of locally collected stone axe-heads reveal anything about the Manx Neolithic?

[2] A small stoop commonly found outside old Manx cottages and made from local Manx Group or Dalby Group rocks is called a 'bink'. Used primarily for gossip and rest.

Figure 1:1 A Topographic Map of the Isle of Man (TerraMetrics Inc., 2015)

Figure 1:2 A Drift Map of the Isle of Man (Murphy et al., 2006, p. 8 Fig. 1.3)

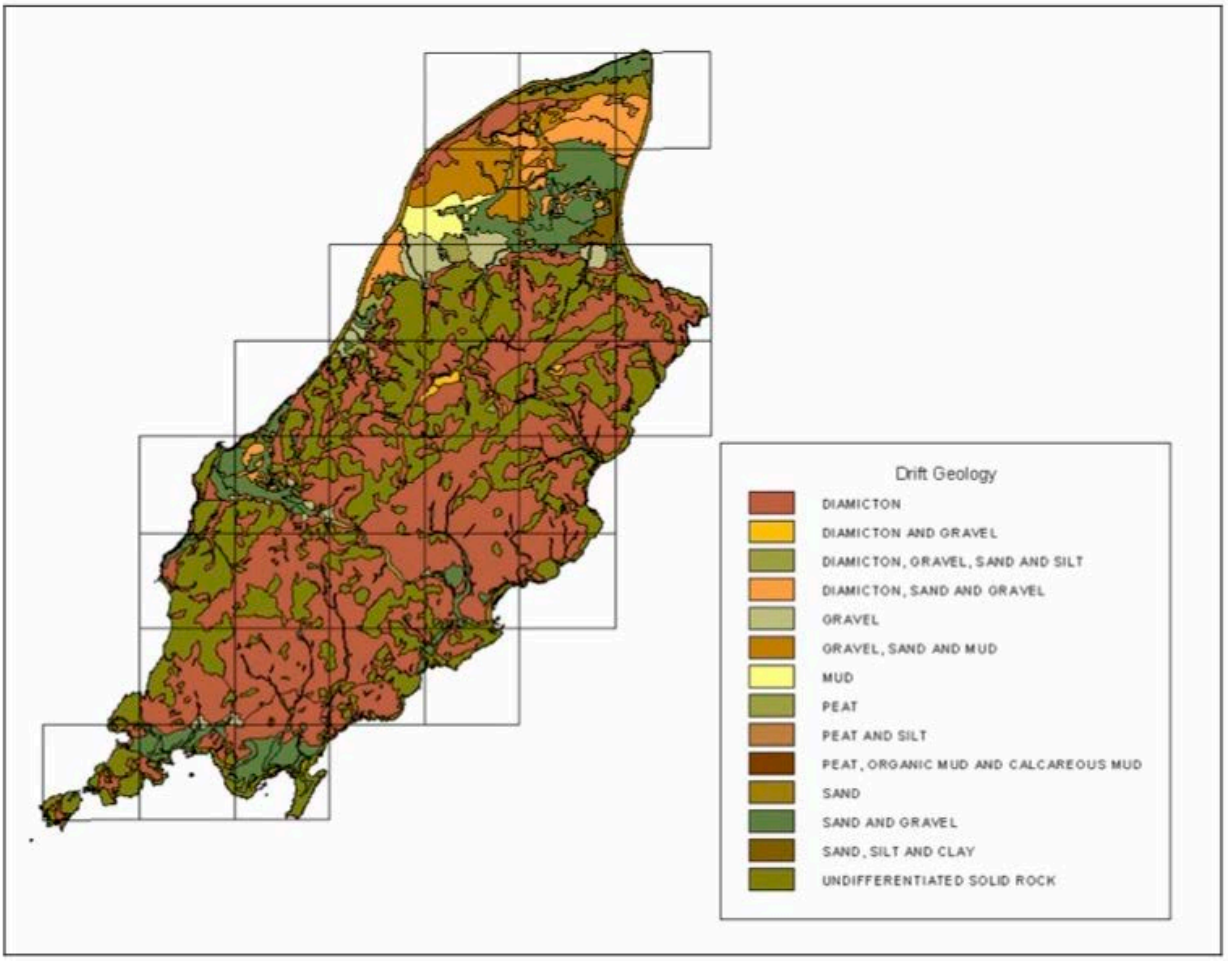


Figure 1:3 Basic geographical facts about the Isle of Man[3]

Latitude:	c. 54.2500°N	**Longitude:**	c. 4.5000°W
Area:	c. 572 km²	**Coastline:**	c. 160 km
Length (max.):	c. 52 km	**Width (max.):**	c. 22 km
Highest Point (Snaefell):	c. 621 m	**Longest River (Sulby):**	c. 18 km

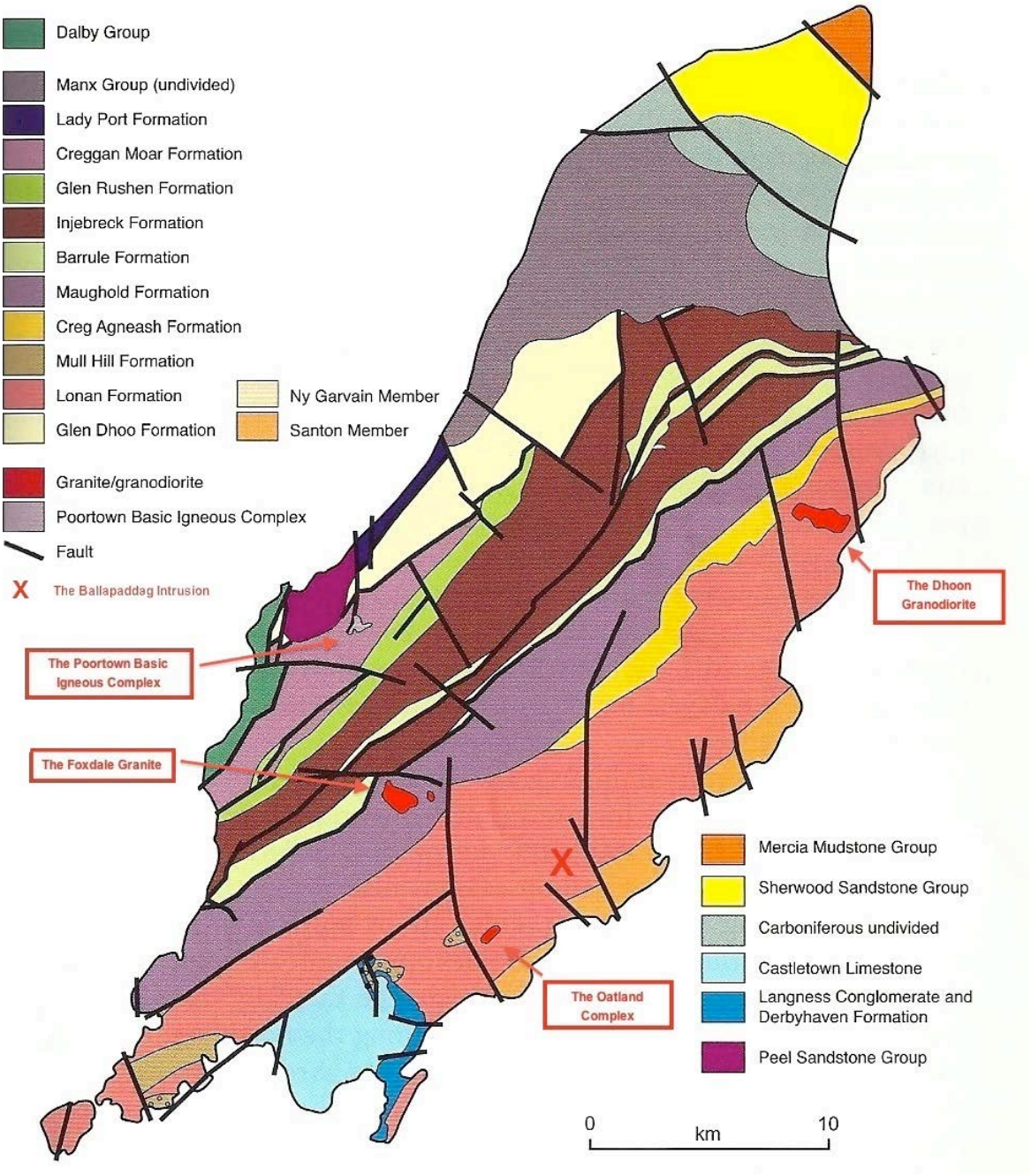
Distance from Scotland (Burrow Head):	c. 26 km
Distance from Ireland (Ardglass):	c. 50 km
Distance from England (St. Bees Head):	c. 50 km
Distance from Wales (Cemlyn Bay, Anglesey):	c. 74 km

Predominant Wind Direction:	west south west			
Average Wind Speed:	**Summer**	c. 7 m/s	**Winter**	c. 12 m/s
Average Temperature:	**Summer**	c. 15°C	**Winter**	c. <9°C
Average Yearly Rainfall:	**Lowlands**	c. 800 mm	**Highlands**	c. 1900 mm

[3] Meteorological data extracted from Diebel, J. & Norda, J., 2015 and distances calculated with Google Maps™, also see the Isle of Man Wikipedia Entry.

Figure 1:4 A geological map of the Isle of Man,

taken from Chiverrell and Thomas (2005, p.3 Fig.1) (with additions in red)



1.3 Project Aims

This project enables the stone axe-heads in the Manx Museum collection to enter the debate about the interactions of prehistoric communities in the Irish Sea Region. Following a summary of the state of current stone axe studies in Chapter 1 and a review of methodology in Chapter 2, the three main chapters are designed to offer some insights into the most relevant, focused perspectives in modern stone axe-head studies, specifically and defined in this case as:

- Morphology (Chapter 3) – a study of the dimensions, weight, appearance and treatment of any particular axe-head, as well as the study of distinguishing features as a group and assessment of trends within the collection;
- Petrology (Chapter 4) – a study of the diversity and origins of the various raw materials used to produce stone axe-heads on the Isle of Man;
- Context (Chapter 5) – a study of distribution, the environment of deposition and individual object histories, as well as a preliminary comparison of the Manx collection with collections from around the Irish Sea region.

1.4 A brief historiography of Neolithic research in Britain and Ireland

The importance of the stone implements and monumental lithic architecture that is scattered across the landscape of Britain, Ireland and the Isle of Man has been recognised for well over a century (see Evans, 1897). In 1836, while organising the 'prehistoric and protohistoric collections of the Royal Commission of Danish Ancient Monuments in Copenhagen', museum curator Christian Jurgensen Thomsen, proposed the 'Three Age System' (Thomas, 2004a, p. 33). The 'Stone', 'Bronze' and 'Iron' Ages were conceptualised to account for the progressive complexity of the ancient implements he was reviewing. Thomsen's volunteer assistant, Jens Jacob Worsaae, later noted, during work on Denmark's coastal shell middens, that the Stone Age could be divided further. However, it was the British archaeologist, Sir John Lubbock, who in 1865, coined the term 'Neolithic'. The name, translated literally from the Greek, means 'new stone age' and was chosen to reflect the difference, originally noticed by Worsaae, between the primitively shaped tools of the earliest prehistoric sites, and the well-formed, precision tools of the period immediately prior to the adoption of metallurgy (Renfrew and Bahn, 2005, p. 199). In his influential book 'Man Makes Himself' (1936) Vere Gordon Childe, a Marxist, interpreted this sharp contrast between Neolithic artefact assemblages and older finds as indicative of a revolution. He invoked an image of the mass migration of 'peoples', along with their practices, mythologies and material culture, to explain the distribution of assigned fashions, or 'cultures', and the corresponding reduction in Mesolithic hunter gatherer assemblages with time. The nationalist attitudes, continued imperialism and crumbling colonialism of mid-twentieth century Europe were all important socio-political forums for his portrayal (Marciniak and Coles, 2010). Unsurprisingly, polished stone axe-heads played a central role in this rendering of prehistory—as weapons for powerful families and tools for clearing large

swathes of land for incoming farming communities to settle. Many museums, interested institutes and enthusiastic amateur antiquarians instigated projects to explore the insights lithic implements could have on the movement of peoples, trade and exchange during this era-defining Neolithic Revolution, see Section 1.4.2.

In southern England, the conspicuous causewayed enclosures (i.e. Windmill Hill in Avebury, Robin Hood's Ball at Stonehenge and Maiden Castle in Dorchester) as well as an intriguingly abundant assortment of other megaliths (including the renowned Stonehenge Circle itself) have been at the core of Neolithic synopses for several generations (Whittle et al., 2011a); however, the amount of work and resources focused on classifying, cataloguing, storing and recording artefacts and structures from this area has led to the formation of a rather 'England-centric' overview of Neolithic Britain (Fokkens, 1992, p. 192; see also Daniels, 1941; Piggott, 1954; Renfrew, 1973; Hodder, 1982; Smith, 1984; Darvill, 1987; Whittle, 1988; Richards and Thomas, 2012). However, since the 1960s, shifting social constructs have allowed more explanations for the rich and varied prehistoric assemblages of Britain and Ireland to be highlighted (see Thomas, 2004a, pp. 55–77; for example Cooney, 2000a; Sheridan, 2007) and in the last thirty years in particular new regional summaries have attempted to do more than just place northern and western communities in terms of their similarities and differences with southern England (Bradley and Edmonds, 1993; Sharples and Sheridan, 1992; Cummings and Fowler, 2004; Whittle and Cummings, 2007).

Today enclosures are known to be an integral part of larger monument complexes, interpreted as central places in the social landscape (Thomas, 1999, p. 164) and although the migration model has not been discounted (Davey and Innes, 2002; Rowley Conwy, 2004) artefacts are no longer seen as fixed and rigid members of specific cultural group assemblages. Recent theories are inclined to emphasise the

importance of scale, exchange, environment, identity, ritual, health and death over the more established cultural history chronologies, or processualist approaches (Bradley, 2003, p. 218; Darvill, 2010; Thomas, 2013). Additionally, other schools of thought suggest that care must be taken not to infer too much from personal experiences, given that it has been established by many, including Gell (1998), that we all possess inherent social assumptions and cosmological constraints, from our own interpretations of the world, which inevitably influence how we interpret the importance of different aspects of the evidence of past actions (Latour, 1993; Searle, 1996; Thomas, 1996).

As well as the versatility of implement forms, the often touted 'Neolithic package' is identified by significant regional variations in settlement and burial types, the use of pottery, by monumental construction and the gradual adoption of agricultural practices (Çilingiroğlu, 2005). However, it is the timing and agency of the various elements of these classically 'Neolithic' practises that continue to be the foci of enquiry (Whittle et al., 2011c, p. 910). The leading issue facing our understanding of the Mesolithic-Neolithic Transition in Britain and Ireland today, as it was in Childe's time, remains migration versus acculturalisation. Essentially the question is still the same: did indigenous 'Mesolithic' hunter gatherer forager fisher populations adopt 'Neolithic' practises via insular innovation coupled with exposure to resource and ideas from across the Channel, or where these practises, ideas and resources brought to Britain and Ireland by incoming communities that settled?

Alison Sheridan, who often works in conjunction with European colleagues, argued that there is no evidence for a slow acculturalisation of indigenous communities in Britain and Ireland (Pailler and Sheridan, 2009, pp. 25–26). Instead she proposed models of repeated, small scale colonisation along various route into different regions of Britain and Ireland (2010, p. 93 Fig. 9.1), allowing for a potentially rapid

acculturation of indigenous hunter gatherer forager communities over a wide area via direct contact with the migrant farming communities settling within their environment around the 38th century BCE (Sheridan, 2013, 2010, 2007, 2004a). In contrast, proponents of the acculturation theory, like Thomas (2004b, 2007) suggest that the adoption of Neolithic practises and material culture was contemporary with the hunter gatherer forager fisher lifestyle for a considerable time before the sedentary agriculture model takes precedence with the proliferation of houses, enclosures and eventually monuments. The material culture, ideologies and traditions of practise are seen to have trickled through the established community over time through exposure. According to Robb and Miracle (2007, pp. 99–100) these models clash without resolve because they view the Neolithic at different scales. Migration models view the population as a whole; acculturation occurs at a much more intimate level.

Several authors have considered the nuances of both interpretations (Garrow and Sturt, 2011; Cooney, 2007; Whittle, 2003), and the debate has been slowly moving away from this binary view of the agency of change. As noted by Thomas (2013, p. 5), the publication of Whittle, Healy and Bayliss' literally era defining *'Gathering Time'* (2011a) has transformed the face of Neolithic studies in Britain and Ireland forever. Using Bayesian approaches to modelling archaeological chronologies (Bayliss et al., 2011a, p. 17) they reassessed over two thousand radiocarbon dates taken from early Neolithic sites in southern Britain and Ireland and determined that the earliest evidence of Neolithic activity (undecorated ceramics) could have been introduced into the south-east of England as early as the 41st century BCE. Shortly after, cereal grains and 'houses' appear in the record in the area, followed by monumental architecture, then flint mines, ground axe-heads, leaf-shaped arrowheads and domesticates by the 39th century BCE (Bayliss et al., 2011b, p. 841 Fig. 14.179).

Movement of at least ideas towards the west is indicated by 'houses' in south-central England dated to the 40th century BCE, followed by evidence of cereal grains, domesticates, undecorated ceramics, leaf-shaped arrowheads and ground axe-heads. Around the end of the 38th century BCE, large enclosures appeared in south-central England and then an apparently rapid proliferation of all the key indicators of the classic 'Neolithic package' occurred across Britain and Ireland (Whittle et al., 2011b, p. 853). However, Whittle et al. did not attempt to define a chronology for North Wales, most of Scotland, central or northern England, and considered the Isle of Man and the parts of Scotland reviewed as a 'selective exercise' in viewing enclosures from southern Britain (including South Wales) and Ireland in a wider context (2011b, p. 808). As such the rapid proliferation seen to date may breakdown to a more nuanced chronology on further inspection of datasets from the northern half of Britain, and the Isle of Man.

As it stands, the finer resolution given by Whittle et al.'s Bayesian approach does not favour either the migration model or acculturalisation entirely, instead there is room for more complex relationships to emerge once Bayesian methods have been applied to suitable datasets (Bayliss et al., 2011a, p. 17). Indeed, current research avenues are dynamic and multi-faceted, with the subject matter broken down and studied from numerous angles at various scales (Smyth and Hoffmann, 2013, p. 12).

Evidence for early Neolithic cereal cultivation is limited but witnessed in both Britain and Ireland (Cooney, 2000b, p. 40) as well as possibly on the Isle of Man (Innes et al., 2003). Likewise, dated timber 'halls' like Balbridie, in Aberdeenshire eastern Scotland, show that cereal was potentially being processed as early as 3900 to 3700 BCE (Fairweather and Ralston, 1993). Similarly, there is evidence, as a result of exponential development in Ireland, for rectangular stone-built early Neolithic 'houses' (Cross, 2003).

These are just some of the strands of enquiry that presents a model for the northern regions of the Atlantic Fringe that challenges a straight forward north west proliferation of Neolithic practises from the south-east of England (Sheridan, 2010, 2013). Sheridan's work on carinated bowls in northern Britain draws parallels with continental Europe (Sheridan, 2007) while the debate over the significance of later grooved ware and Beaker pottery is ongoing (Sheridan, 2004b; Thomas, 2010). In addition, the importance of the Irish Sea as a conduit rather than a barrier has most recently been explored by Duncan Garrow and Fraser Sturt. Their work on the western seaways highlights the significance of these routes for localised, short-haul excursions in all direction throughout prehistory (2011, pp. 68–69; see also Cummings and Fowler, 2004; Cummings, 2009). Interesting results from new multi-proxy evidence mapping subsistence change in the north east Atlantic archipelagos from the Late Mesolithic through Neolithic that used 'a novel suite of lipid biomarkers… preserved in cooking vessels' (Cramp et al., 2014) suggests that the 'rejection of marine resources by early farmers coinciding with the adoption of intensive dairy farming'.

As a result, Childe's grand narrative—popularised by Piggot (1954)—has become regionalised but it still shapes most interpretations. There is no longer an expectation of one narrative for the British Isles, since it has generally been acknowledged that the transition to a society dominated by agriculture was much more complex and variable than any single model proposed to date suggests (Sheridan, 2013; Thomas, 2013).

For the rest of the Neolithic, and the later 'transition' to metalworking, the picture is just as regionalised. The stone walled houses on Orkney and Shetland are a notably rich exception to the general absence of 'houses' seen in the rest of Britain during the Late Neolithic (Bradley, 2007, p. 94), although as shown by recent work at

Stonehenge new discoveries are still being made (Pitts, 2010). These various 'houses' are very different to earlier forms and are seen by Bradley in Britain and Smyth in Ireland, as 'ephemeral' in contrast to the central role seen for earlier structures (Bradley, 2007, p. 94; Smyth, 2006, 2010). Indeed, several authors question the value of terms like 'house' and 'hall' for the period entirely, noting that the terms imbue meaning that is not necessarily supported by evidence (Crellin, 2014, p. 288; Sheridan, 2013).

Burials, cremations and pit deposits receive as much attention as the settlements and have been considered from as many perspectives (Cooney, 2010; Darvill et al., 2005; Fahlander et al., 2008; Fowler, 2001). Although consensus on many points in unlikely, an appreciation of the benefits that re-analysis of the dating of the form and distribution of the evidence with Bayesian approaches is widespread; even before Bayliss et al.'s seminal paper, interpretations of the evidence for 'domestic, ritual, and industrial' activity in Britain and Ireland during the Neolithic were being revised into discussions of 'producing, celebrating and abiding' in the British and Irish 'Neolithics' (Cross, 2003, p. 197). Bayliss et al.'s work allows these ideas to be placed in finer resolution. The 'big picture' of Neolithic life had been augmented by treatment of symbolism, the environment, world views and interaction, in a range of new frameworks, on a much more local scale, both spatially and temporally (Sheridan, 2010). As such, the 'variety, messiness and localness' of the Mesolithic-Neolithic Transition in Ireland as identified by Gabriel Cooney (Cooney, 2007, p. 543) could easily be applied to a much larger area and time span (Bradley, 2003, pp. 218–222).

In this way the Irish Sea region is an important area of recent research, representing a vital, and enduring, maritime avenue of movement and interaction. Understanding the complex variations in abundance, distribution and form of the archaeological

evidence for this area has been the focus of much inquiry, and certainly benefits from increasingly inter-disciplinary approaches. Alison Sheridan (2004b) concluded that megalithic tombs on all sides of the Irish Sea seem to represent competitive emulation of form. Shared motifs and Passage Tomb decoration across the area also suggest that regular contact must have been upheld although subtle—but distinctive—differences between regions is increasingly apparent (Cooney, 2000b; Darvill et al., 2005, p. 326). Similarly, the variety and distribution of pottery (Burrow, 1997a; Sheridan, 2004b, 2007) and polished stone axe-heads (Bradley and Edmonds, 1993; Cooney, 2007) has established patterns of interaction in all directions, indicating consistent, but fluctuating contact between communities in all areas of the Irish Sea region during the 4th Millennium BCE.

In view of these new frameworks, refined chronologies and the changing theoretical backdrops of the last few years, it is possible that, by adding another perspective from the very heart of the Irish Sea region, with consideration of research conducted on the surrounding islands—like the work of Stephen Burrow on Manx late Neolithic 'Ronaldsway Culture' pottery (Burrow, 1997a), Timothy Darvill's Billown Neolithic Landscape Project (Darvill, 2003a) and Rachel Crellin's recent research on the Manx 'Neolithic-Bronze Age Transition' (Crellin, 2010, 2014), see Section 1.5—a thorough characterisation of the Neolithic axe-heads found on the Isle of Man could add significantly to modern interpretations of Neolithic Irish Sea regional interactions.

1.4.1 Provenance Studies: an inter-disciplinary, inter-national approach

To understand the importance of reviewing the Manx stone axe-head collection at this time it is necessary to look at how much inter-disciplinary science has added to archaeological investigations more generally. Unsurprisingly, archaeologists have a long history of collaboration with historians, geographers and geologists, and have been calling upon the expertise of those geologists (specifically 'petrologists') to

identify rock types and postulate potential quarry locations since before the subjects became defined as distinctive academic disciplines.

Late nineteenth century antiquarians like John Evans in Britain and William Wilde in Ireland could be said to have spurred the movement because their work on collating and categorising the myriad forms of ancient implements in their respective regions inspired the early pioneers of stone axe-heads studies, including W.J. Knowles (1832-1927) in Ireland and S.H. Warren (1872-1958) in Wales.

William James Knowles' early work on various implements in Irish collections drew from Evans' compendium on Britain's collections, and expanded on Wilde's preliminary assessment of notable Irish assemblages (Knowles, 1893, 1903, 1906). He highlighted differences in the petrology and form of axe-heads within the Irish collections by classifying and characterising implements based on petrology (i.e. flint, coarse or fine) and shape (i.e. stout ovate, broad ovate, oval axe-head, squared or flat sided, straight sides, oblique edges, etc.). Although his interpretations are dated, he studied 2056 Irish artefacts, many of which would now be considered as prehistoric ground/polished stone axe-heads. Knowles was also responsible for identifying the first Neolithic axe-head quarry site in the British Isles (Jope et al., 1952, p. 31).

Around Cushendall in Knowles' home county of County Antrim his extensive field walking and interactions with local farmers revealed over 800 fragments, roughouts and axe-heads in various stages of manufacture of what he described as a fine grained bluish black metamorphic rock with a flinty fracture. Although he believed at the time that the distinctive boulders were transported from Scotland as erratic material, local sources were eventually identified at Tievebulliagh by E.E. Evans in the 1930s, and described by geologists Agrell and Langley in 1958 in the first published example of pyrometamorphism (Agrell and Langley, 1957; Jope et al.,

1952, p. 38; Keiller et al., 1941, pp. 63–64). A similar geological feature was also recognised a decade later on Rathlin island (Dawson, 1951). The rock is porcellanite, which unlike flint is an extremely sturdy rock that can be sharpened and polished relatively easily.

Another fine grained rock that produces a sharp edge is Scottish pitchstone. The sources of pitchstone on Arran were first studied in thin section by Alexander Scott for the esoteric antiquarian Ludovic Mann's review of the prehistoric use of pitchstone and obsidian in Scotland (Mann, 1918). Recognised along with abundant chert artefacts as a local substitute for flint, which although available does not occur in primary deposits in Scotland (Wickham-Jones, 1986), the quality of pitchstone nodules is variable. Its significance wasn't appreciated again until the nineteen eighties when Thorpe and Thorpe recorded 1400 artefacts from 100 locations traced to the Isle of Arran (1984). Torben Ballin's recent reappraisal of pitchstone in northern Britain is discussed below (Ballin, 2009, 2015).

In the early part of the twentieth century several interest groups around Britain were compiling lithic implement collections and examining their petrology and form. Features and artefacts composed of coarse igneous rocks found in the south of England drew particular attention from English archaeologists and petrologists for a long time. Collectively known as 'greenstones', there are few geological sources for these rocks in the southeast of England.

The first coarse-grained igneous outcrops in Britain to be linked to prehistoric activity were in Wales. In 1908, analysing samples using transmitted light petrography Herbert Henry Thomas, formerly a geologist latterly an archaeologist, proposed that the 'bluestones' (spotted dolerites) at Stonehenge were sourced approximately 225 km away (as the crow flies) at Carn Menyn in the Preseli

Mountains[4] in Pembrokeshire, Wales (@51.95949, -4.701952) (Thomas, 1923). In contrast, the large sarsen blocks forming the trilithons were most likely quarried from the Marlborough Downs, c. 32 km north of Stonehenge. Ten years later, S. Hazzledine Warren published an account of his visit to Graig Lwyd, in Penmaenmawr, Caernarvonshire; he described the 'felsite' (augite granophyre) igneous body and discussed the debitage he found there (Warren, 1919, 1921). Graig Lwyd was then labelled as the first 'axe factory site' in Britain, and further work to identify the provenance of other axe-head petrologies in various regional collections intensified.

In the early nineteen thirties, Welsh archaeologist W.F. Grimes was vocal in his desire to see archaeological enquiry formalised, and urged a move away from the haphazard antiquarian investigation of features and artefacts seen until then in Wales and beyond (Grimes, 1932). He was one of many researchers promoting the scientific approach to implement study, urging collectors and institutes to allow artefacts in their possession to be thin sectioned. In 1936, also influenced by Childe's emphasis on technological, economic and social revolutions, England's 'South-Western Group of Museums and Art Galleries' formed a sub-committee (hereafter called the 'South Western Group or 'SWG') to investigate the geological provenance of the polished stone axe-heads, perforated stone axe-heads, adzes, and axe-hammers that had been found in the British Isles, with particular emphasis on artefacts recovered from the counties of south west England (Keiller et al., 1941, p. 50). Alexander Keiller and Stuart Piggot enlisted the help of interested petrologists, including F. S. Wallis, to utilise common geological procedures in an attempt to identify the region from which the raw material used to make lithic implements may have been quarried. By 1941, nine source areas had been identified and the SWG

[4] Technically hills.

published its first report on implements and their provenance in the Proceedings of the Prehistoric Society (PPS), numbering these areas as 'Implement Group' sources. Several significant areas were located in Cornwall, collectively the 'Cornish greenstones' (Groups I-V), as well as a source of fine grained volcanic tuff from Cumbria (Group VI). The Welsh axe-head factory at Graig Lwyd, Penmaenmawr became Group VII and another source of silicified tuff from South Wales was labelled Group VIII. In County Antrim, the porcellanite axe-heads identified by Knowles as significant in Ireland, were labelled by the IPG as Group IX (Clough, 1988, p. 4; Keiller et al., 1941, pp. 51, 61, 63–64); see also Figure 1:5.

In 1945, following the formation of the Council for British Archaeology (CBA) in 1941, the 'Implement Petrology Committee' (IPC) working group comprising W.F. Grimes, F.S. Wallis and F.J. North, was set up by the CBA's Natural Sciences Panel to investigate the burgeoning relationship between archaeology and petrology. Seven years later SWG merged their work with the IPC and then in the nineteen nineties (when CBA Select Committees were disbanded), the collective became the independent 'Implement Petrology Group' (IPG) funded primarily by membership. In successive and expanding reports, the IPG continues to analyse and publish findings relating to the petrology of prehistoric implements (Keiller et al., 1941; Stone and Wallis, 1947, 1951; Evens et al., 1962; Clough and Cummins, 1979, 1988; Davis and Edmonds, 2011), while the SWG remains supported by funding from subscribing member museums, with current members, David Dawson, Joan Taylor, Thomas Cadbury, Barry Chandler, Roger Taylor and Jane Marley still actively analysing axe-heads linked contextually and petrologically to the south western counties of England.

The first four SWG papers were limited in scope but identified several prominent rock types within the collections of the south west of England as a whole. As well as

the original nine groups postulated in SWG 1, several subgroups were identified in the second report in 1947 as well as two more main groups (X and XI). Group X was later reassigned to a French source (see below), and Group XI, identified as a very fine grained silicified tuff from two fragments found at Windmill Hill, Wiltshire, was later sourced to Cumbria. SWG 3, published in 1952, expanded the catalogue tremendously after 710 implements had been scrutinised in total, including seven examples from the Isle of Man. As more implements were examined, the difficulties of linking implements to sources became increasingly apparent.

Originally, Groups I-V were identified as 'greenstones' from various outcrops of uralitised gabbros, epidorites, picrite and hornfels in Cornwall. However, by SWG 2 Group V was dropped entirely and Group IA, IIa, IIIa and IVa were added. All were considered compositionally close to the corresponding main group, but distinctive enough to warrant reclassification in their own right. A similar issue occurred in Wales. As noted by Clough (1988, p. 9), had it not been identified earlier, the spotted dolerites (‘bluestones') of Pembrokeshire assigned to Group XIII in SWG 3 would have been classed as Group XXIII, which ranges from graphic pyroxene granodiorite (Group XXIIIa) to quartz dolerite (Group XXIIIb) later identified with outcrops between the Preseli Hills and St. David's Head, Pembrokeshire, Wales.

Figure 1:5 A list of source rocks used in the production of polished stone axe-heads in Britain and Ireland, compiled by the Implement Petrology Group (Clough and Cummins, 1979, p. 127)

Group I Uralitized gabbro, epidiorite, or greenstone. Source in Mount's Bay area, near Penzance, Cornwall. Widely distributed and abundant. Keiller, Piggott, and Wallis, *PPS,* **7** (1941), 51.

Group Ia Close to Group I. Stone and Wallis, *PPS,* **17** (1951), 105.

Group II Epidiorite or greenstone. Source near St Ives, Cornwall. Rare. Keiller *et al, PPS,* **7** (1941), 55.

Group IIa Close to Group II. Stone and Wallis, *PPS,* **17** (1951), 106

Group III Epidiorite or greenstone. Source near Marazion, Cornwall. Rare. Keiller *et al, PPS,* **7** (1941), 55.

Group IIIa Close to Group III. Stone and Wallis, PPS, **17** (1951), 106.

Group IV Altered picrite. Source near Callington, Cornwall. Locally abundant in the south-west. Keiller *et al, PPS,* **7** (1941), 56. Redefined by Evens, Grinsell, Piggott, and Wallis, *PPS,* **28** (1962), 215.

Group IVa Sheared greenstone, close to Group IV. Stone and Wallis, *PPS,* **13** (1947), 49. Defined by Stone and Wallis, *PPS,* **17** (1951), 114. Redefined by Evens et al, *PPS,* **28** (1962), 215.

Group V Calc-silicate hornfels. Source said to be probably near St Ives, Cornwall. Very rare. Keiller *et al, PPS,* **7** (1941), 56.

Group VI Epidotized intermediate tuff. Factories in Great Langdale and Scafell Pike area of the Lake District. Widely distributed and very abundant. Keiller *et al, PPS,* **7** (1941), 58.

Group VII Augite granophyre. Factories in the Penmaenmawr area, Caernarvonshire. Widespread and abundant in some areas. Keiller *et al, PPS,* **7** (1941), 61.

Group VIIa Stone and Wallis, *PPS,* **17** (1951), 121. Later given full group status as Group X *(qv).*

Group VIII Silicified tuff. Source in south-west Wales. Widely distributed and locally abundant. Keiller *et al, PPS,* **7** (1941), 63. See also Stone and Wallis, *PPS,* **17** (1951) 122.

Group VIIIa Close to Group VIII. Evens *et al, PPS,* **28** (1962), 217.

Group IX Porcellanite. Factories at Tievebulliagh and Rathlin Island, County Antrim, Ireland. Widespread but relatively uncommon outside Ireland. Keiller *et al, PPS,* **7** (1941), 63.

Group X Fine dolerite. Factories near Sélédin, Brittany. Rare in Britain. Evens *et al, PPS,* **28** (1962), 218. Equivalent to Dolerite Type A. See Le Roux, *Antiquity,* **45** (1971), 283. An earlier Group X (Stone and Wallis, *PPS,* **13** (1947), 52) and Group Xa (Stone and Wallis, *PPS,* **17** (1951), 127) have been superseded.

Group XI Fine silicified tuff. Source in Great Langdale area of the Lake District. Rare. Stone and Wallis, *PPS,* **13** (1947), 52. See also Stone and Wallis, *PPS,* **17** (1951), 124, 126, and Plint, *Trans Cumberland Westmorland Antiq Archaeol Soc,* **62** (1962), 6, 7.

Group XII Picrite. Source near Hyssington, on the Shropshire-Montgomeryshire (Powys) border. Axe hammers and battle axes only, Abundant in the west Midlands. Shotton, Chitty, and Seaby, *PPS,* **17** (1951), 159.

Group XIII Spotted dolerite or preselite. Source in the Preselau Hills, Pembrokeshire (Dyfed). Rare, but important as 'Blue Stones' of Stonehenge. Stone and Wallis, *PPS,* **17** (1951), 128. See also Group XXIII.

Group XIV Camptonite. Source near Nuneaton, Warwickshire. Rare. Shotton, *PPS,* **25** (1959), 135.

Group XV Micaceous sub-greywacke. Source in southern Lake District. Widespread and locally abundant (particularly as axe hammers). Shotton, *PPS,* **25** (1959), 137.

Group XVI Epidiorite or greenstone. Source near Camborne, Cornwall. Locally abundant in the south-west. Evens *et al, PPS,* **28** (1962), 220.

Group XVII Epidiorite or greenstone. Source near St Austell, Cornwall. Rare. Evens *et al, PPS,* **28** (1962), 223.

Group XVIII Quartz dolerite. Source in the Whin Sill, northern England. Widespread and locally abundant (particularly as axe hammers). Evens *et al, PPS,* **28** (1962), 224.

Group XIX Greywacke. Source probably in Cornwall. Rare. Evens *et al, PPS,* **28** (1962), 226.

Group XX Epidotized ashy grit. Source in Charnwood Forest, Leicestershire. Widespread and locally abundant. Shotton, *PPS,* **25** (1959), 141.

Group XXI Baked shale. Factory at Mynydd Rhiw, Caernarvonshire. Rare. Houlder, *PPS,* **27** (1961), 113 ff.

Group XXII Riebeckite felsite. Factory in Shetland. Unknown outside Shetland, though possible examples from mainland Scotland await thin-sectioning. Ritchie in *Studies in Ancient Europe* (eds Coles & Simpson) (1968), 128 ff. Group number allocated after publication.

Group XXIII Ranges from graphic pyroxene granodiorite (Group XXIIIa) to quartz dolerite (Group XXIIIb). Source area between Preselau Hills and St David's Head, Pembrokeshire (Dyfed). Group XIII is an individual rock type which falls within the petrological and geographical range of Group XXIII. It might have been classed as a subgroup of XXIII but for its prior publication as a group in its own right. Rare. Shotton in *Prehistoric Man in Wales and the West* (eds Lynch & Burgess), (1972), 89.

Group XXIV Calc-silicate hornfels. Factory near Killin, Perthshire. Ritchie in *Studies in Ancient Europe* (eds Coles & Simpson) (1968), 126 ff. Group number allocated after publication.

Group XXV Altered quartz diorite. Source south-west of Douglas, Isle of Man. Locally important but as yet unknown outside Isle of Man. Coope (publication in preparation).

In the first SWG report in 1941, F. S. Wallis listed 12 axe-heads, 2 axe fragments and 4 'flakes from implements' found in the southern English counties of Wiltshire, Gloucestershire, Dorset, Oxfordshire and Berkshire and formerly defined Group VI (representing a significant 6% of the examined collection at the time). Petrologically, he described this group as 'an epidotised tuff of intermediate or basic composition' from the upper portion of the Bedded Tuff formation of the Borrowdale volcanic series (Keiller et al., 1941, pp. 58–60). Wallis confirmed that the source for these Group VI axe-heads was at Stake Pass in Cumbria where D.M.S. Watson and J.W. Jackson found a small site of worked boulder and five axe-heads/fragments in the early part of the twentieth century. Around the same time Watson's contemporaries T. Sheppard and H.H. Thomas also examined several axe-heads found in Yorkshire and identified many of them as 'Borrowdale ash' (Warren, 1921, p. 198). In 1949 Bunch and Fell published the results of their extensive study of the region and recognised the extent of axe-head making activity in the area. As such the source had been redefined as the Great Langdale area more broadly even before the discoveries in 1961 6 km west of the Langdale Pikes, around Scafell Pike, showed that rock of the same petrological type was being exploited there as well (Houlder, 1978, p. 87).

The successful identification of sources for Group VI axe-heads, and the realisation of the extent of the distribution of these axe-heads, inspired interested individuals in several other neighbouring regions to look more closely at their own collections. R.B.K. Stevenson, Keeper of the National Museum of Antiquities of Scotland between 1946 and 1978, took responsibility for examining the petrology and typology of the whole Scottish stone axe-head collection during his tenure. A macroscopic examination of petrology and a limited thin-section survey was conducted for him by F W Anderson of the Geological Survey, but the results (although relied on by Piggott in his 1954 review of the Neolithic Communities of the British Isles) were not

published until their inclusion in Ritchie's review in the nineteen eighties (see below). In Ireland, at this time Jope was reassessing Knowles' work on Irish axe-heads and realised the extent of Group IX axe-heads in Ireland, as well as highlighting the occurrences of Group VI axe-heads from England in Ireland (Jope et al., 1952).

Then in 1978 the first part of a three volume research project entitled *'Stone Axe-head Studies*' (SAS) was published as a result of the IPC *'Neolithic and Bronze Age Stone Implements*' Symposium held at the University of Nottingham in January 1977 (Clough and Cummins, 1979, p. vi). According to Houlder, whose own contribution was strictly 'an observational study of the sources of one rock type already defined by petrologists', in general the symposium had a clinically objective petrological approach to provenance studies, but also offered a more humanistic angle that, to an extent utilised contemporary ethnographic approaches to tool typology, as well as 'in the sociological and economic aspects of trade and tool usage' (Houlder, 1978, p. 87). By 1988, the first two volumes had attempted to incorporate all of the recorded artefacts from England, as well as examples from Wales, Scotland and Ireland and held over 7,500 records. Earlier 'artefact by rock type' distribution maps were amended and extended, rock types were confirmed and new sources postulated. A table of the original 25 groups in the appendix to SAS Volume 1 and the later, largely Scottish, additions up to Group 34 in SAS 2, became the standard to which other stone axe-heads were then categorised. The range of rock sources, places of manufacture and variations in axe-head morphology that were established by this study are its main findings, but it also stands as an excellent example of the evolution of the hybrid discipline 'Geoarchaeology', showing that inter-disciplinary research which combines perspectives from different fields of study can help refine understanding, hopefully allowing higher confidence in conclusions than

independent studies could offer on their own. In 1986 Alison Sheridan summarised the research undertaken to date on the Irish axe-heads and urged for them to be revisited in light of the work undertaken in Britain, and the advances that had been made in archaeological sciences (Sheridan, 1986). The mantle was taken up by Gabriel Cooney and Stephen Mandal who embarked on a decade long review of Irish axe-heads, that has since inspired further work on lithic implements and potential source locations (Cooney et al., 2013; Bayliss et al., 2011b).

Around the same time, Timothy Darvill reviewed the axe-heads in Wales and mid-west England (Darvill, 1989) and a team of Scottish archaeologists led by P.R. Ritchie were responsible for the review of Scottish unperforated lithic implements in the late 1980s for the second SAS volume. Ritchie first published a review of the petrology of Scottish lithic implements in Cole and Simpsons' 1968 book entitled 'Studies in Ancient Europe' (Ritchie, 1968). However Scottish sources were not assigned IPG Groups until their inclusion in SAS 2. Ritchie's work on the Shetland felsite axe-heads led to the inclusion of Group XXII; the epidiorite or altered dolerite of Dalarian aged rocks of northern Scotland were given the appellation Group XXXII; and the biotite-silliminite-quartz-schist bearing metamorphic rocks of Aberdeenshire were assigned to Group XXXIII (with a distinct subgroup XXXIIIa—an andalusite-bearing schist) (Ritchie and Scott, 1988)

Although many potential source areas had been identified previously, the corpus of work undertaken in SAS 1 made comparisons between axe-heads from different areas with the UK more feasible (Sheridan et al., 1992; Bradley and Edmonds, 1993). The IPG map of sources produced from these volumes is duplicated in Figure 1:6. With the help of the IPG[5] network of Regional Recorders which operated until the mid 1980s, it was realised that approximately 40% of all the grouped axe-heads

[5] Then known as the Implement Petrology Committee IPC)

found in Britain (1612 individual axe-heads at the time) had been quarried from the Langdale area of Cumbria (implement group, Group VI) (Bunch and Fell, 1949; Cummins, 1978, p. 7; Clough and Cummins, 1988, p. 4; Bradley and Edmonds, 1993). The IPG's on-going study of these 'Langdale Axe-head Factories' (Group VI) led by Claire Fell, Vin Davis, Mark Edmonds and Jamie Quartermaine has identified over 580 Neolithic axe-head-working sites around the summits of the Lakeland Central Massif in Cumbria (Claris et al., 1989; see also Edmonds, 2004; Davis and Edmonds, 2009). There is hope that targeted use of modern geochemical analysis coupled with detailed fieldwork and further petrological investigation could help differentiate between several similar sources within the Borrowdale Volcanic Group used to produce Group VI axe-heads, as has been the case in Ireland with porcellanite from County Antrim (see below). However, producing a unique geochemical signature for each source area and being able to link it to specific axe-heads is not straightforward and there is no single method that works for all rock types (Markham, 2009).

When in 1990, Gabriel Cooney and Eoin Grogan at University College Dublin instigated the 'Irish Stone Axe Project' (ISAP) they did so in order to understand more about the knowledge axe-head producers in Ireland had about their environment and the resources available to them (Cooney and Mandal, 1998, p. 2). At the forefront of lithic analysis in the nineteen nineties ISAP took a broad approach to the study of Ireland's axe-head collection and since 1992 the project has analysed over twenty-thousand axe-heads found in Ireland (Mandal et al., 1997, p. 757). A trinity of perspectives—contextual, morphological and petrological—enabled a comprehensive review of the collection, and the creation of a centralised, standardised computer database to allow access to a wider audience so comparisons between datasets could be drawn, was insightful and progressive.

In the process ISAP established that over half of Ireland's axe-heads were made from Group IX porcellanite, and using trace element geochemical analysis, it was possible to differentiate between the two similar sources of porcellanite used in the production of axe-heads within County Antrim (Mandal et al., 1997, pp. 761–762). ISAP also conducted a case study on the prevalence of axe-heads designated by the IPG to 'Group VI', from the source rocks in the Langdale area of Cumbria, England enabling more detailed discussions about the movement of axe-heads in the Irish Sea Zone.

In 2011, the IPG published Stone Axe-head Studies Volume 3 (Davis and Edmonds, 2011) which represented a thorough review of the progress that has been made in the study of lithic implements and the significance of social contexts, not only in Britain and Ireland, but also across Europe and beyond. The focus of the third volume differs from the first two, which concentrated primarily on Britain's various source areas and the petrological diversity of axe-heads in British collections. In the third volume, in keeping with contemporary theoretical frameworks, interesting parallels are drawn between disparate datasets; the environment and landscape of the source areas are also considered, and the status and symbology of implements of different styles and rock types postulated. This most recent volume represents an expansion of the geographic horizons of the IPG, highlighting the variety of different methodologies and interpretations that have been developing in different regions. While overriding parallels are drawn, it is acknowledged that the potential significance of comparisons depends on the choice of scale.

Under Vin Davis' leadership (1992-2015), one of the main aims of the IPG became the standardisation of implement studies in Britain and Ireland; by reaching out to individual researchers in disparate areas and openly consulting on data collection criteria Vin’s passion for the subject invigorated interest in the study of axe-heads.

Similarly, Vin was instrumental in updating the format and content of IPG record sheets; a current example of the axe-head record template and shape classification standards (as of Summer 2015) can be seen in Figures 1:7 and 1:8 respectively (Davis, 2015, p. 3) Today, there is a vast amount of 'grey-literature' in university, museum and private archives around Britain and Ireland related to the study of stone axe-heads of specified regions. However, known problems with the very nature of typological studies and the lack of uniformity between researchers has created a need for a centralised methodology and web-accessible databases that can allow for more accurate comparisons between artefacts from different areas. Funding is being sought by the IPG for various projects aimed at digitalising British implement record collections, for example the Mike Pitts archive (Sheridan, J.A. pers. comm.). Other recent IPG projects have included Rosemary Stewart's analysis of chert sources in Scotland (Stewart, 2015), Katherine Walker's look at the roles of imported axe-heads in identity formation in Neolithic Britain (Walker, 2015) and efforts to understand more about outcrops of coarser sources, like the Whin Sill (Group XVIII)—a difficult to provenance source of dolerite in the north east of England—led by Mik Markham, Chris Fowler and Pete Topping (Markham, M. pers. comm.). Most excitingly however, the forthcoming IPG 'Atlas' of implement group sources will include a detailed entry for every known source, including a description of the geology and petrography, and examples of artefacts made from these sources. Geochemical analysis of several potential source locations is also desired and further work into the reliability of these methods is ongoing (Davis, 2015). In the north of England few axe-head working sites have been found for doleritic sources, but axe-heads have been attributed to several groups and linked to a potential Whin Sill sources regardless. Ritchie and Scott (1988) suggest that erratic material from sources further north have a similar geochemistry to Whin Sill samples. Unfortunately,

efforts to clarify the compositional differences between axe-heads, like those ascribed to Group XVII, and various coarse grained potential sources is always problematic. In 2009 Torben Ballin published his review of pitchstone that updated the previous work of Williams-Thorpe, (Ballin, 2009; Thorpe and Thorpe, 1984). Ballin added approximately 20,300 worked pieces from 350 sites to his database (available on CD in selected Scottish museum archives) and highlighted examples from all parts of Scotland, northern England, Northern Ireland and the Isle of Man (Ballin, 2009, p. 1; see also McCartan and Johnson, 1991). He showed the exchange of the pitchstone as raw material from Arran to the rest of northern Britain, was likely to have taken place during the Early Neolithic, 'although with some later use in Argyll (which might have formed one part of a social territory in which Arran was also included) and Orkney in the far north (which in so many respects represents a 'special case')'. However, by 2015 he could also confirm 'a Late Neolithic phase of pitchstone use and exchange along the western seaboard of Scotland and extending as far north as Orkney', which he considered 'to be part of a reciprocal movement of ideas, objects and people at that time – the use of Grooved Ware and timber/stone circles spreading south-westwards down the Atlantic façade and, among other things, pitchstone northwards along the same route' (Ballin, 2015, p. 1).

Various independent petrological research projects started at the Open University in the 1990s by Philip Potts and Olwen Williams-Thorpe on the Cornish 'greenstones' and Preseli dolerite 'bluestones' (Group XIII) aimed to redefine and clarify the provenance of select implement manufacturing sites using geochemical analysis, specifically X-Ray Fluorescence Spectrometry (XRF) (Potts et al., 1995; Williams-Thorpe et al., 1999b, 2006). Their work stressed the importance of considering the distribution of glacial erratics and unconsolidated moraine, and how utilisation of these rock types during prehistory may explain some of the long distance movement

commonly attributed to various mechanisms of social exchange (Williams-Thorpe et al., 1999a). More recently, work in Cornwall by the IPG's Mik Markham has utilised ever more sophisticated geochemical analyses in an attempt to refine earlier source definitions and related implement groups. This resulted in the reclassification of some axe-heads and the confirmation that many of the actually areas quarried in Cornwall are likely to have since been submerged (Markham, 2009; Markham and Floyd, 1998).

In Ireland, Gabriel Cooney has led surveys on Ireland's island quarries including Lambay and Rathlin (Cooney et al., 2013; Dolan and Cooney, 2010; Cooney, 2009). Similarly, on-going projects using the latest geochemical analysis and extensive fieldwork led by Gabriel Cooney and Mark Edmonds with the IPG at the prehistoric quarries in Shetland and Orkney (Ballin, 2011; Clarke, 2011; Cooney et al., 2013), are helping to organise the Scottish axehead collection across various Scottish museums, while Torben Ballin's recent publications (Ballin, 2011; Cooney et al., 2013) on Group XXII—the impressive felsite quarries of North Roe, Mainland Shetland, that were used to produce axe-heads and 'Shetland knives'—have shown that different sources of felsite were valued for specific morphological requirements which parallels the findings of research in Europe on Alpine jadeitite axeheads, see below.

In addition, as is the case in Cumbria with the prevalence of Group VI axe-heads in local collections, few axe-heads made from imported sources have been recorded locally in Shetland (Ballin, 2011, p. 128). However, unlike Group VI Langdale axe-heads where the distributed range of Group VI finds extends way beyond the regional in scale, finds of Group XXII felsite axe-heads are to date restricted to the Shetland Archipelago contrasting with pitchstone which is found throughout Scotland *excluding* Shetland (Ballin, 2015).

Figure 1:6 The IPG distribution map of grouped rock sources (as of 1988) duplicated here from SAS II: 'The location of known and probable sources of grouped rocks in Great Britain... (certain smaller groups) are not shown...' (Clough and Cummins, 1988, p. 265)

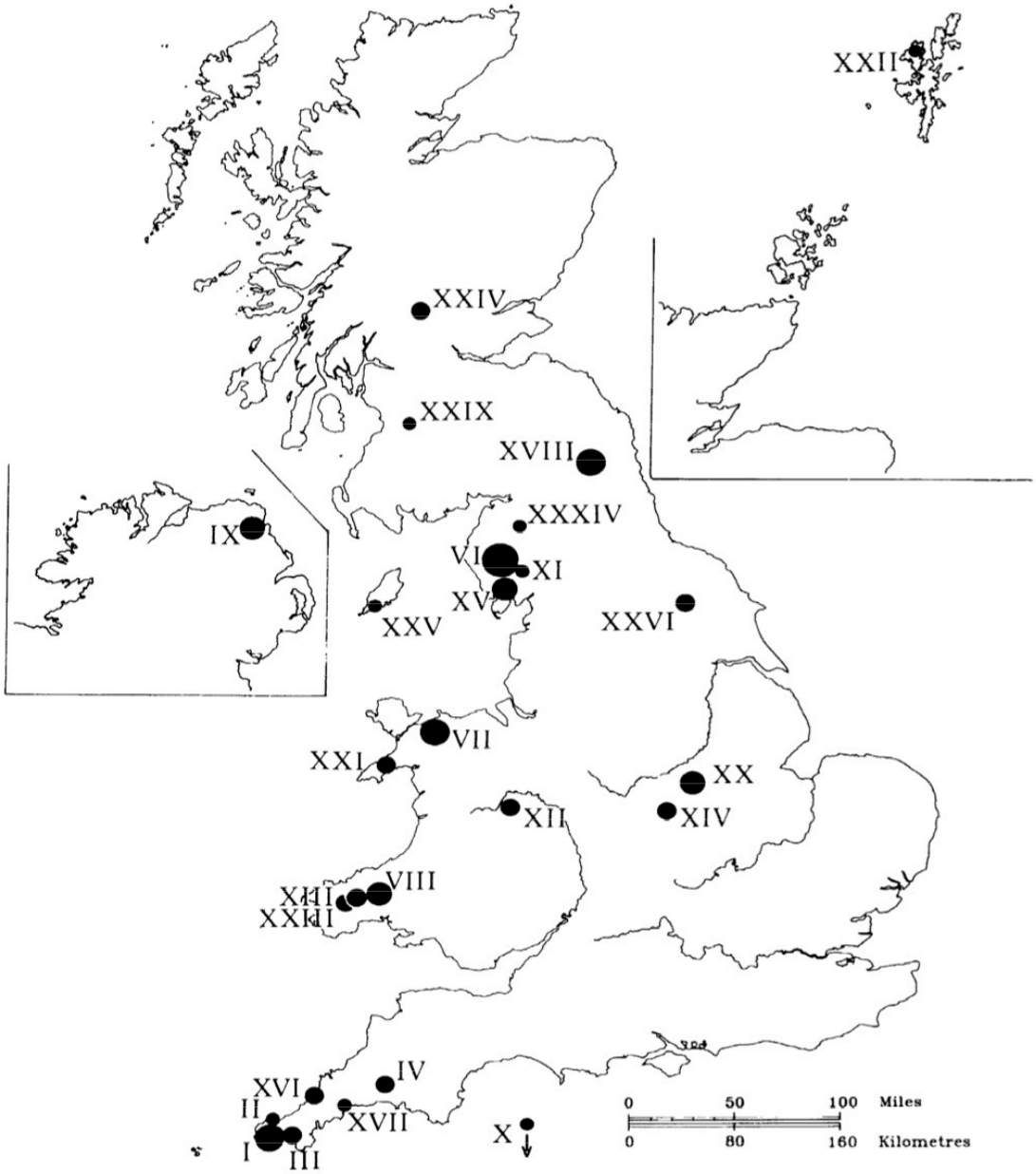


Figure 1:7 IPG Axe Record Sheet (DRAFT 2015-07) (Davis, 2015, p. 6)

Implement Petrology Group: **AXE Record**

IPG / CBA Reference:	County:
Collection:	Parish:
Museum Reference:	Findspot:
Current Location	
Address:	
Archaeological Description by: Date: ___/___/_____	OS Grid: ___ _____ _____
	OS Datum: _____ m asl
Macroscopic Geological ID by: Date: ___/___/_____	Date of Discovery: ___/___/_____
Petrological Description by: Date: ___/___/_____	Discovery Circumstances:
Axe Sectioned ☐ / Axe Cored ☐	
Location of thin section:	Context code: ___ ___
Axe Drawn ☐ / Photographed ☐	Object type:
Publication	Length (mm) / Width (mm)
SMR Reference:	Thickness (mm) / Weight (grams)

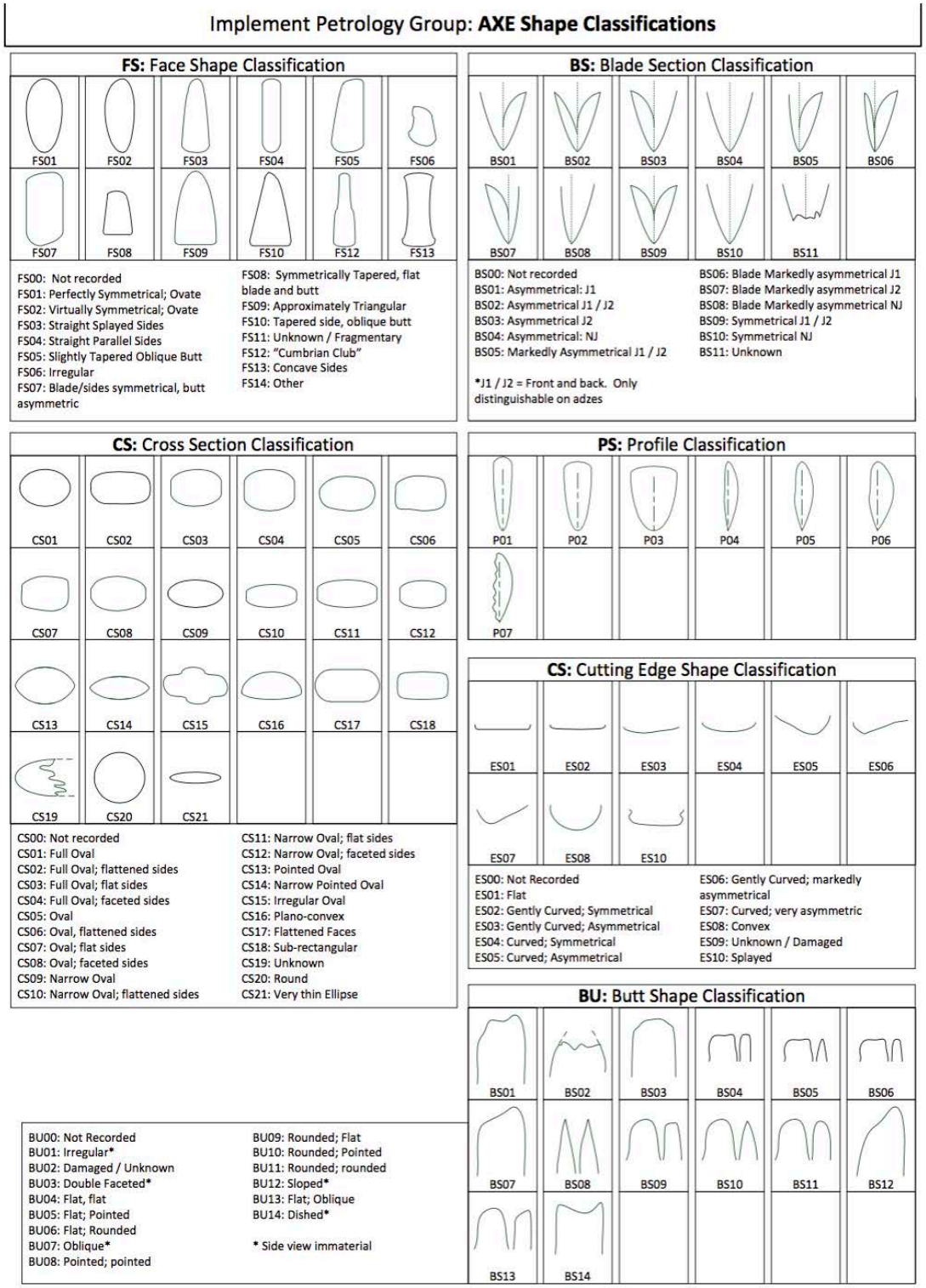
Archaeological Description

Primary Treatment:	
Secondary Treatment (yes / no) Blade ground/polished: ☐ Sides ground/polished: ☐ Faces ground/polished: ☐ Butt ground polished: ☐	
Description Codes Face Shape ☐ Cross Shape ☐ Edge Shape ☐ Profile ☐ Blade Section ☐ Butt shape ☐ Hafting ----------	
Macroscopic Geology:	Specific Gravity:

Petrological Description

Geochemical Analysis			Reference	
Group	Certain ☐	Near ☐	Not Grouped ☐	Suggested Location
Computer record made by: Date: ___/___/_____			From Old Card: From New Coded Card:	

Figure 1:8 IPG Axe Revised Shape Classification (DRAFT 2015-07) (Davis, 2015, p. 8)



1.4.2 Interpreting Neolithic trade and exchange

Polished stone axe-heads are durable and easily identified artefacts, and as such have continued to arouse interest and provoke debate for well over a century (Evans, 1897). The repeated occurrence of axe-heads in a variety of settings indicates they were an integral part of the material culture of prehistoric communities throughout Europe. Unearthed in settlements, pits, ditches, monuments, burials, wetlands and rivers settings, as well as represented in rock art (for some examples see Simpson and Thawley, 1973; Bradley, 1984, pp. 53–57; Cooney et al., 1999, p. 15; Armit et al., 2003), axe-heads have contributed significantly to reconstructions of the period, and are today generally considered to have held both symbolic and utilitarian importance within communities at the time (Davis and Edmonds, 2011, pp. 2–3).

Bradley and Edmonds established that stone axe-head production in Britain occurred between the 37th and 35th century BCE; the earliest assemblages were much lighter and more transportable than later well-finished examples (1993, p. 185). Flint dominates the profile early on, to be replaced with a wider variety of tools including much coarser examples that require entirely different methods to produce. According to Bayliss et al. (2011b, p. 794) Cumbrian, primarily Group VI, sources came into circulation in southern Britain later than those from south-western sources, and their models indicate a date of '3705-3540 cal BCE (at 95% probability), probably 3670-3630 cal BCE (at 29% probability) or 3610-3555cal BCE (39% probability)', which they point out is 'only slightly later than the start of enclosure building in 3765-3695 cal BCE (at 95% probability), probably 3740-3705 cal BCE (at 68% probability)'. Bayliss et al. also suggest that Bradley and Edmonds interpretation for a later intensification of exchange network for non-local sources around 3400BCE does not hold up to the finer scale their models allow (cf. Bradley and Edmonds, 1993, pp. 40, 177), but it would seem Ballin's pitchstone revival does (Ballin, 2015).

In Europe, the study of implement petrology has been critical to the debate surrounding large scale prehistoric trade and exchange routes: several areas have been identified as prehistoric quarries, or large scale centres of production, for both flint and stone tools, as well as ornaments and adornments. For example, Casa's petrographic study in the Italian Alps (Casa, 2005), linked resources from different mineral veins and stratigraphic layers, to different production sites. One example at Wartau, Ochsenberg, in the Rhine Valley, has been established as a critical connection route to the central Alpine Pass. The site was settled in the 'Copper Age' or 'Chalcolithic' (c.3300 BCE) and eight different types of raw material have been found in various stages of manufacture, along with flint daggers, which have been traced to a 'South Alpine origin' (Casa, 2005, p. 226 and Fig. 3). Most recently, Pierre Pétrequin initiative, 'Programme JADE', has conducted a multinational review of the distribution and morphology of Neolithic axe-heads made from Alpine sources of jadeitite[6] and established that there was considerable typological diversity - proof of long term activity, and of the evolution of forms. It was also found that the reshaping of jadeitite from one typology to another had occurred, and there was a dominance of locally popular styles (see Pétrequin, 2012). The work is continuing with Programme JADE 2, expanding to look more closely at artefacts from eastern Europe where the initial study highlighted the need to look at the area more closely (Pétrequin et al., 2015).

The distribution of axe-heads, and the importance of establishing the provenance of the raw material used in their production, has been the primary focus of repeated investigation (Clough and Cummins, 1979, 1988; among others see Bradley and Edmonds, 1993; Cooney and Mandal, 1998). Interestingly, the interpretations originally extracted from the SWG/SAS datasets drew comparisons between the

[6] Rocks that consist almost entirely of jadeite are called jadeitite.

geographic distribution of various implement group rock types, and the relative economic value of axe-heads produced from those sources. Several models of Neolithic trade and exchange in Britain, Ireland and throughout Europe have been postulated using these datasets and others like them (Pétrequin, 2012; Davis and Edmonds, 2011; Bradley and Edmonds, 1993; Sheridan et al., 1992; Darvill, 1989; Hodder, 1982). However, as highlighted by Bradley and Edmonds (1993, p. 224) utilitarian approaches to interpretation cannot account for ritualistic deposition, or the potential symbolic value of an axe-head, regardless of its prowess as a tool, as such axe-heads today are appreciated as much more than just economic indicators. The axe-head's symbolic significance, and its relationship to personal, as well as social identity has been an increasingly essential part of the debate into Neolithic interaction from an interpretive standpoint (Cooney and Grogan, 1994; Pétrequin et al., 2002; Cummings and Fowler, 2004; Barrowclough and Malone, 2010; Davis and Edmonds, 2011; Feeser and Furholt, 2013). Similarly, interpretations of the importance and function of quarry sites has diversified in recent literature. It has been noted that, like Alpine sources of jadeitite, several of the main British 'axe-head factory' sites, notably Graig Lwyd in North Wales and Langdale in Cumbria, are often located at high altitude, even though the same rock type is found in more accessible areas. This observation has been used to support contemplation that 'axe-head factory' sites were sometimes situated in exposed rocky places, in order deliberately to restrict access to them, perhaps, increasing the value of the stone axe-heads as prestigious items and making possession representative of a type of 'rite of passage' (Edmonds, 1997, p. 68; Whittle, 2003, p. 27).

1.5 Manx Neolithic research

The Manx Neolithic has been treated in largely the same framework as the Neolithic of Britain and Ireland for over one hundred years. Evidence for the transition between the Mesolithic and the Neolithic and the transition from the Neolithic to the Bronze Age are very different in both abundance and type on the Isle of Man. However, it was suggested for a long time that both transitions were perhaps redundant on the island since no distinctive changes, which could have been said to have heralded a new era, were found on the island to correspond with the evidence from elsewhere (Davey and Innes, 2002, pp. 52–54). This interpretation is under scrutiny in this thesis.

Like elsewhere, antiquarian researchers dug the interesting bits, preserved the glorious bits, fixed the ugly bits and discarded the mundane (Swinnerton, 1891; Kermode and Herdman, 1894; Fleure and Neely, 1936). Later researchers like Clarke (1935) and Piggot (1954) were keen to methodically—and to a limited extent scientifically —categorise and define Manx prehistory, mostly in relation to perceived similarities and differences with the evidence from 'cultures' discussed in Britain, and to a lesser extent Ireland (Moore, 1909; Piggott, 1954). Since then each generation of researchers has continued to reinterpret the limited evidence as it stands within the new frameworks that have evolved (Bruce et al., 1947; Moffatt, 1978; Burrow, 1997b; Fowler, 2001; Davey and Innes, 2002; Davey and Woodcock, 2003; Darvill, 2003a; Barrs, 2010, Garrow and Sturt, 2011; Crellin, 2014, 2015). The publication produced as a result of the 1977 '*Man and the Environment in the Isle of Man'* conference hosted by Peter Davey and the University of Liverpool's then '*Institute of Extension Studies'* (Davey, 1978a), included several chapter on Manx prehistory that attempted to place the Manx material evidence within the processualist framework of archaeological research conducted in the nineteen

seventies (Clarke, 1973; see also Smith, 1974). Editor Peter Davey considered Bronze Age metalwork (Davey, 1978b). The Mesolithic period was dealt with by Peter Woodman (Woodman, 1978). Shelia Cregeen summarised the 1971 excavations of a chambered tomb and cremation cemetery at Ballaharra near St. Johns (Cregeen, 1978). Audrey Henshall reviewed Manx Megaliths and placed the majority within the Irish 'Court Cairn' and Scottish 'Clyde Cairn' cultural groups (Henshall, 1978). Peter Moffatt (1978) covered the late Neolithic Ronaldsway Culture (see Section 1.5.1) and Larch Garrad produced several papers including her first paper on Manx axe-heads (Garrad, 1978a), see Section 1.5.2, as well as another paper on field walker C.H. Cowley's collection of artefacts that were largely found in the west of the island (Garrad, 1978b). In the same year A.M. Cubbon, then director of the Manx Museum, published his report on the Killeaba site at Ramsey (Cubbon, 1978).

Stephen Burrow when he completed his PhD in the nineteen-nineties on Ronaldsway Culture Pottery, did not believe there was evidence for the 'seed' of the distinctive Manx Late Neolithic Ronaldsway Culture in any other region (1997b, p. 27), see section 1.5.1. His work thoroughly catalogued the island's Neolithic pottery in relation to pottery style in Britain and Ireland. With Timothy Darvill, he also established a series of broad radiocarbon dates for the Late Neolithic Ronaldsway Culture (Burrow and Darvill, 1997 see also below and Chapter 5, Figure 5.4.).

At the turn of the 21st century environmental studies in the north of the island took precedence over pottery and megaliths for dating the Neolithic (Gonzalez et al., 2000). Core and pollen samples were taken to provide a date for land clearance and cereal cultivation, both traditional markers for the change from Mesolithic hunter-gatherer societies to Neolithic farming communities. Dates from disputed cereal pollen were obtained and at the time were considered by some to be amongst the earliest for the British Isles (Brown, 2007, pp. 1042–1043; Davey and Innes, 2002, p.

661, 2003); interpreted as evidence for small scale land cultivation of the area before the Elm Decline (c. 3940 BCE, see Parker et al., 2002; but cf. Whittle et al., 2011b, p. 560). According to Davey and Innes in 2002 there was still no evidence for definitive early Neolithic activity on the island, instead, evidence of a Mesolithic lifestyle was abundant (Davey and Innes, 2002, p. 47). However Davey recently conceded that the relatively early dates obtained from Billown (Darvill, 2001, p. 15) tend to undermine this observation (Davey, pers. comm.).

In February 2014, winter storms revealed more of a prehistoric forest bed currently eroding from the cliffs at Port Cranstal. The complex postglacial relationships between terrestrial, lacustrine, palustrine and marine deposits revealed at several sites in the north of the island have made defining a chronology for Holocene environmental change challenging; however, it has been established that conditions continued to fluctuate into the early Neolithic up until the Elm Decline (see McCarroll et al., 1990; Gonzalez et al., 2000; Chiverrell et al., 2001; Innes et al., 2004; Chiverrell et al., 2005). Radiocarbon dates were obtained during two previous periods when it has been exposed. This time, a small rescue excavation carried out by Philippa Tomlinson and Andrew Johnson revealed over one thousand carbonised hazel shells, heat shattered stones and 56 pieces of worked flint including 'tools of the 'heavy-bladed' type typical of the Manx Later Mesolithic'. Approximately 450 metres further along the coast (@54.403651, -4.3617061) a possible Bronze Age burnt mound was highlighted by Peter Davey and an instrument survey was conducted by David Martin. Samples from both areas currently await radiocarbon dating (Davey, 2014).

There is still very little evidence for the transition to farming on the island but it is generally accepted that the evidence from the Isle of Man is comparable to the evidence from the rest of Britain and Ireland (Crellin, 2014, p. 5). The majority of the

earlier Middle Neolithic evidence on the Isle of Man supports the argument for regular interaction with the surrounding areas of the Irish Sea region, for example leaf arrowheads, stone axe-heads, long barrows/court cairns and passage graves. (Davey and Innes, 2002, p. 52; Whittle et al., 2011b, p. 560).

Exploitation of the Manx Uplands during the Middle Neolithic has been researched to a limited extent by Woodcock (see Davey and Woodcock, 2003). Stephen Burrow believed the Manx megaliths were dated to the Manx Middle Neolithic, built at the start of the 4th millennium BCE (Burrow, 1997b, p. 11). Surprisingly, Quartz mounds found in the Parish of Patrick have given earlier dates than for comparable mounds elsewhere in the region (see Pitts, 1999). Most quartz mounds excavated in the British Isles have been dated to the Bronze Age; however, radiocarbon dated evidence from excavations in 1999 and 2000 suggest that the Manx examples may have been in use during the Middle Neolithic c. 3646-3041 cal BC (AA-39813) (Davey and Woodcock, 2003, p. 132; Pitts, 1999, p. 134). Interestingly, unlike burnt mounds excavated elsewhere, they are not associated with water sources. Crellin and Fowler agree that more work is needed on the subtler transient features of Neolithic life like quartz mounds (see Crellin, 2014, p. 79; Fowler, 2001).

As at Billown, these excavations highlight the importance of quartz on the Island (Darvill, 2002); they are found broken and heat-exposed at the mounds, associated with lithic (flint) waste, Early Bronze Age pottery and polished stone axe-heads.

Some of the unique elements of the Meayll (Mull Hill) site described originally by Kermode and Herdman (1894) as well as the later Ronaldsway Culture (see below), have led to a belief that the island was distinctly different from the surrounding areas during the Late Neolithic. Regardless of an increasing number of rectangular 'houses' being found in the wider area (Smyth and Hoffmann, 2013) and notwithstanding the fact that parallels have been drawn with other regions in Ireland and Scotland

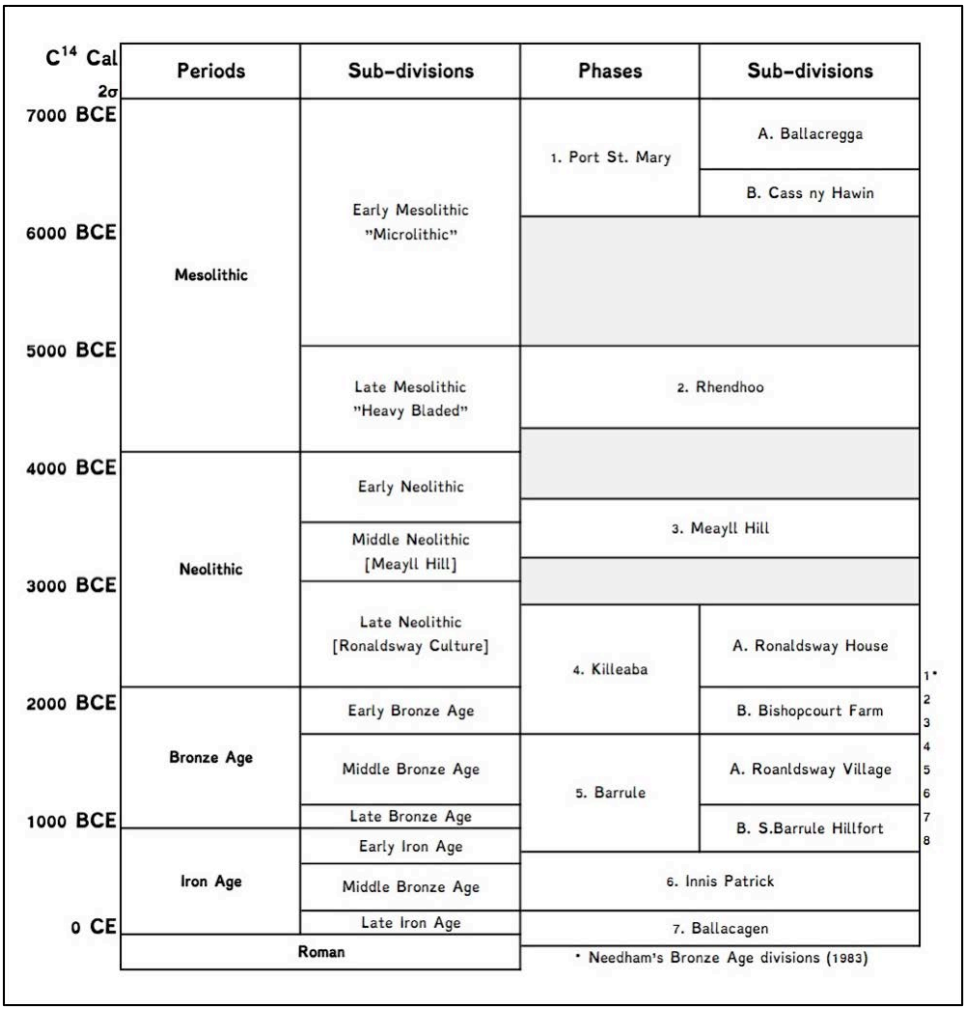
particularly with the rounded bottomed pottery of the Meayll (Burrow, 1997b, pp. 11–18), the Late Neolithic has repeatedly been interpreted as a period of apparent isolation.

In 2002 Davey and Innes suggested (2002, pp. 52–53) that the conventionalist model that divided the Neolithic into two halves (see Clarke, 1935) was broadly acceptable for the island; however, they proposed a new local chronology taking into account more recent discoveries. Phase 3 (3600 - 3300 cal. BCE) and Phase 4A (2900 - 2100 cal. BCE) of Davey's proposal represent the Meayll and Ronaldsway periods respectively, see Figure 1:9. They also note (2002, pp. 53–54) that the distinct separation between these cultures may represent periods of change regarding the population of the island; perhaps emigration of one group followed by immigration of another.

As such, even though as previously mentioned 'cultures' are no longer seen as rigid divisions between regions and stylistic variations, it has generally been accepted that the term 'Ronaldsway Culture' is still valid (Crellin, 2014, p. 5). For some researchers the 'Ronaldsway Culture' terminology remains important because there is seen to be sufficient evidence to suggest that the Isle of Man developed independently for a period towards the end of the Neolithic. This was not thought to relate to a lack of communication (Burrow, 1997a, pp. 14, 27) instead, in parallel with the overarching migration vs. acculturation debate happening in Neolithic studies in Britain and Ireland more generally, a focus on local interpretation of external influence has been debated. In light of newer frameworks, the author and Rachel Crellin agree that isolation is not necessarily the reason for the island apparent uniqueness (Crellin, 2014, p. 69). This is discussed more in the conclusions, see Chapter 6.

Figure 1:9 Conventional and proposed period names for Manx prehistory

(adapted from Davey and Innes, 2002, p. 51 fig. 7)



For his part, Darvill, in *Gathering Time* (Whittle et al., 2011b, p. 553) clarified his published views on the dating of the Manx prehistory in light of new dating evidence in Bayliss et al.'s synthesis. Whilst acknowledging that there are still a lot of unknowns, he disputed the early small scale farming hypothesis proposed by Davey (Whittle et al., 2011a, p. 560) and concurs that many facets of the earlier Manx Middle Neolithic have obvious parallels in other areas.

Darvill's new interpretations for the presumed enclosures gives a younger date than his original reports from the Billown Neolithic Landscape Project (hereafter 'BNLP, see below). Radiocarbon dating now suggests that activity at the site was established

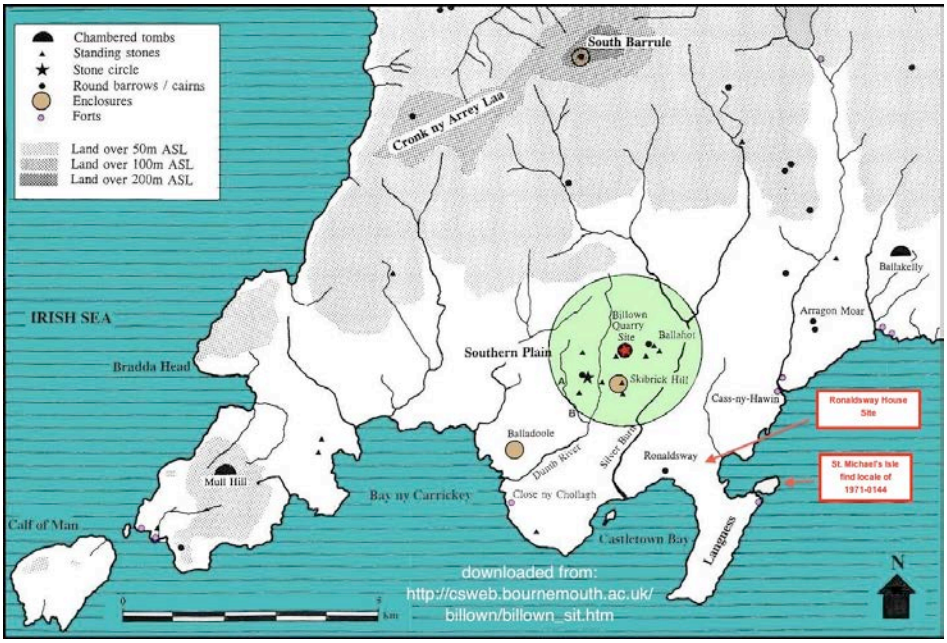
in the 38th or 37th century (Whittle et al., 2011b, pp. 560–561). He admits the evidence is slight: one radiocarbon date (Beta-140098) was 'associated with fragments of a polished stone axe fragment and sherds of plain Bowl which could be taken as early in the (Meayll) tradition'; the other date (OxA-10182) appeared 'to be a residual early Neolithic barley grain in a later 4th millennium pit'.

The BNLP was the largest prehistoric excavation programme ever undertaken on the Isle of Man. It began in 1995, when the University of Bournemouth, in conjunction with Manx National Heritage, broke ground at a site designated for quarrying, in the Parish of Malew in the south of the island. The BNLP was primarily a rescue, and educational training excavation, as well as a survey project, directed by Timothy Darvill. The site was chosen for the study after former Manx Museum Director William Cubbon's 1945 excavation of features in the area (Cubbon, 1945; Moffatt, 1978, p. 179), and because in 1993, 'pits, postholes and gullies' containing Early and Middle Neolithic pottery and flint work were reportedly found in the same place (Darvill, 2003a, pp. 112–113). The site's proximity to the Ronaldsway House site in Castletown, and the Meayll in Rushen, as well as its position at the foot of South Barrule between the tributaries of two of the south of the island's main rivers, make the BNLP site a potentially vital area of research into the lifestyles and habits of those groups who utilised the island's resources in the Neolithic. Geophysical surveys were carried out on the site, and over the course of the project, the area of interest widened to include several other prehistoric sites in the area (see Figure 1:10). Round cairns across the south of the island were examined in 2003 (Darvill and Chartrand, 2004, p. 37); the Booilvane standing stone, the Billown stone circle and another standing stone in the grounds of Ballahot Farm have all been surveyed. Further analysis by Darvill at Langness and on South Barrule widened the scope of the project even further in an attempt to understand the environmental appreciation of

the Neolithic inhabitants of the island (Darvill and Chartrand, 2004, pp. 37–56). The quarry site itself revealed a spectrum of evidence for long term repeated use of the area. Features included circular huts, pits, post-holes, shafts, causewayed ditches, flint, stone implements, pottery and abundant quartz fragments, and young field boundaries (Darvill, 1996, 1997, 1998, 1999, 2000, 2001, 2003b; Darvill and Chartrand, 2004). So far, Darvill's interpretations have focused on the importance of burials, ritual, and the significance of death to the living of the Neolithic (see Darvill, 2003a). This angle contrasts sharply with the functional approach adhered to in the twentieth century by the likes of Cubbon (1934), Clark (1935) and Piggott (1954). However, the final report on the BNLP is still in progress. The Centre for Manx Studies' publication 'Isle of Man New History Series' will also eventually include a volume on Manx prehistory including a chapter on the Neolithic by Darvill. This new book is currently being compiled, and should be a comprehensive overview of the cumulated knowledge of all the local scholars of the last two and a half centuries, channelled through Darvill's perspective.

Figure 1:10 The Billown Neolithic Landscape Project Map,

downloaded from the Bournemouth University Archaeology website (with additions in red)



The Isle of Man has also appeared in several recent edited volumes on Irish Sea archaeology and environment (Armit et al., 2003; Cummings and Fowler, 2004; Fleming, 2005). In 2004, Victoria Cummings and Chris Fowler compiled a collection of papers that emphasised sense of place and experience in their interpretations of Neolithic sites around the Irish Sea (Cummings and Fowler, 2004). Three papers were written specifically on the Isle of Man (Darvill, 2004; Davey, 2004; Fowler, 2004). By highlighting 'a number of high level similarities in material culture which are brought about by common patterns of social interaction and shared cultural concepts' Timothy Darvill's short paper attempted to re-align Neolithic studies on the island away from prescriptive chronologies based almost entirely on monument and artefact classes. He cited pit digging, the use of quartz and strategically placed stones in the facades of long barrows/court cairns as 'activities with strong material expression' (Darvill, 2004). In the book in general, attention was drawn to the similarities between the setting and outlook of monumental architecture in different parts of the Irish Sea region (Sheridan, 2004a; Watson, 2004): the repeated importance of water and mountains to their construction was noted, and following contemporary trends less consideration was placed on the description of individual sites and finds, than on their similarities and differences. Instead, each area was considered unique and the evidence of settlement and utilisation of resources, was examined in relation to the environment in which they were situated. Regardless of influences, each community was considered to have adapted trends and innovations according to their own experience within a particular area (Fowler, 2004).

The most recent research was conducted by Rachel Crellin (2010, 2014, 2015). For her PhD (2014), Crellin addressed 'the changing relations with earth' she saw at what has traditionally been viewed as the 'Neolithic-Bronze Age Transition' (but cf. Roberts and Frieman, 2012, p. 34). In a concise reappraisal of the evidence for key

activity indicators (including changes to burial, settlement and material culture practises) Crellin reviewed the Manx stone and bronze axe-heads assemblage 'as a means to explore the effects of changing technology'. In particular, she performed use-wear analysis on the Manx Early Bronze Age metalwork collection 'in order to understand the impact of bronze as a new material'. She also received funding from MNH for twelve new radiocarbon dates that helped in her consideration of burial practices from 3000-1500 cal BCE. In addition, she has reassessed the changes seen at several sites including the Ronaldsway 'house site', Knocksharry in German and Killeaba in Ramsey (Crellin, 2014, 2015).

Previous work on the Manx early Bronze Age is limited (Davey, 1978b, 1999; Woodcock, 2008). During the transition towards the Bronze Age, Crellin argues for consideration of the similarities and continuities of practise seen, in addition to the differences that have been the focus of studies in the past (Crellin, 2014, pp. 104–106). Davey, Darvill and Crellin's interest has done for the chronology and agency of the progression of Manx later prehistory what Whittle et al. *Gathering Time (2011b)* has done for the study of 'Neolithic' Britain and Ireland more broadly. They have started a new dialogue. Darvill has reframed the earlier Manx Middle Neolithic into discussions of the 38th to 37th century BCE, the Middle Neolithic could be better dated internally, but sits between 37th to 30th century BCE. Crellin has brought the discussion of change with the adoption of metallurgy clearly away from the persistent culture history shadow of older interpretations that equate change (i.e. the arrival of bronze) with migration by showing that change is evident as an inevitably dynamic part of life for communities throughout the later period on several scales (Crellin, 2014, pp. 5–6, 17–18).

It is the calibrated dates that are significant; now that it is becoming increasingly possible, a century scale analysis is the stated aim (Crellin, 2014, p. 18). Crellin's

dates for change (3000-1500 BCE), are longer than those noted by Bradley in Britain and Ireland of between 2500-2000 BCE (Crellin, 2014, p. 17; see also Bradley, 2007, p. 91). Crellin divides this period into the Late Neolithic 3000-2500 cal BCE, Beaker period 2500-2250 cal BCE (although potentially redundant on Mann) and Early Bronze Age 2250-1500 cal BCE, considering the term 'Chalcolithic' to add unnecessary periodisation (see also Allen et al., 2012). She defines the entire period by continual change. Essentially, change is inevitable, fluctuating and unceasing so should not simply be interpreted as if it were a divide between either cultures, ideologies or genetics.

1.5.1 The Ronaldsway Culture

On publication, Grahame Clark's summary of the prehistory of the Isle of Man was an informed deliberation of the available facts. In his introduction (1935, p. 7) Clark suggested that the inherent isolation arising from the island's size and location relative to Britain and Ireland 'ensure(d) vigorous local developments' since it was first settled in the Mesolithic. As such, Clark considered the interaction between British and Irish influences, tempered by 'occasional insular developments' the 'chief features of the island's prehistory'.

Using evidence from the Glencrutchery House site that were stored in the Manx Museum archives Clark first proposed the existence of a local culture in his 1935 book 'The Prehistory of the Isle of Man', but it should be noted that he was not originally present at the discovery of the site. The Glencrutchery House site was discovered during building work in 1893 and when conducting research for his book Clark recognised the similarities between the Glencrutchery pottery, William Cubbon's Knocksharry pottery and chance finds of 'cinerary urns' from Ballacross, Ballahot, Ballaquayle and Colby.

Clark classified this pottery as ‘Ultimate Bronze Age’ and, therefore, failed to consider it as being related to the flint and stone artefacts which he thought were much older (Moffatt, 1978). Before Clark others mentioned the likelihood of an insular culture on the island during the Neolithic, however, it was in a 1947 publication by Bruce and Megaw that the Ronaldsway Culture was 'created' and Bruce’s Ronaldsway site then became the type-site for the new late Neolithic local culture. After that, Clark's dating was dismissed relatively quickly, when the association of Clark's pottery with the lithic evidence was noted for the first time. Twenty-three other sites around the island which had produced similar items in similar settings, where quickly ascribed to this new local style, in particular, the destroyed 'house' at Glencrutchery reviewed by Clark, the Billown site first excavated by William Cubbon in 1945, and Gerhard Bersu's cemetery at Ballateare (Moffatt, 1978, p. 177).

It was in 1943, as a result of the wartime extension of the runway at the airport in Castletown, that J. Ronald Bruce, Basil Megaw and his wife Eleanor, conducted the rescue excavation that revealed the remains of what appeared to be a prehistoric residence at Ronaldsway, see Figure 1:11 and Figure 1:12. The finds included a rectangular stone built structure with a hearth, distinctive rounded bottomed pottery, and a variety of unusual tools (Bruce et al., 1947, pp. 141–142). However, the discovery of several axe-heads with a unique morphology was one of the most intriguing finds. According to Bruce many appeared to have been 'deliberately roughened and truncated at the butt… made from oblong pebbles of a coarse grained igneous rock… with a portly, …almost pear-shaped' profile (Bruce et al., 1947, pp. 146–147). Other interesting finds from Bruce's excavation included the pottery, 'incised slate plaques', 'hump-backed scrapers' and 'lozenge shaped arrowheads' (Burrow, 1997a, p. 21). Together these items were dated by comparison to styles

found in other parts of the British Isles to the Late Neolithic period. However, Bruce concluded that these artefacts were sufficiently different to the other known styles, to become the basis of the definition for a new local culture, the 'Ronaldsway Culture'.

Figure 1:11 Eleanor Megaw's plan of the Ronaldsway House Site

(Bruce et al., 1947, p. 144)

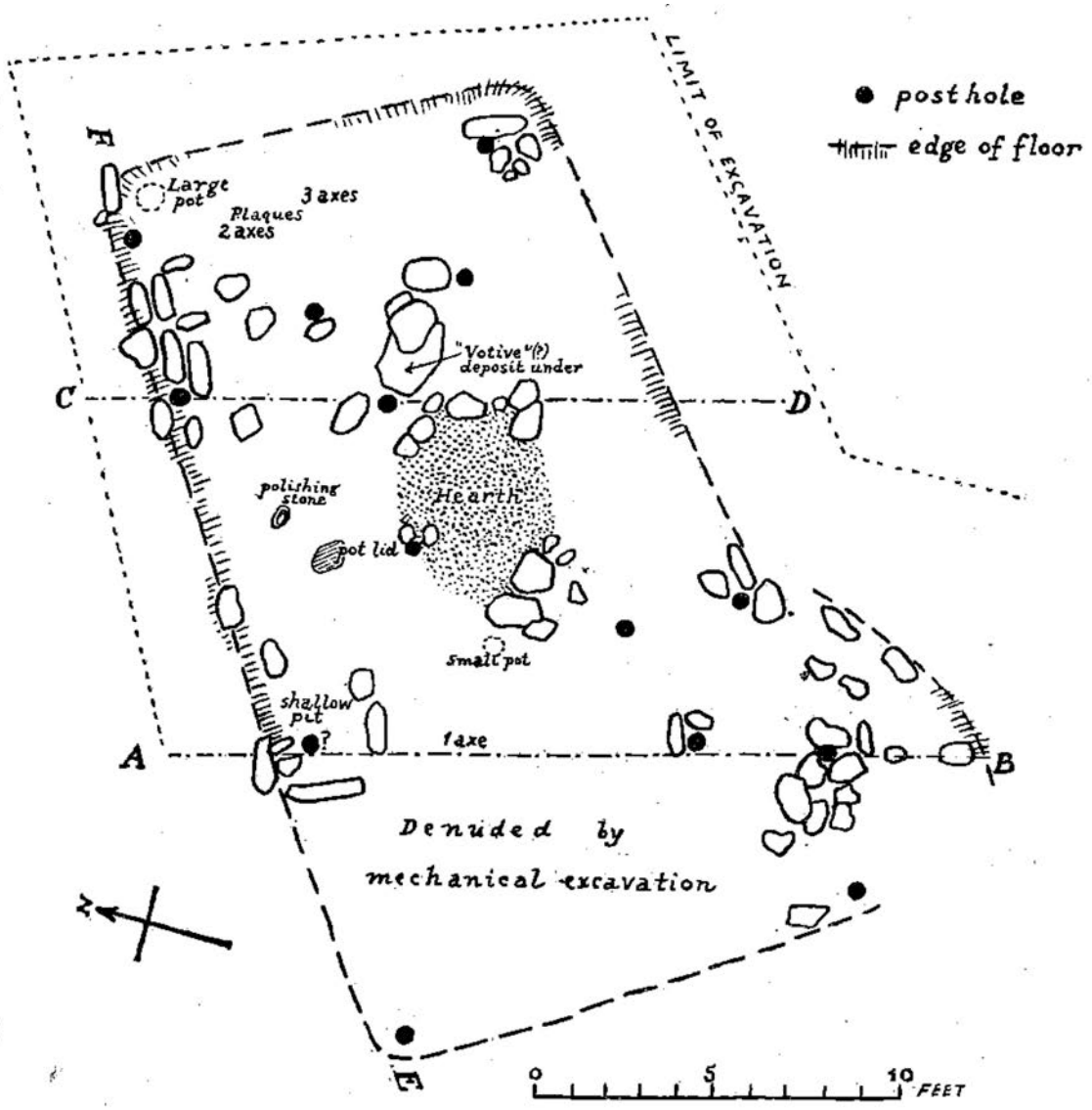


Fig. 3
Plan of the Ronaldsway house-site.
Compare sections (fig. 2) and pl. XVII

Figure 1:12 Eleanor Megaw's cross-sections through the Ronaldsway House Site (Bruce et al., 1947, p. 142)

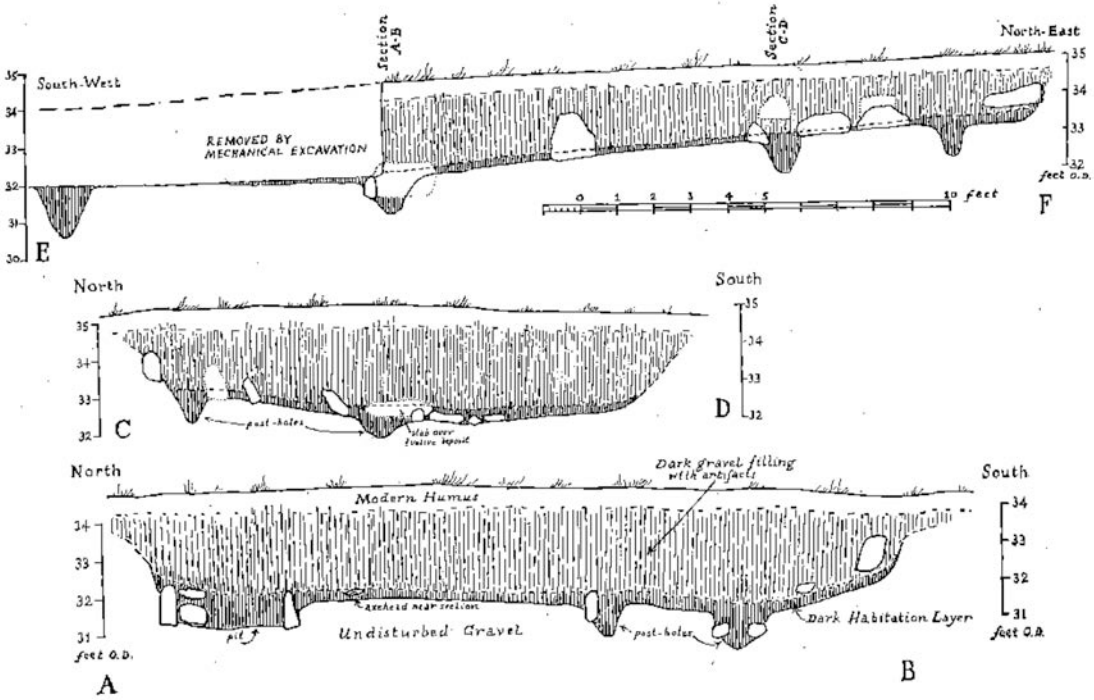


Fig. 2

Sections through the Ronaldsway house-site.

Section A-B corresponds to the vertical face exposed by mechanical excavation.

According to Bruce et al. (1947, p. 142), at Ronaldsway:

> *'the absence of any alien cultural material, together with the absence of sterile layers in the material accumulated in the pit, suggests a continuous period of occupation until the site was abandoned... (Which) means that we may consider the whole material broadly as one large associated find... (That) confirms absolutely the association noticed at Glencrutchery and Billown (Cubbon, 1945) of a Neolithic stone industry with what had previously been considered a much later type of pottery. There was no trace of metal or of any relic characteristic of a period later than the end of the Stone Age'.*

In the same decade, Gerhard Bersu discovered a prehistoric 'cemetery' while excavating a Viking burial ground at a farm just inland on the north west coast of the island at Ballateare, Jurby in 1947 (Bersu, 1947). Then in 1954, Stuart Piggott published detailed drawings of the finds from the three main sites (the Ronaldsway House site, Glencrutchery House site and Ballateare Cemetery site), as well as stray finds and noted that the evidence suggested 'notable insular individuality' on the island (1954, p. 351).

Together with the roughened and truncated butt axe-heads (RTBA), Bruce originally described the pottery found at the Ronaldsway type site—by far the largest collection of pottery fragments; approximately 550 sherds representing a minimum of 44 vessels (1947, pp. 152–157) as a defining feature of the Ronaldsway Culture.

It was noted later that in general the Ronaldsway Culture showed a prevalence for 'ceramic jars placed upright in the ground with their tops just below ground-level and covered by a stone slab, known as Ronaldsway or 'Earthfast Jars' (Burrow and Darvill, 1997, p. 417). However, while Burrow and Darvill believe that the RTBAs represent local development and 'single houses rather than villages were represented, as were cremation cemeteries.' (Burrow and Darvill, 1997, p. 417), they noted similarities between Ronaldsway ceramics and both earlier and contemporary deep baggy vessels from elsewhere in the British Isles and highlighted the fact that Piggott (1954, p. 351) noted similar styles in Icklingham, Suffolk. They also quoted more recent studies which confirmed 'the widespread yet proportionately small-scale presence of deep jars, sometimes with lugs and cordons, in both British and Irish Middle Neolithic assemblages', referencing Smith in Mercer (1981, Fig. 72), Cleal (1992 p. 293) and Sheridan (1995). Likewise, 'although more heavily decorated and significantly different in their fabric and vessel' the Hebridean style of the Western Isles (as identified by Henshall (1972, p. 153-156) and Kinnes (1985, p. 22) and the

domestic site of Eilean an Tighe, North Uist, where considered by Burrow and Darvill as 'interesting parallels for the Ronaldsway forms' (Burrow and Darvill, 1997, p. 417). The Ronaldsway Culture continues to be defined by its material remains, principally: stone axe-heads with roughened butts (RTBAs), engraved stone plaques, thick hump-backed flint scrapers, polished flint knives, hollow scrapers, lozenge-shaped arrowheads, and deep baggy ceramic jars with overhanging rims. According to Burrow's 1999 interpretation around 2200 cal BCE this Ronaldsway Culture 'appears to have been abandoned in favour of Beaker traditions', (Burrow, 1999, p. 34; see also McCartan and Johnson, 1991). As mentioned above however, today Crellin appreciates a more nuanced interpretation of the manifest changes and argues that the status of the Ronaldsway 'house' in defining the culture has been counterproductive; its exceptional assemblage and questionable 'house' layout have tainted all subsequent interpretations (Crellin, 2014, p. 288).

1.5.2 Manx Axe-head Research

> *'We have as yet no information concerning a very important group of axe-heads, usually made of a coarse stone, that have the butt-half of their length roughened by pecking and often reduced in size, obviously for mounting in the socket.'—*
>
> *(Kendrick and Hawkes, 1932, pp. 72–73)*

Before Bruce, others (see Kendrick and Hawkes quote above) noted the unusual butt end features appearing as the Manx Museum's collection grew. Once it was established that the roughening of the butt end represented a distinctive local axe-head style, more Manx examples were classified as 'roughened and truncated' at the butt (hereafter RTBA). Then, in 1951, seven axe-heads from the Isle of Man (the 'Original Manx Seven' or 'OM7') were thin sectioned for microscopic analysis by petrologist Frank Shotton at the University of Birmingham, as part of the SWG third report (see Stone and Wallis, 1951).

Four examples from the Ronaldsway House excavation and one from each of the Parishes of Onchan, Santon and Jurby where selected, see Section 4.1. The most interesting of these axe-head was discovered at the Glencrutchery House site in Onchan (along with other items diagnostic of the Ronaldsway Culture (see above and Moffatt, 1978, p. 182). Microscopic analysis conduct as part of Project JADE revealed that it was 'exotic'—made of jadeitite, from Mount Viso—and could have travelled from the Breton region of France (Pétrequin et al., 2008). Four others were eventually classified as Group VI from Cumbria and two were considered locally sourced. Collectively, this research not only indicated a Manx contribution to regional axe-head movement, as well as potential local utilisation of resources, but also possible contact with mainland Europe, or at least, a chain of exchange that reached the Continent.

In 1976, as a result of the success of identifying the petrology of the 'Original Manx Seven' (OM7), the Trustees of the Manx Museum agreed to have a further 40 of the broken and fragmentary axe-heads found on the Isle of Man thin sectioned. Larch Garrad, Assistant Keeper at the Manx Museum, in conjunction with Russell Coope, a petrologist from the University of Birmingham, undertook an evaluation of all the axe-heads from the Isle of Man, concentrating on the petrological identification of the source rock used in the production of the Manx axe-head collection.

One year later, at the 'Man and the Environment in the Isle of Man' conference Coope announced the discovery of a new Manx stone axe-head factory (given the appellation Group XXV), which he suggested had produced the raw material for seven of the axe-heads thin sectioned and nineteen of the axe-heads considered similar by basic comparisons in the hand (Coope and Garrad, 1988, p. 69; Garrad, 1978a, pp. 167–169 Fig. 11.1). A preliminary list of the Ronaldsway Culture RTBAs from the island, (including those considered to be made from this local source of

rock) was produced, as was a distribution map see Figure 1:13 (Garrad, 1978a, pp. 167–170).

A decade later Coope and Garrad were again asked to summarize the Manx collection as part of the IPGs' SAS volume 2 (1988), see Figure 1:14. The paper confirmed the speculation that these peculiar RTBA were 'frequently made of insular stone... (whose source was) tentatively identified as (either) being in the Ballapaddag area, on the boundary between the Parishes of Braddan and Santon', or near Oatland in Santon, 'about 6 km south west of Douglas'; both sites include 'basic igneous rocks that resemble' the material used in the production of many of the RTBAs (Coope and Garrad, 1988, pp. 67–69). However, originally Coope was cautious: 'the axe-heads are made of a rock in which the feldspars are more highly altered than in any sample (that has been) examined from these intrusions (at Oatland and Ballapaddag)' (Coope and Garrad, 1988, p. 69); the authors admitted that their conclusions relied on limited analysis of a small selection of thin sections and they stressed that the work 'must be viewed as an interim report'. Since then however, their findings have been repeated with conviction (Burrow, 1997a, p. 22; Burrow and Darvill, 1997, p. 417)

> *'Local development is supported by the restricted distribution of stone implements of quartz diorite/tonalite (Petrological Group XXV) identified to a source on the south-eastern side of the island (Coope and Garrad, 1988). Implements in this stone, including the distinctive axe-heads with roughened butts, are apparently absent from Ireland (Cooney and Mandal, 1995), southwest Scotland (Ritchie and Scott, 1988), Cumbria (Fell and Davis, 1988) and North Wales (Houlder, 1988).' —(Burrow and Darvill, 1997, p. 417)*

Unfortunately, at present the provenance of the source for these local axe-heads actually remains unverified. Likewise, the significance of the RTBAs' unique butt end

and their relationship to the new local source has not been explored in detail. Garrad's research formed the foundation of the original analysis of the Manx axe-head collection for the author's Master dissertation in 2010. However, whilst retrieving the appropriate axe-heads, it was possible to visually inspect the rest of the collection, and as a result, further axe-heads where included whenever they appeared to show defined RTBA traits or local source characteristics. On completion of the analysis of RTBAs, the venture was expanded to include all axe-heads in the Manx Museum collection and the present Manx Stone Axe-head Project developed.

Figure 1:13 Garrad's distribution map of Manx stone axeheads (Garrad, 1978a, p. 166)

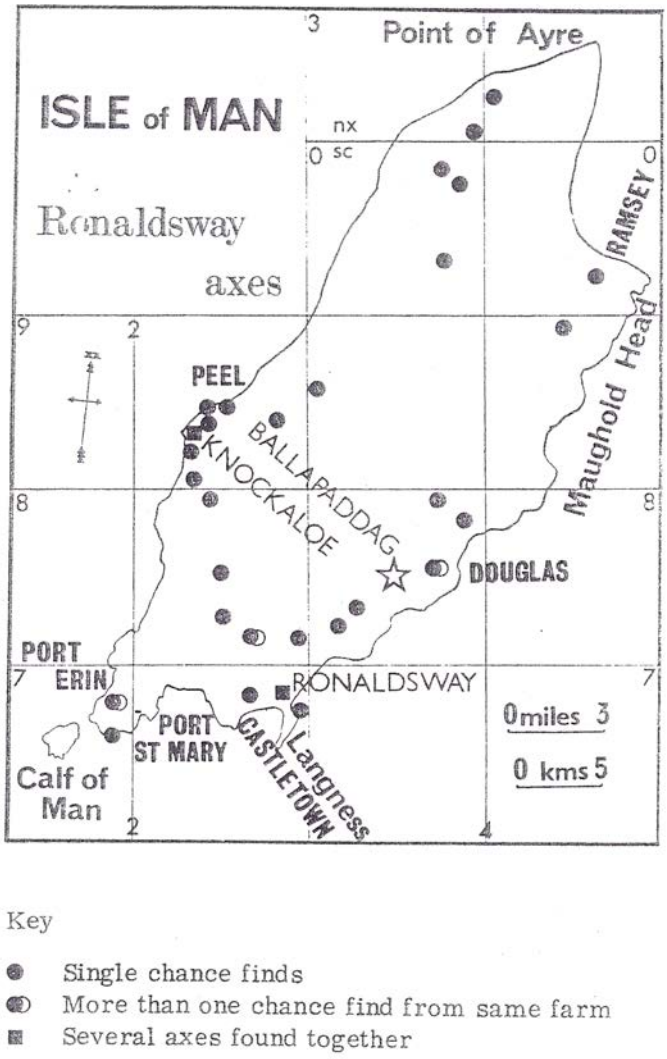


Figure 1:14 Larch Garrad's distribution map of analysed RTBAs (Coope and Garrad, 1988, p. 68)

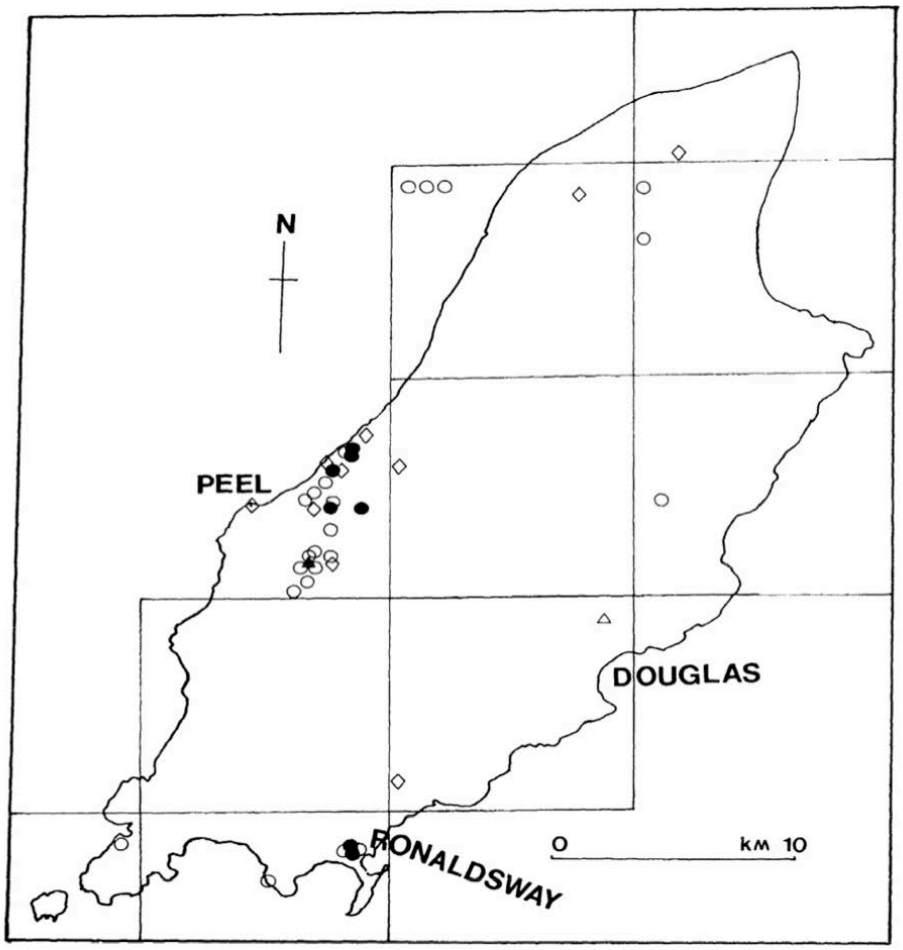


Fig 10 Distribution of analysed axes in the Isle of Man: solid circles = Group XXV; open diamonds = Group VI; solid triangle = Group VII; open triangle = jadeite; open circles = other rocks

CHAPTER 2

2.1 The Manx Stone Axe-head Project

In Larch Garrad's 1978 paper, from an estimated total of one hundred and forty axeheads in the Manx Museum collection, forty-eight artefacts were classified as Bruce's Ronaldsway Culture RTBAs (n=48/140, 34%). Twenty-six of these were identified by Coope as produced from the Group XXV source (n=26/48, 54%) (Coope and Garrad, 1988, p. 69; Garrad, 1978). In 2010, for the author's Master Project (MSAP1), sixty-nine Manx stone artefacts from the Manx Museum collection were analysed (n=69/191, representing 36% of the lithics reviewed at the time (n=191), including four fragments (n=4) and one piece of debitage (n=1) (Barrs, 2010). It was possible to locate forty-three (n=43/48, 89.5%) of Garrad's RTBAs (axe-heads nos. 1954-0581; 1954-1128/36; 1965-0139; 1971-0088; 1965-0001/007 could not be found). After an initial review of the lithic collection twenty-six additional axe-heads were included in MSAP1 (n=26), selected on the basis of the shape of the butt and/or the macroscopic identification of the rock type, as belonging to Group XXV according to the definition given by Coope and Garrad (1988, p. 69). In addition, that year six (n=6) artefacts[1] including four axe-heads, one fragment and a piece of debitage, as well as fifty-seven (n=57) thin sections mainly from broken axe-heads and fragments (see Section 4.2), were repatriated from the Lapworth Museum in Birmingham (six axe-head thin sections are broken, four of them from RTBAs).

MSAP1 focused on the roughened and truncated butt axe-heads within the collection by cataloguing the contextual, morphological and petrological details available in the Manx Museum archives, following a simplified version of the methodology applied by ISAP (Cooney and Mandal, 1998). After visual inspection of each artefact, with all

[1] None of the artefacts repatriated were RTBA or Group XXV, as such they were not included in MSAP1.

details collated in a Microsoft Excel spreadsheet, it was established that thirty-three (n=33) axe-heads (n=33/69, 48%) could have been produced from the un-located Group XXV source, and these axe-heads were found in thirteen (13) of the seventeen (17) Parishes, with the highest concentration of RTBAs in Malew (n=27). Speculation into the reason for the unusual morphology was kept to a minimum, but the popular notion that a roughened and truncated butt end may have helped adhere the head to the haft remained convincing.

By building on the author's Masters Project (Barrs, 2010), this dissertation aims to begin reassessment of the whole Manx axe-head collection using or utilising both the technological and the theoretical advances that have been made since the last work in the eighties. Following, in principal, the methodology employed by the Irish Stone Axe-head Project (see Cooney and Mandal, 1998, 1996, pp. 41–43, 1995, pp. 969, 972–973; Mandal et al., 1997, pp. 758–760), the contextual, morphological and petrological features of each implement in the Manx collection has been analysed and made accessible to interested researchers for their own analysis.

2.2 Methodology

The first artefacts studied were those housed in the Manx Museums' store rooms. Individual axes are stored wrapped in museum quality tissue paper and placed in a plastic sandwich bag. Several (depending on size) are then stored together in cardboard boxes in the Museum's secure basement storage rooms. A record has been made of the references written on the storage bags, as well as any notes and tags stored with specific axes, or more generally in the boxes, as well as box numbers, to allow for quick retrieval.

In total, three hundred and twelve artefacts were reviewed, including two hundred artefacts recorded as axe-heads, adzes or chisels, see Figure 3.2a. For the morphological analysis one hundred and eighty-six axeheads, adzes and chisels were

studied (n=186), fourteen were discounted for various reasons (n=14), see Section 3.3. For the petrological and contextual analysis (n=206), all artefacts studied for morphology were studied as well as all fragments (n=16) and debitage (n=4). Individually each artefact was studied macroscopically and under x10-60 magnification with a hand lens, in an attempt to determine petrology. Observations were input into an Apache Open Office Spreadsheet (currently version 4.1.1, 2016/04/25). Surface features, (like weathering, polishing and pecking), colour (and patina if applicable) as well as the extent and nature of any damage were also recorded. The axe-heads were then weighed, measured and coded using the IPG Shape Classification Criteria (see Figure 1.8 and Chapter 3).

The project started in 2011, by the end of 2012 all artefacts had been studied, including those on display in various areas of the Manx Museum; documentation from the Museum, IPG records, correspondences and notes were also collected. Increased familiarity with the collection meant that revisiting axe-heads often led to revised opinions, particularly regarding morphological features. The significance of collecting certain kinds of information was not apparent at the beginning, as such axe-heads studied later on generally had more rounded descriptions. All the axe-heads would be better viewed together, physically compared and grouped as required by their similarities and differences, preferably in a large well lit room, however the nature of artefact studies makes that highly idealistic and thoroughly impractical in practice.

In late 2012, Manx National Heritage's [MNH] Official Photographer, John Caley, kindly began to photograph the majority of artefact in the Museum's collection. In total he produced 1199 individual images to the most professional standard and also painstakingly modified the original images to remove holding clamps and naturalise the colour; Figure 2:1 is an example of his images before and after his modifications.

Where possible six images were taken of each artefact, and the images coded as follows:

- Face Side A
- Side Profile A
- Butt End
- Face Side B
- Side Profile B
- Blade End

In 2013, in the period between original analysis of the axe-heads and receiving the modified photographs in 2015, a study of the axeheads in collections in Britain was undertaken (see Chapter 5). It was naively assumed that all the photographs would be available before the trip to Britain commenced in August; allowing direct comparison between the Manx photographs and British artefacts, unfortunately this was not feasible. Nevertheless, visiting as many collections as possible increased familiarity with axe-head forms immensely; so when in 2014, one hundred Manx axe-heads were briefly transported to Liverpool for further analysis, it was again confirmed that greater familiarity changes subjective analysis.

Following categorisation of the axe-heads, potential Manx sources were also investigated using the same techniques. In addition, while in Liverpool a small number of rock samples were also analysed. These samples were collected from areas with potential source material on several field trips. This included twelve samples from Oatlands in Santon (a potential Group XXV source area), four from a granodiorite at the shores of Loch Dhoon in Dumfries and Galloway to the north of the Island that was considered at the time to be a potential source of erratic material used to make axe-heads on the Island) and four more samples from Cumbria, (Group VI tuff from the scree slope at the Pike o'Stickle to the east of the Island).

In addition, a collection of source samples were kindly provided by Peter Davey, included samples from Ballapaddag (the other presumed Group XXV source area), Tievebulliagh in County Antrim (Group IX) and Welsh Sources: Mwyd Rydd (Group

XXI) and Graig Lwyd (Group VII). Again, increased familiarity with more source areas made re-reassessment of assigned axe-head petrology a renewed priority. The majority of axe-heads could only be analysed macroscopically, however, forty-one (n=41) axe-heads could be correlated to thin sections (see Section 4.2, especially 4.2.3) so photomicrographs were taken at the University of Liverpool's Central Teaching Lab. Similarly, eleven (n=11) Group XXV axe-heads and potential source materials were analysed geochemically using portable x-ray fluorescence spectrometry [PXRF].

When the finished MNH photographs were received in 2015, it was an opportunity to collate all the disparate data available on individual axes into a coherent whole.

Figure 2:1 Photographs before and after Photoshop™

2.3 The Manx Stone Axe-head Database

In keeping with the desire to modernise the British, Irish and European axe-head record collections within an interdisciplinary framework (Ballin, 2009; Cooney et al., 2011; Davis and Edmonds, 2009; Sheridan and Pailler, 2012), the Manx collection first requires a dedicated digital database to record all information for each artefact. This comprehensive database needs to be:

- Manipulatable
- Searchable
- Printable
- Capable of supporting attachments/links
- Mac-, Linux- and PC-friendly
- Web-friendly
- Adaptable and easy to convert into new formats as required

In a well-planned digital database, data can be stored, retrieved and maintained simply and effectively. The model chosen for any given application usually depends on the end-users' needs, the intensity of on-going maintenance schedules, and the nature of the data stored. Many standard models are available, but in all cases, the data is stored in a file —only the way it is stored and retrieved differs between models. For the purpose of immediate data manipulation, management and, most crucially, information sharing, it was not necessary (or even truly possible without ongoing funding) to create a bespoke object relational database [ORD] structure in this case. However, there are several web-based applications already in existence suited to this purpose, and as the digitalisation of cultural heritage continues at pace more options will no doubt become available. For a small collection, it is more important that the data is kept in a common and easily importable format. Microsoft Office Excel (in this case, for Mac 2016 (currently version 15.21.1, 2016/04/25) was chosen for its ubiquity, overall usability and the availability of

online support for the software (although several precursory databases were attempted using various versions of LibreOffice and Apache OpenOffice software; none were rated as highly in all categories). Pivot tables and the filter feature in Excel allow the entire collection to be manipulated depending on the search criteria defined for any given column. It is crude, but enables quick retrieval of relevant information and an accurate portrayal of how many items conform to the criteria under scrutiny. More advanced software is able to manipulate the data further but for a base level database Excel offers a standard format that is a common import file type. Overcomplicating the raw data file is inadvisable because it will be necessary to update the database going forward. Future permutations of both the hardware and software used to access the data need to be considered, but it is possible to maintain a simple database in a widely used format that can be copied and converted into a readable format (e.g. comma separated value files [.csv]) for more elaborate data manipulation both now and in the future as required in dedicated software and on severs like the Archaeological Data Service [ARS].

Zotero was chosen to host a working copy of the records and images associated with the artefacts because it allows users to create focus groups for collaboration which can be set to 'private', accessible by invited individuals only, or 'public', allowing anyone online to find the data (Zotero, 2016). The Zotero group for the Manx Stone Axe-head Project contains a full list of the artefacts under scrutiny, and each artefact is tagged with the properties listed in the raw data Excel spreadsheet. It is recommended that the Manx Stone Axe-head Database Zotero group is searched alongside this document for a first hand appreciation of the artefacts in the MNH collection. A spreadsheet alone, even when graphically represented, cannot give the same impression of any individual artefact as is possible when viewing digital

collections of images and documents; potentially an impression second only to the tactile experience of examining the axe-head in person.

To allow the data to be clarified, all terms used in the database are listed in the reference sheet designed to accompany the artefact record sheet [ARS], see Appendix 1. These ARS are digital forms created in Abobe's Acrobat software (currently version 2015, 008.20082, 2016/04/26, see Adobe website), based originally on the data collection criteria established by ISAP and under constant refinement by the IPG. It is also necessary to help promote consistency in data input going forward. The Adobe software then has a function that can merge these data forms into a single Microsoft Office Excel spreadsheet. This spreadsheet can then be converted to a (Windows™ friendly) .csv file and exported to other applications, as well as in any number of specialised data manipulation applications or GIS software.

At a very late stage in this project, another application, Scrivener was discovered (currently version 2.7, 2016/04/25 see Literature and Latte website). Originally designed with screenwriters in mind, several academics dealing with large datasets extolled its virtues in online discussion forums, it was downloaded with curiosity as a trial. Then quickly purchased once the adaptability of the programme was appreciated.

There are three components to Scrivener. Firstly, the Binder (see Figure 2:2) on the left of the screen: in this area each artefact was created as a folder containing all relevant attached files This is where the axe-head data is stored, and all the functions within Scrivener work with the data from here. When available the official MNH photographs were attached along with the relevant ARS, plus any digitalised paper record, scans and correspondences from MNH, and older photographs, IPG Records, IPG shape classification criteria, dimension data and photomicrographs, plus the results from petrological investigation (including any geochemical analyses) when

applicable. Similarly, links to maps for artefacts with contextual data, extraneous notes, queries and miscellaneous records, are all attached to the relevant artefact images and tagged for easy search and retrieval, all in common image (.jpeg), document (.pdf), text (.rft) or spreadsheet (.xlsx) formats. Copies of any original specialist files like those required for the photomicrographs (.sif) are also attached to the relevant artefacts. Inevitably not all implements have the same quality of information available. In addition, a lot of the data collated is itself fluid in many ways; as discussed in the following chapters many of the classification criteria rely on subjective analysis and are open to on-going discussion. As such, the database is not, as it seems, designed as a fixed and definitive representation of information available on the axeheads of the Isle of Man; instead the database has been created as a test of the data collection criteria and is subject to continuing refinement. Once the data has been gathered, the primary function of the database is to return queries based on defined criteria. As such, it is essential to anticipate the types of questions that are likely to be asked of the raw data, to dictate the most appropriate categories to define each criterion. There are a relatively broad range of possible motives for accessing data on the Manx stone axe-head collection; academic research is the most immediate and obvious reason. Scrivener, although not currently shareable like Zotero, has proved to be a very efficient way to deal with the database, and has become a vital precursor to the 'live' group available on Zotero.

The second feature of Scrivener is the Editor in the centre of the screen (see Figure 2:3): this is an area that can be viewed in three ways, as text files (called 'scrivenings'), as images/index cards, or as a spreadsheet (called 'outliner view'). Additionally, the Editor can be split in two either horizontally or vertically. At its simplest this means that two axeheads in the binder can be viewed simultaneously and compared, furthermore the binder can be searched and these searches can be

saved as an automatically updating collection. It is also possible to make manual collections from any folders, files, or images in the Binder. All views can be locked in place, or saved as layouts. Thirdly, the Inspector on the right summaries all the data available (see Figure 2:4). The axe-head folders can be assigned both a picture and a synopsis (see Figure 2.2), as well as user-defined colour coded labels, icons and status options. Most importantly it is possible to create a seemingly infinite number of user defined meta-data categories. In this case the ARS categories were transcribed across, and it is possible to limit searches to meta-data or title or synopsis etc. only; this proved to be very beneficial because it enabled, as an example, all images of axeheads found in Ayre to be saved as an automatically updating collection, which could then be compared in the split screen Editor to all axeheads found in Glenfaba.

The value of Scrivener cannot be overstated, but it required a lot of time to setup because there is no way to input data en masse. As such everything had to be transposed separately. In addition, the ability to search multiple terms or to specify which meta-data category to search would be even better. Initially, if medium sized axeheads were searched, the resulting collection would also include any reference to medium grained that may occur in a different category with the metadata. To combat this, it was necessary to carefully sieve the database for these issues and create unique terms for each column; for example, all references to 'medium' with regard to grain size were changed to 'med' in the petrological descriptions column, so that the term 'medium' only occurred in the size column when related to morphology. As can be imaged this was an extremely tedious process but once completed truly invigorated the project. The meta-data input into Scrivener can also be exported as.csv files, and this has been included in Appendix 2.

Figure 2:2 Inside Scrivener: the binder

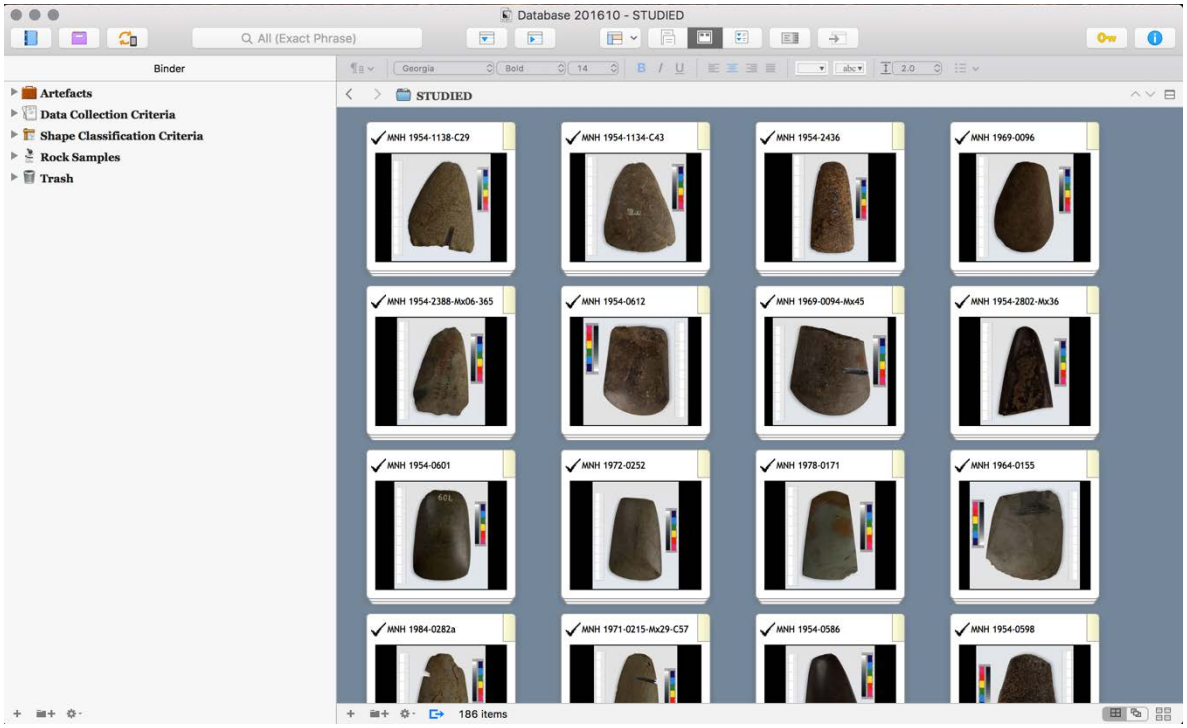


Figure 2:3 Inside Scrivener: the editor

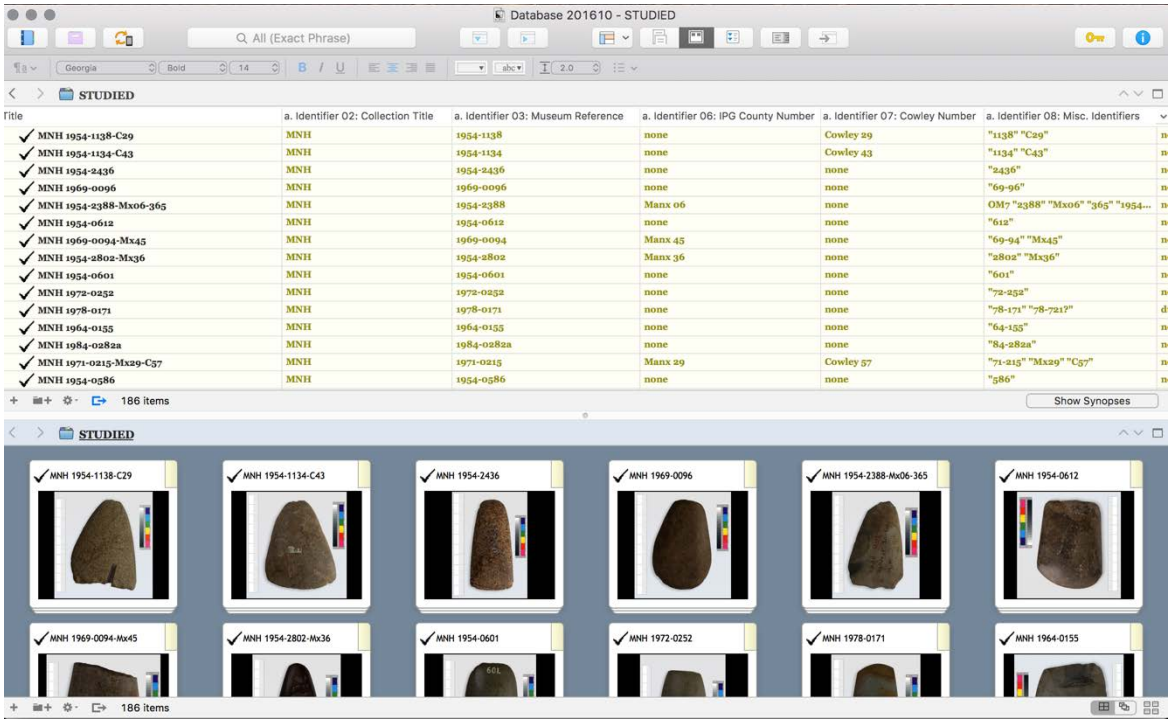
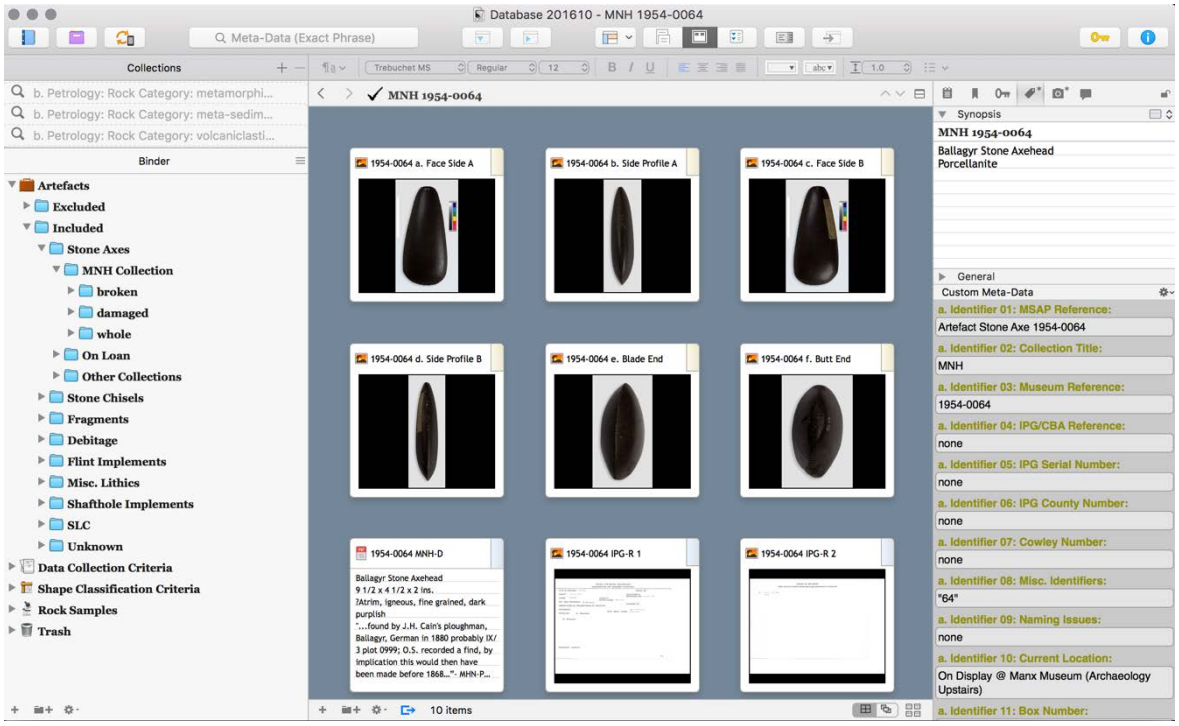


Figure 2:4 Inside Scrivener: the Inspector



A website for the Manx Stone Axe Project has also been prepared and awaits funding. Ideally it will be linked to the online Zotero group which itself is now maintained in the background via the primary Scrivener database. However, Manx National Heritage [MNH] has spent considerable time, money and resources developing its own website and iMuseum, which currently displays information on a wide range of records housed in the MNH archives. Members of the public can sign up to access family history data, photographs, newspapers, and maps among other things. The information collated for this project could be linked to the iMuseum to allow individuals who have been granted access a chance to examine the artefacts and related material. In either scenario, the Manx Stone Axe-head Database will be one of the first collections of physical artefacts in the Manx National Heritage collection to be available digitally on the Island.

CHAPTER 3

3.1 Morphology

Analysis of an artefact's shape is often accompanied by an in-depth look at the raw material used in its production, as well as contextual setting. This leads to a more holistic analysis since petrology places limitations on morphology, and solid find contexts can help to refine regional chronologies based on morphological variations. Nevertheless, shape remains a very important consideration in its own right, as long as it is remembered that the physical properties of any given archaeological artefact intrinsically lie on a spectrum, and as such vary due to a host of factors. Not only the pliability of the raw material, but the skill of the craftsman, intended function, use-life damage, environment of deposition, and discovery circumstances (even processing technique and storage) must be considered when classifying any artefact by its shape. The stone axe-heads found across Britain and Ireland display a wide range of shapes and sizes and cataloguing this variety continues to be an enormous challenge for researchers, not least because the objectivity of classification poses a significant problem when collections reviewed by different researchers are compared.

Macroscopically, the axe-heads can be compared in terms of colour, texture, and size. Although this is a very simplistic and subjective way of analysing artefacts it is arguably one of the most important. Precise weights, measurements and shape classification criteria help us to categorise artefacts but it does not necessarily follow that these properties were significant in their own right initially. Acceptance by the scientific community of the concept of millimetres, grams etc. as the international standards is very recent, in contrast the intrinsically tangible properties of an axe-head, i.e. the 'look and feel', has always been apparent even for the makers and users.

These properties are ultimately reliant on petrology; every rock type reacts differently to being shaped. Similarly, the effects of weathering cannot be over stated. As such, it is important when comparing axe-head features to combine certain attributes in order to consider them in the proper context, i.e. colour, rock type and weathering, or texture and grain size, or damage and rock type.

3.2 Quantifying Morphological Data

ISAP consider Irish stone axe-heads to be defined as 'axeheads with a provenance in Ireland' and include in their database 'all known Irish examples (including axe-heads, adze and chisels)' (Mandal et al., 1991, p. 1). For the Manx collection, the terminology used for stone axe-heads parts is given in Figure 3:1 and the morphological features of each axe-head are categorised using the format initially employed by ISAP in Ireland (Cooney and Mandal, 1998, pp. 14–25), and more recently redrafted as part of the IPG's ongoing project in Britain, see Figure 1:8. Each artefact was assigned a code for all surfaces. This allows swift identification of the basic shape of each stone axe-head, and simplifies the creation of statistically manipulatable datasets. However, it should be noted that realistically the stone axe-heads collectively display a range of shapes, and categorising morphological features is speculative.

The common problems associated with typology are discussed by many including Thomas (2004, pp. 55–77) and Andrefsky (2005, pp. 61–85). In general, there is a debate about the various merits of lumping (i.e. categorising things broadly), and splitting, (i.e. more precise categories, with fewer members). This is an issue of particular importance to the subjective decisions involved in categorising lithic morphology. In this case, an artificial division between axe-head shapes is generated. In reality, no two axe-heads are identical, and any classification is susceptible to personal opinion. Given the constraints of petrology, categories need to be fluid

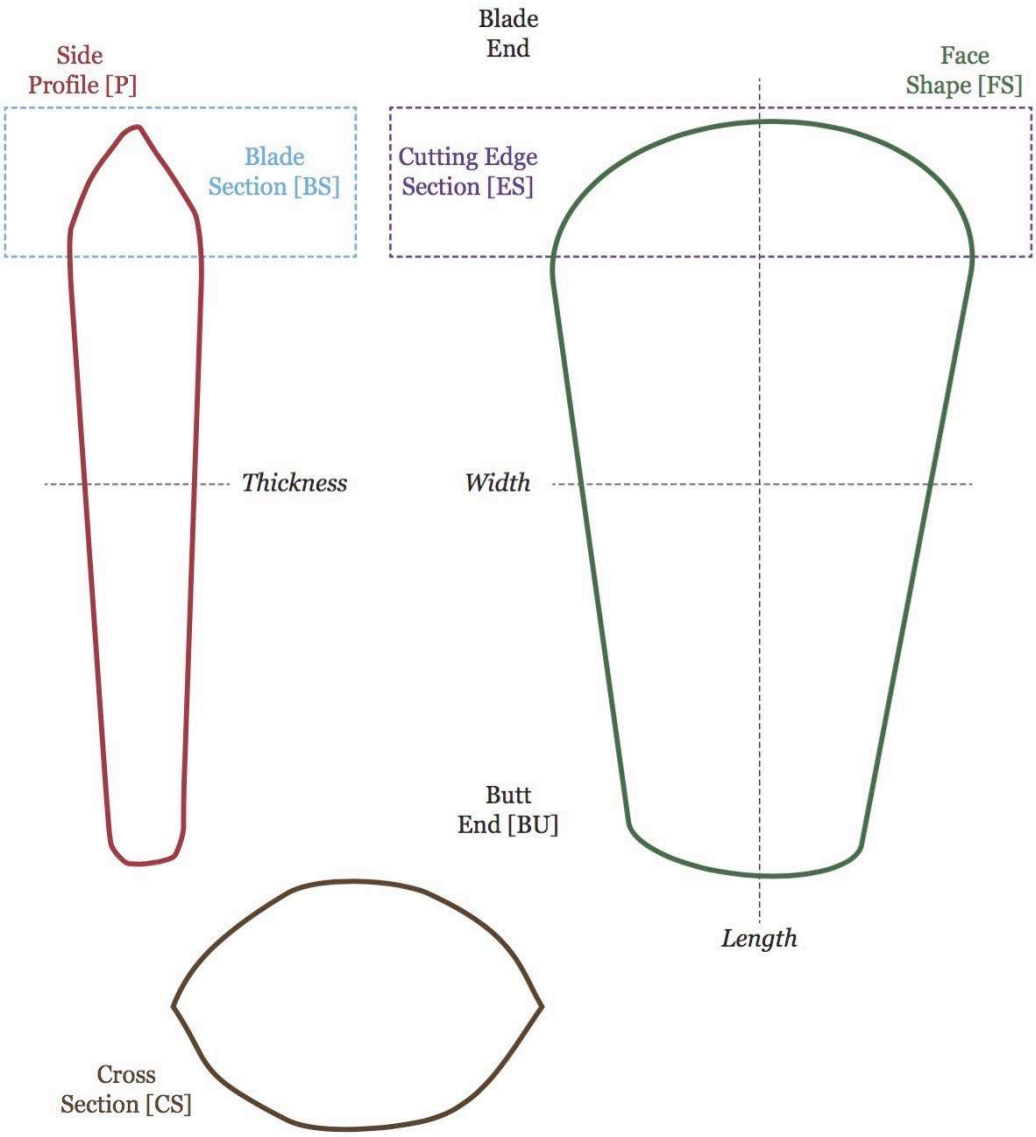
enough to allow for some natural variation (which would perhaps be less of an issue for cast metal artefacts, for example), and understood as an idealised summary rather than an accurate representation. This suggests it would be more beneficial 'lumping' artefacts of broadly similar shape together, rather than splitting out the slightest variations into new categories. However, with modern technology a greater number of categories gives the ability to do refined searches with several criteria and allows for faster and more precise data retrieval for comparisons.

The use of pre-defined criteria in studies like this, in this case particularly the IPG standard shape classification, helps to keep testing the validity of the established criteria in addition to summarising the physical attributes of the collection as a whole. Likewise, any trending attributes not satisfactorily covered by established criteria could be considered more likely to represent localised differences than the artefacts which conform to known parameters, at least until the criteria have been applied to the British collections as well.

The database created for this project aims to rely where possible on the established criteria and standards used across Ireland and Britain, but it needs to be considered as a flexible tool, with the photographs placed as the central focus point of the collection. Regardless of the preconceived outline of the object, the material used in its production and the damage received during and after its 'use life' influence morphology, and therefore overt reliance on classification criteria alone is unadvisable. By photographing each artefact and creating a searchable online database where each artefact is tagged with its properties, interested researchers, regardless of their location, can access all the raw data available for an appreciation of the varying styles found on the Island to be understood both in their own right and in relation to other collections. This helps makes the assessment of collections as a whole a collective venture, where many voices can contribute to an ongoing dialogue,

instead of committed and fixed sets of isolated definitives born from lone researchers in the dusty bowels of museum store rooms as has been the case for many collections in the past.

Figure 3:1 the nomenclature of axe-head parts (illustrated by Pip Kewley)



3.3 Object Types and Nomenclature

The morphological data for the stone axe-heads in the Manx Museum's collection is limited to measurements (in inches) and a brief written description of notable characteristics. For a small number of axe-heads there are also sketches or photographs available. For this study, this information was recorded, but new measurements were taken (in ISO standards) as well as new photographs.

Initially, the artefacts were divided into group based on overall shape, and the object types listed in Figure 3:2a were discerned. One hundred and eighty axe-heads were recorded in the Manx Museum collection during this study (n=180). Of them, thirty-two were broken (n=32) and a further nineteen were damaged (n=19), see Figure 3:2b and Section 3.3.1.1. There were also six stone chisels (n=6), see Section 3.3.2, as well as sixteen axe-head fragments (n=16) and four recognisable pieces of debitage (n=4), discussed further in Section 3.3.1.2. The flint implements included (n=31, see Section 3.3.4), do not necessarily represent the Manx Museum's entire collection, as more are likely to be found from an investigation of the unsorted flint material in the Manx Museum archives (Fox, A. pers. comm.).

Miscellaneous lithics and potentially utilised, naturally rounded stones are discussed in Section 3.3.5 (n=14) while possible manuports, that have been excluded from the database, including three artefacts described in the Museum's records as 'Shoe Last Celts' (n=3) are covered in Section 3.3.6. Artefacts only known from records or thin sections are labelled 'object type unknown' (n=30).

Statistical analysis of shape included all axe-heads (n=180) and chisels (n=6). However statistical analysis of dimensions was restricted to complete axe-heads (n=129) and chisels (n=6), including five axe-heads and one chisel on long-term loan to the Manx Museum from private collections (n=6).

In addition, there are four axe-heads that reportedly form part of a 1905 loan from the Natural History and Antiquarian Society, recorded as 'exotic' (n=4) they are not included in the statistical analysis. There is one from New Zealand, one from Cleveland, America, one from Castle Douglas, Scotland and one from a 'Pacific Island' referred to as 'Heavey Island'.

Eleven Shafthole Implements (n=11) found in the museum archives are discussed further in Section 3.3.3. They were recorded but they have been excluded from the overall statistical analysis because the IPG have generated specific shape classification criteria for Shafthole implements, and they are likely to be younger than the rest of the artefacts under scrutiny. Similarly, four other tanged/flanged artefacts that were examined appeared to be modelled on later copper axe styles or hammer-stones (n=4) and so were also excluded after the initial review.

Furthermore, nine axe-heads from other collections were noted (n=9): three axe-heads were found by Tim Darvill's Billown Neolithic Landscape Project including two broken examples, one of which was associated with a n early Middle Neolithic date, (see Section 1.4.2 and also illustration in Figure 3:3). A single axe-head found in Port Erin was relocated from its thin section to the Manchester Museum collection (n=4). In the course of examining axe-heads in museum and university collections in South West Scotland and North West England, five further examples were discovered off-island (n=5), including two Group XXV RTBAs (n=2, one of which is broken, see Chapter 5). The remaining three axe-heads were discounted from analysis because they have no relationship to the island (two serve only to highlight the fact that roughening is commonly found in other collections (n=2, see Figure 3.26); the final axe-head, found at the Hunterian Museum in Glasgow, was originally thought to be a Group XXV, but later discounted entirely, see Chapter 4.

Figure 3:2a Studied Artefacts by Object Type

Object Type	Total No. Artefacts Recorded	MNH Collection	On Loan at MNH	Other Collections	Wrong Age	NMS Loan	Total No. Artefacts Reviewed
complete stone axe-heads	135	124	5	6	1	4	140
broken stone axe-heads	35	32	0	3	0	0	35
damaged stone axe-heads	19	19	0	0	0	0	19
Total Axe-heads	**189**	**175**	**5**	**9**	**1**	**4**	**194**
stone chisels	6	5	1	0	0	0	6
fragments	16	16	0	0	0	0	16
debitage	4	4	0	0	0	0	4
misc. lithics	14	12	2	0	3	0	17
flint implements	31	30	1	0	0	0	31
shafthole implements*	11	11	0	0	0	0	11
shoe last celts§	3	3	0	0	0	0	3
unknown^	30	30	0	0	0	0	30
Total Artefacts	**304**	**286**	**9**	**9**	**4**	**4**	**312**

Notes:
Figures in grey represent the artefacts excluded after the initial review.
Figures in yellow and blue represent the artefacts included in the statistical analysis of shape classification discussed in Section 3.4.1 (n=186).
Figures in blue represent the artefacts included in the statistical analysis of dimensions discuss in Section 3.4.2 (n=135).
Figures in yellow, blue and green were used for petrological and contextual analysis, see Chapters 4 and 5 respectively, (n=206).
*probably younger than the axe-heads, see text.
§possible manuports, see text.
^artefact known from records or thin sections only.

Figure 3:2b Object Types by Damage

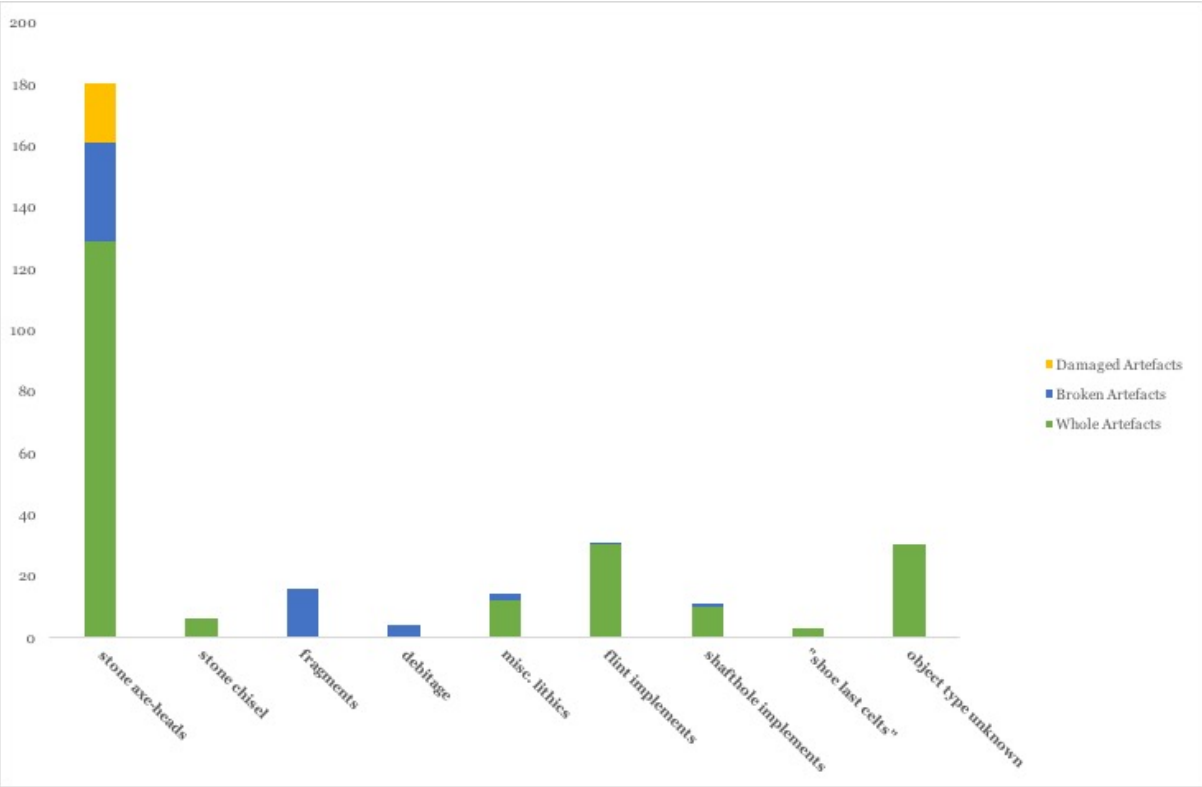


Figure 3:3 Broken axe-head from Billown Quarry Site (Darvill and Chartrand, 2004, p. 18)

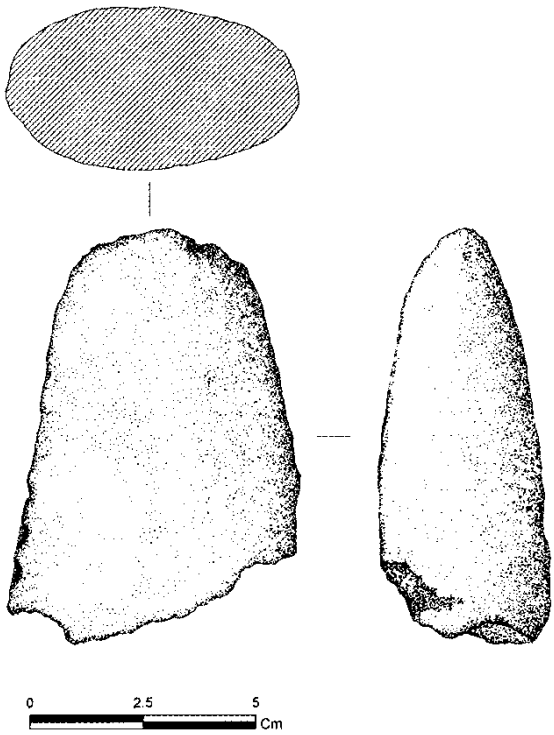


Illustration 11 – Billown Quarry Site. Stone axe from F1222.
[*Drawing by Georgina Wilson*]

Once the stone axe-heads where collated, they were inspected, measured, weighed and organised. Following this, each surface was coded using the latest draft of the standard IPG classification criteria. The colour and condition were also noted, as well as any distinguishing morphological features like roughening, thin sectioning or damage. The apparent relative size (small, medium, large or very large) and the completeness (as a percentage of presumed whole) were also recorded.

None of the artefacts in the Manx collection were reported to have been found hafted; the acidity of Manx soil makes preservation of organic material less likely, and until relatively recently little information could be extracted, especially from small samples or residue, as such antiquarian collectors rarely kept such material for analysis, and many axe-heads have been cleaned. Equally rare in Britain and Ireland, only a handful of hafts have ever been found, one—the Shulishader axe haft—was found on Lewis, in the Outer Hebrides of Scotland with a porcellanite axe- head still in position, see Figure 3:4a. It was radiocarbon dated to the Middle Neolithic c.4470±95 BP (3490–2910 cal BC at 2σ, OxA-3537) (Sheridan, 1992, pp. 198–201). According to Sheridan 'it had been deposited complete but peat-digging had removed its butt part; its extant length is 480 mm and it will have been made from a piece of round wood at least 160 mm in diameter. Of the rosaceous woods, it is most likely to have been made from hawthorn. Most of its surface is covered with adze facets, which may have been left deliberately as a decorative feature. The haft swells towards the top, but has an unexplained deep square cut where the back of the axe-head would have sat, thereby weakening the haft – a sacrifice possibly made to allow the display of the quality of the axe blade' (Brophy and Sheridan, 2012, pp. 96–97). However, across Europe handles were also often made from ash (Louwe Kooijmans and Fokkens, 2008, p. 234; see also Harding and Young, 1978).

Figure 3:4a The Shulishader axe haft, drawn by Helen Jackson for NMS (Brophy and Sheridan, 2012, p. 95)

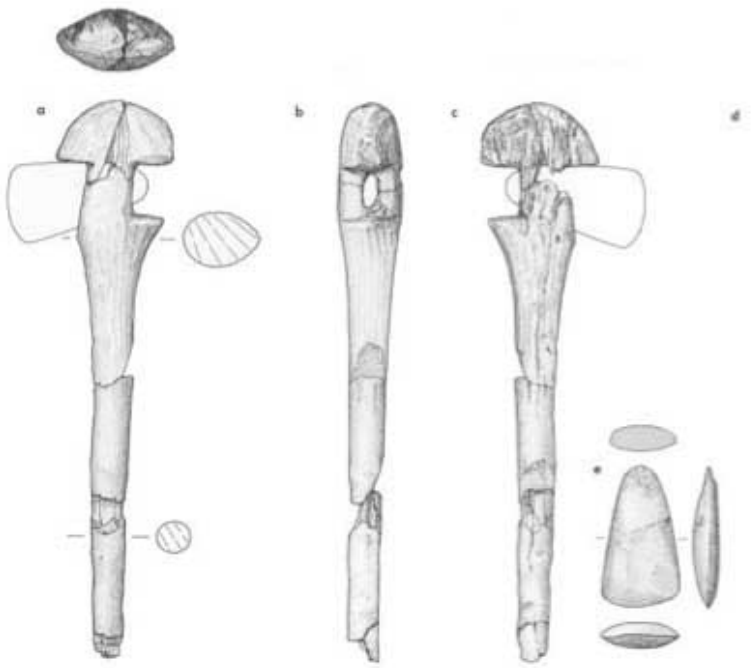
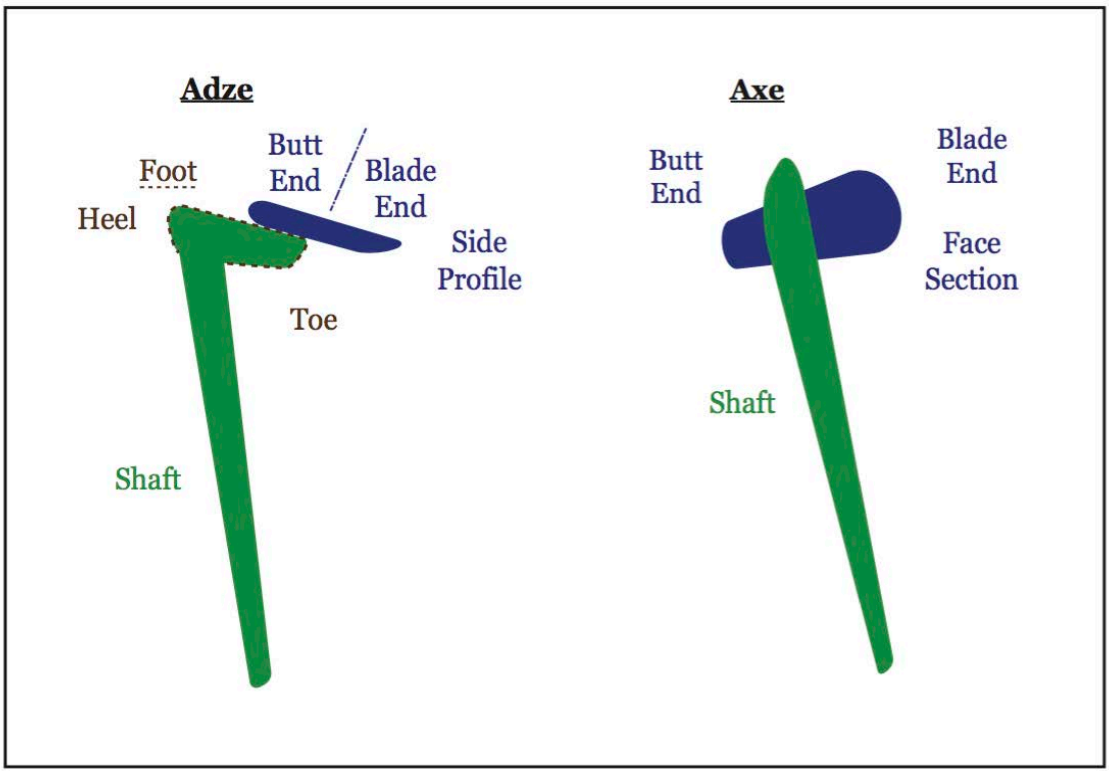


Figure 3:4b The hafting of axe-heads and adze



3.3.1 Axe-heads and Adzes

In Britain and Ireland, a polished stone axe-head is a tool from the Neolithic typically used for chopping wood, with a two sided cutting edge attached in line with a wooden handle (also known as a haft, helve or shaft), whereas an adze is similar to an axe-head but with an asymmetrical cutting edge hafted at right angles to the handle, see Figure 3:4b. These differences represent functional differences; stone axe-heads are better suited to felling trees and splitting wood whereas stone adze can be used to shape wood once it has been felled, as well as function as a hoe to break up soil, all vital elements of land clearance, weeding and tilling. Realistically, over time—and dependent on its petrology—the same stone implement could be reshaped, or shaped through repetitive usage, morphing from a symmetrically bladed axe-head suited to hafting in the plane, to an asymmetrically bladed adze better hafted at right angles, or vice versa.

A detailed analysis of the shape classification of the complete axe-heads/adzes and chisels in the database has been undertaken in Section 3.4 (n=186). Of the six chisels, two have minor damage, but they are all over 150mm in length. Regarding just axe-heads housed at MNH (n=180), the 'complete' category contains the largest number of artefacts (n=129/180, 72%) and includes pristine examples without any signs of damage. However, the boundary between chipped and broken at one end and broken and fragmentary at the other is not as clear as it would seem; some artefacts represent only 20% of the presumed whole, but if that 20% is a well-defined sharp blade with a clean break it is more useful to the general discussion than an unremarkable, dubiously shaped broken axe-head at 50%.

3.3.1.1 Damaged and Broken Axe-heads

When Garrad and Coope proposed that the Museum should have artefacts cut for petrographic analysis in the 1970s they focused on the 'broken and fragmentary' examples. A difference has been maintained in this database between the descriptive terms 'damaged', 'broken' and 'fragment'. Artefacts were either clearly broken stone axe-heads (n=32/180, 18%) missing more than 40% of the presumed whole, for example Artefact 1954-0596a and Artefact 1971-0309-Mx13-C37, see Figure 3:5. Damaged axe-heads (n=19/180, 11%), i.e. 60-95% whole, are generally only missing part of the butt and/or blade end.

The significance of the condition of the axe-heads found on the island ties in to the broader discussion of how to interpret what the state of an artefact meant at deposition and during its *afterlife* (Davis and Edmonds, 2011, p. 5). What damage actually reflects is a subject under scrutiny by experimental archaeologists keen to objectively understand the use-life histories of these artefacts. Replication studies have contributed a great deal to our understanding of the functional aspects of tool use—felling trees, working wood etc., and also attempt to tackle practical issues relating to the time and care needed to create and maintain stone tools (among others see Harding and Young, 1978; Mathieu and Meyer, 1997; Yonekura et al., 2008; O'Neill and Gilhooly, 2015, also Gilhooly, 2012). This is aided by research into cultures with long standing oral history traditions, as well as ethnographic studies of stone tool using communities from the more recent past, for example in the Americas, Papua New Guinea and Australia (Chacon and Dye, 2007; see also Davis and Edmonds, 2011, pp. 2–4; Brumm, 2011, p. 94; Pétrequin and Pétrequin, 2011, p. 337). The deliberate deposition of broken axe-heads in ritualised settings—graves, pits, rivers, etc.—is a recurrent theme that can be extracted from archaeological evidence in many regions (Larson, 2011). Understandably there is no universal

reason for any one ritualised behaviour; instead a variety of interpretations are postulated for the symbolism of these actions. However, the symbolism imbued is largely dependent on the choice of scope, the scale of the interpretations and the social-political circumstances of the researchers and region under scrutiny (Davis and Edmonds, 2011, pp. 2–5).

Nevertheless, context of deposition is a very important factor to consider in parallel with the condition of the artefact. The 'cleanness' of the break is also significant; a stone axe-head's response to pressure is dependent on petrology and morphology. For the damage to be interpreted as deliberate the possibility that it could have been sustained in the action of, for example, cutting down trees, needs to be eliminated. Likewise, the effects of post-depositional weathering need to be considered (see Sections 3.5 and 4.2.2) and the influence it has on current morphology should not be overlooked. As mentioned previously 'broken and fragmentary axe-heads' are disproportionately represented by the thin sections: the majority of the broken axe-heads are thin sectioned (n=23/32 = 72%); collectively sixty-eight percent of the thin sections (n=39) are from broken axe-heads (n=23), damaged axe-heads (n=8) or fragments (n=8). As such, a relatively comprehensive picture of broken axe-heads in the collection is available.

Figure 3:5 Incomplete Axes

Broken:
Artefact 1954-0596a

Broken:
Artefact 1971-0309-Mx13-C37

Damaged:
Artefact 1954-0579

3.3.1.2 Fragments and Debitage

Artefacts classified as fragments (n=16) include both definite axe fragments (including imports of Cumbrian tuff and Irish porcellanite) as well as featureless flakes that may not have been stone axe-heads originally (as Artefact 1971-0210-Mx10-C30, see Figure 3:6). However, most of these fragments have at least one obviously worked face or cutting edge and are likely to be either incomplete, unfinished or reworked stone axe-heads. Many were labelled as 'utilised' or 'worked stone' in the museum records, i.e. Artefact 1954-3651 — a rough fragment with a fine worked blade, see Figure 3:6. This artefact has been thin sectioned and appears to be made from Irish porcellanite, it was probably originally an axe/adze, or a fragment chipped from a larger implement. Two other artefacts of particular interest are Artefact 1954-0611 and Artefact 1954-1130-Mx44-C38; they are very similar, large and rounded, presumably reworked as hand-held blades from broken axe-heads. These are also shown in Figure 3:6, as is Artefact 1971-0210-Mx15-C40 which was one of many artefacts found by fieldworker C.H. Cowley in the west of the Island (Garrad, 1978). It was thin sectioned by Larch Garrad, who believed it was likely to be a natural fragment, made of Ailsa Craig micro-granite; by implications this could make it erratic material. However, the overall shape suggests to this researcher that it could have been deliberately shaped at some stage. It would be interesting to confirm Ailsa Craig as a source for stone axe-heads in other regions, especially finds further from the natural glacial drop zone. More obvious debitage from imported rocks (n=4) include an unlabelled porcellanite fragment, a thin sectioned but unprovenanced siltstone fragment and two pieces of Cumbrian tuff (n=2).

Figure 3:6 Reworked Stone

Artefact 1954-0611

Artefact 1954-1130-Mx44-C38

Artefact 1954-3651

Artefact 1971-0210-Mx15-C40

Artefact 1971-0210-Mx10-C30

3.3.2 Chisels

Large heterogeneous implements, with narrow profits and short blades, have been classified as chisels by Museum curators (n=6). There is no other information regarding Artefact 1954-2621 in the records but Artefact 1971-0200-C07, the longest artefact in the collection, is part of the Cowley collection and was given to the fieldworker by the Christians family who found it in the field below the Haggart at Ballagyr, in German. Four other long and narrow artefacts are Artefact 1954-21399, Artefact 1954-5885, Artefact 1954-6836 and Artefact 1964-0230. Artefact 1954-2621 has a very square cross sections (CS18 'Sub-Rectangular'), while the others are all much more rounded (CS01 'full oval' (n=2), CS08 'Oval Faceted Sides'(n=1) and CS09 'Narrow Oval' (n=1), see Figure 3:7. All of them are classified as FS04 'Straight Parallel Sides', with the exception of Artefact 1954-6836, which has Straight Splayed Sides, FS03. Petrological, two chisels are recorded as Cumbrian tuff (n=2), three are dolerite (n=3) and one is basalt (n=1).

Figure 3:7 Chisels in the Manx Museum collection

Artefact 1954-2621

Artefact
1971-0200-C07

Artefact
1954-21399

Artefact
1954-6836

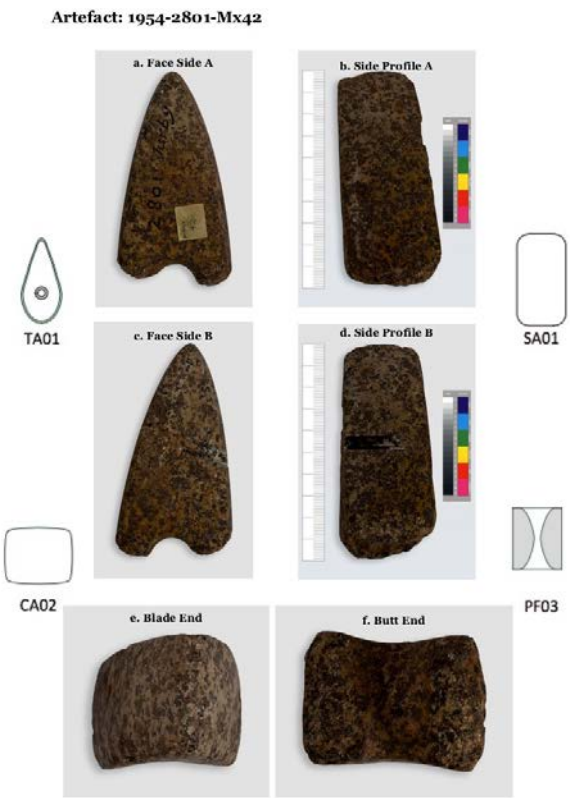
Artefact
1964-0230

3.3.3 Shafthole Implements

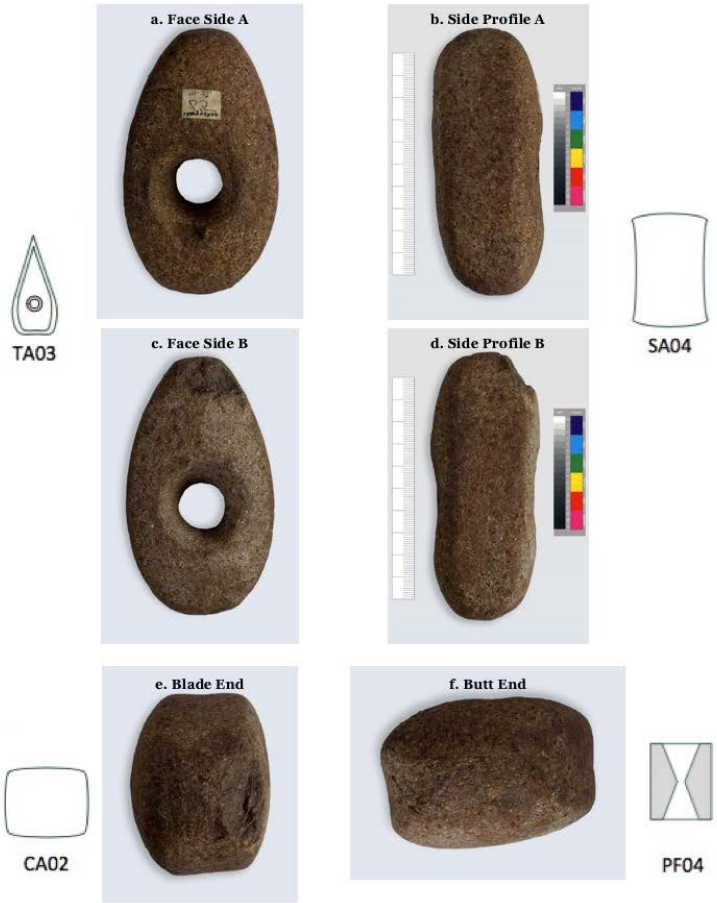
As mentioned previously, the IPG also designed dedicated shape classification standards for the study of the morphology of 'shafthole implements' i.e. perforated implements, that have been found in the United Kingdom. According to the 2015 draft of these standards (Davis, 2015, p. 8): the 'distinction of battle-axe and axe hammer is a matter of size and quality. Axe hammers are normally more than 180mm long and/ or 90mm wide and are clumsily made. Maceheads have cylindrical perforations and are finely finished. Shafthole adzes have one clear blade; hammers do not' (Davis, 2015). There are eleven (11) Shafthole Implements that have been treated separately from the stone axes, excluded from the general data analysis because they are likely to be younger. One example (Artefact 1954-2801-Mx42) was found in Jurby and is broken across the shaft hole. At some point a replica butt end has been made for display. The implement has been thin sectioned and is made of a coarse weathered speckled grey granitic rock composed of quartz and hornblende: a diorite, coarser and more even grained than any example classified as Group XXV, see Chapter 4. The remaining fragment is approximately 90 mm in length and 45 mm width at maximum and following the IPG classification it would be considered as top view 'TA01 Narrow Raindrop', cross section 'CA02 Rounded, Square' and side view 'SA01 Straight; Faces Parallel' see Figure 3:8. Although broken, the shape of the perforation is visible — it is convex, a slightly hour-glass shape, with an approximately 20 mm diameter described by one of the IPG's perforation classifications, P03. Another example found at Lhergydhoo (Artefact 1971-0201) has been classified as TA03 'Raindrop with flattened butt', SA04 'Faces Slightly Concave', CA02 'Rounded, Square', and PF04 'Hour-glass, Angular'. Two of the artefacts classified as Shafthole Implements were reportedly found in a cist; one from Spanish Head, Rushen (Artefact 1954-2781) that was found with a number of other artefacts

and is potentially a reused axe. The other was found at Knockaloe, Patrick (Artefact 1954-0593) where a hoard of axeheads was also found separately in the vicinity (see Chapter 5). The Knockaloe example has a cylindrical perforation, PF01, one face is fat, the other is convex longitudinally and transversely. The Spanish Head artefact is exceptionally long and the perforation is incomplete. It does not conform to any of the categories defined by the IPG for Shafthole Implements (see Figure 3:9), but instead could be categorised using the IPG axe shape classification, with the addition of a partial PF04 angular hole near the butt end. Of the remaining Shafthole Implements, four have contextual information: one was found in Foxdale (Artefact 1954-0617), one at Gat-y-Whing, Andreas (Artefact 1965-0017), and one at Ballakilley, Rushen (Artefact 1980-0406). Artefact 1958-0015 could not be relocated, and is only known from MNH records.

Figure 3:8 Manx Shafthole Implements



Artefact: 1971-0201-C65



Artefact: 1954-2781

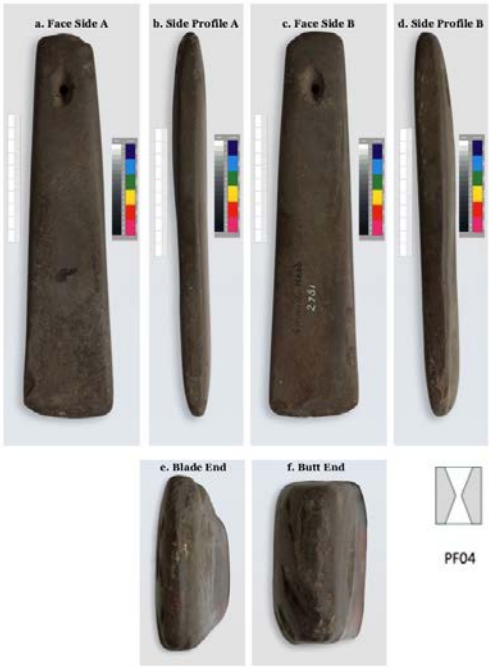
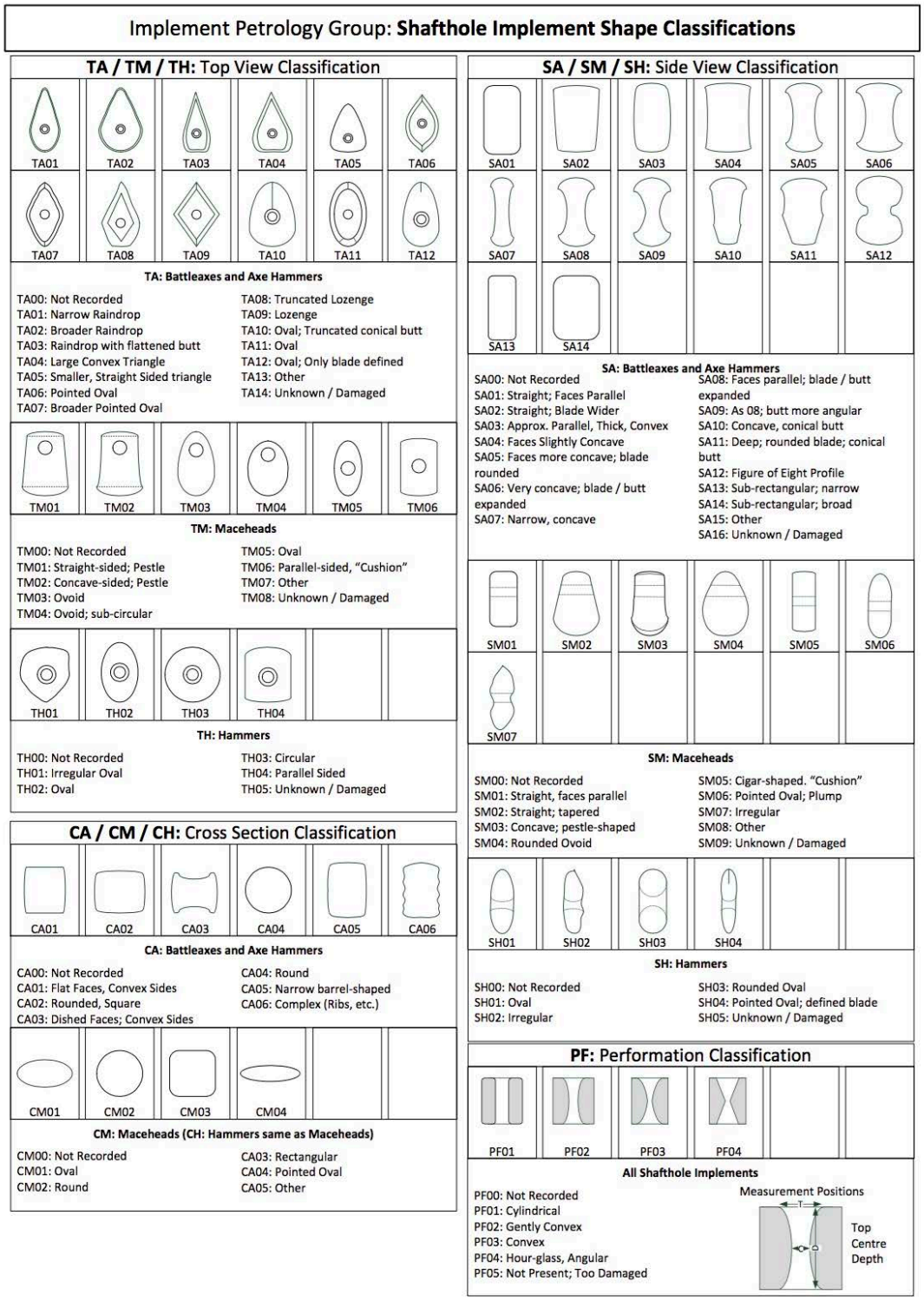


Figure 3:9 IPG Shafthole Shape Categories



3.3.4 Flint Implements

As mentioned by Darvill (1989) and Davis (2015) historically a difference between 'non-stone' and 'non-flint' has meant that rarely have heterogeneous and homogenous lithic implements been analysed collectively. This project focuses on the heterogeneous (non-flint) axe-heads found on the Island but an appreciation that homogenous (non-stone) axe-heads have also been found in the collection is equally important.

While there are no primary deposits of flint on the Island, flint and cherty material can be found as beach pebbles along the coast, particularly in the north of the island, and it can be noted that flint implements appear to have been an integral part of a diverse lithic tool kit in Manx prehistory (Garrad, 1978b). However, it was decided that flint implements require a comprehensive study in their own right because at present there is large amount of unsorted flint material at the Manx Museum. Nevertheless, thirty-one flint axe-heads were located in the Manx Museum archives during the course of this study, including one on loan (n=31). A selection of them are shown in Figure 3:10. A further three examples are known from private collections, indeed there are certainly many more unrecorded. A detailed studied of the unsorted flint material in the Manx Museum collection is highly desirable. Likewise, a detailed study of the geochemistry of both flint implements and potential sources in Britain and Ireland is needed, as well as research into the distribution of erratic and glacial flint nodules in the Irish Sea region. Collectively, this would allow the Manx prehistoric flint collection to be placed in a much broader context.

Figure 3:10 Flint Implements

Artefact Flint 1954-0094

Artefact Flint 1954-0631

Artefact Flint 1954-1140

Artefact Flint 1954-1148

Artefact Flint 1954-1653

Artefact Flint 1965-0001-04

Artefact Flint 1975-0113

Artefact Flint 3

Artefact Flint 5

Artefact Flint 6

Artefact Flint L21888c

Artefact: Flint 1985-0007

Artefact Flint 1

Artefact Flint 4

Artefact Flint 1965-0001-01

Artefact Flint 1954-1943

3.3.5 Miscellaneous Lithic Artefacts

There are two interesting miscellaneous lithic artefacts that are certainly imports. Artefact 1966-0369 is very small, axe-head shaped and has a chalky white patina, similar to some of the Group VI examples. It was found in the curragh mollagh (i.e. rough wetlands), in Andreas but does not really appear to have been worked although this may be due to weathering. It is worth mentioning because if it is made of Group VI, it would still be considered an item of interest even if it has not been worked. Similarly, a single undecorated and slightly elongated item that appears to have been used as a pounder, was found at Bellavista, Douglas in the Parish of Braddan, in the Sheading of Middle. It is made of IPG Group IX porcellanite, and is polished and pecked with minimal weathering.

In addition to Artefact 1966-0369, three other examples have been singled out as potentially natural, rounded pebbles (n=4), see Figure 3:11a. Artefact 1954-1304 is composed of a yellow grit, found in Lonan by the Reverend Canon John Quine and again has a strikingly familiar shape, but no evidence that it has been worked except some minor damage near the very blunt 'blade end'. Artefact 1954-0300 appears to be a natural pebble with an eye-catchingly straight breakage and a vague, rounded blade end shape. Finally, the reason for the collection and cataloguing of Artefact 1985-0020a labelled 'Axe Heads + !?!' 'field of the Monoliths' 'near Oak Hill Entrance to Marine Drive !?! 21st Sept 1919' '60-7F' remains a mystery as no other information has been found relating to its discovery or classification; it appears to be just a flat water rounded pebble. However, if the unintelligible word on the label refers to this item, then the actual associated stone axe-head is missing.

These artefacts, previously classified as stone axe-heads now considered unworked, have been treated as miscellaneous lithic along with more obvious worked lithics

(n=14). For example, Artefact 1960-0007, shown in Figure 3:11, which does not have a notable blade end but appears to be deliberated faceted all around the edges. Furthermore, there are five interesting incised slabs that were included in this review (n=5). The museum records state that Artefact 1954-2918a, a 'slate stone' was found at some point in Ballalargy, Patrick, by William Dodd and a 'curiously-shaped flat slate' (Artefact 1954-2783) approximately 84 mm in length but broken, was found by the Keggin family in the 1870s, at 'the highest field up' on Spanish Head in a burial cist along with the partially perforated implement, Artefact Shafthole Implements 1954-2781, mentioned in Section 3.3.3 above.

Two small miscellaneous Manx Group meta-sedimentary slabs on long term loan to the museum (Artefact L21888a and Artefact L213888b), referred to in the records as 'oddly shaped pieces of slate', were reportedly found in May 1985 alongside a beautiful IPG Group XXV RTBA axe-head (Artefact L21388) while mechanically digging a pond downstream of Fairy Bridge in Malew. This is not far from both the Ronaldsway type site which is closer to the coast at Castletown (@54.085604, -4.6230769) to the south, or the Oatlands area of Santon (@54.120935, -4.5675000), the potential IPG Group XXV source, which is towards the north east. Interestingly, at the Ronaldsway type site two more incised slate plaques, also made from meta-sedimentary Manx Group rocks, were found by Bruce at the rescue excavation that originally defined the Ronaldsway Culture in the 1940s. Likewise, at Oatlands two axeheads, as well as Artefact 1954-0299 (a small perforated implement, or whorl) and a pounder were found when the granitic quarry site was prepared. They were associated with a 'circle' or 'hut' c.1900 - see also Artefacts 1954-0600, 1954-0620 and 1954-0591. A flint axehead (IOMMM 1653) that was given to the Museum by R. Lace may also be associated with these finds.

A publication on all these slates by Andrew Johnson and Rachel Crellin is pending; they recently organised to have slates photographed by Reflectance Transformation Imaging (RTI) and for the first time the markings are clearly visible. According to Crellin, 'there are multiple layers on top of each other and more interestingly they have grinding to remove earlier marks and the top edge has been worked to a narrow point (like a blade edge...) on some of them' (Crellin, pers. comm.).

As can be seen in Figure 3:11b, Artefact 1966-0398, is approximately 85 mm long, 34 mm wide and made of a dark grey fine grained rock. It is smooth with a faceted notch at one end giving a leaf-or heart shaped appearance. Defined and illustrated by Kermode in the Manx Museum's Accession Register III its function, if it had one, is unknown. Another artefact (Artefact 1954-2918b) originally recorded in P.M.C. Kermode's Register, described as a 'utilised tabular block' with 'wear on edges', is overall 110 mm long by 55 mm by 12.5 mm and considered possibly associated with a shieling site in Dreemlang, Marown.

Figure 3:11a Natural Stone

Artefact 1966-0369

Artefact 1954-1304

Artefact 1954-0300

Artefact 1985-0020a

Figure 3:11b Miscellaneous Lithic Implements

Artefact 1960-0007

Artefact (Stone Pounder) 1

Artefact 1966-0398

Artefact 1971-0208-Mx12-C35

3.3.6. Manuports

There are three implements defined as 'Shoe Last Celts' in the Museum literature (n=3). Artefact 1954-2918 and Artefact 1980-0223 are shown in Figure 3:12, there are no photographs for the third implement, Artefact 1985-0114. The form of these implements is very similar to European forms so care must be taken when judging whether they truly represent part of the spectrum of implements used on the Island in the 4th millennia BCE.

For the 6th and 5th millennia, Schuhleistenkeilen (aka 'shoe last celts'), largely amphibolites, are a diagnostic tool of the LBK in central and north west Europe. Unlike axeheads, they were hafted with their blade at right-angles to the haft. The examples in Figure 3:13, both unperforated and perforated, are from Germany and look similar to some of the Manx examples. Since this specific artefact type does not appear in Britain and Ireland, it seems very likely that the Manx 'Shoe Last Celts' represent recent manuports from a collector who had acquired them from the Continent (Přichystal, 2015 and Sheridan, A. pers. comm.). The possibility that these are unique Manx example is small but not entirely implausible, as some do have contextual data available, see Chapter 5.

In Europe, the sheer variety of lithic implement styles has led to regional classification schemes with differences in nomenclature evolving over time. In the terminal Mesolithic-Early Neolithic Linearbandkeramik Culture (LBK) and post-LBK traditions (c. 5300-4000 cal BCE) of the Lower Rhine Basin the distinction between tool types like 'flat adze' (Flachhacke) and 'shoe last adze' (Schuhleistenkeile ' lit. 'Shoetree wedges') (also known as 'high adze') varies due to width:thickness ratios, with flat adzes being wider than thick, see Figure 3:13a (Verhart, 2012). These artefacts are 1000 years older than the Manx examples but show remarkably similar forms. Excluding petrology, the size (length:width:thickness ratios) and shape,

particularly the symmetry of the blade, treatment of the butt and presence/absence of perforations, are often the only discernible differences in object type once an artefact has been removed from context; so although it will forever remain an idealistic scenario, the simplification and standardisation of classification criteria is essential if confusion is to be avoided. At the very least an awareness of the nuances in nomenclature by region is important.

Figure 3:12 'Shoe Last Celt' in the Manx Museum collection

Artefact 1954-2918

Artefact 1980-0223

Figure 3:13a Early Neolithic Axes from the Lower Rhine Basin

Figure 1 Adzes can be divided in two main groups: when width exceeds thickness they are named flat adzes (Flachhacke) (left); when thickness exceeds width they are called shoe-last adzes (Schuhleistenkeile), or high adzes (right). Scale 1:1 (after Bakels 1987, Figure 1. Photo Faculty of Archaeology, Leiden).

Top: from Verhart (2012) fig.1p.7

Below; German Schuhleistenkeilen or 'shoe last adze' (Sheridan, pers.comm.)

Regarding roughened examples of unusual morphology (excluded from statistical analysis), there is are clear similarities between two of very large examples, both flaked deliberately across the butt half and along the edges with splayed sided, see Figure 3:13b. One of them, according to R.B.K. Stevenson in 1955, is from New Zealand (MNH-L 1954-0456) and part of the loan from National Museum of Antiquities of Scotland, this suggests that the other unprovenanced example is likely to be a manuport. As with any collection, the reliability of any interpretations based on morphological analysis depends on the veracity of the contextual data available.

Figure 3:13b Unusual Roughening

National Museum of Antiquities of Scotland Loan (MNH-L 1954-0456)

unknown provenance (MNH 1954-0230)

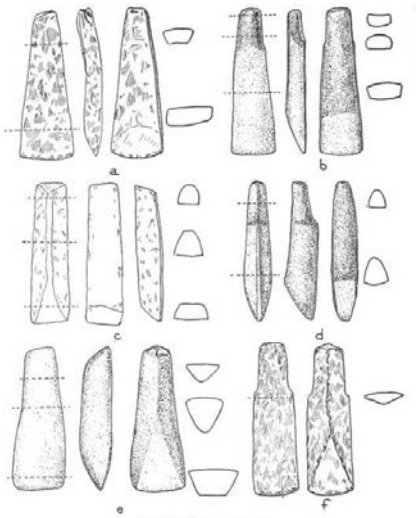


Fig. 36. Adze subgroups.
a, quadrangular, untanged; *b*, quadrangular, tanged; *c*, triangular, untanged; *d*, triangular, tanged; *e*, inverted triangular, untanged; *f*, inverted triangular, tanged.

Image of 'Figure 36 Adze subgroup' from the New Zealand Electronic Text Collection, The Coming of the Maori by Te Rangi Hiroa (1949)

3.3.7. Replicas

There are two RTBA plaster-cast replicas in storage with the Manx Museum's axe-heads (Artefact 1976-0016-17 and Artefact Plastercast 1976-0016-18), see Figure 3:13. These are thought to have been made by Larch Garrad in 1976 during her initial inspection of the axe-heads but no records exist to explain them, and they are not mentioned in her correspondence.

None of the artefacts are confirmed replicas but antiquarian replication, modern models and even forgery cannot be discounted. Similarly, stone axe-heads could have been made at any point since prehistory, so without exact contextual data it is difficult to confirm they were all made during the 4th millennia BCE, although it remains highly likely in many case, especially those artefacts from identified areas of prehistoric activity, found in the vicinity of other datable finds.

Figure 3:14 Replicas

Artefact 1976-0016-17

Artefact 1976-0016-18

3.4 The Morphology of Polished Stone Axeheads on the Isle of Man

Manx axe-heads display a spectrum of shapes and sizes, were possible these shapes have been categorised using the ISAP/IPG shape classification criteria. The axe-heads have also been weighed and measured, and observations regarding the surface treatment, condition and weathering of each axe-head has been made where possible. Below, these physical attributes are first outlined before being discussed in relation to petrology and context.

3.4.1 Shape Classification

There are six shape categories: face shape, blade shape, cutting end shape, butt shape, profile shape and cross section shape. For damaged and broken axe-heads, the ability to accurately classify shape is dependent on extrapolating the presumed whole. In two cases, the artefacts consist of only the very tip of a well-defined blade end (Artefact 1978-0114-Mx46 and Artefact 1971-0309-Mx13-C37); although clearly axe-heads they were deemed too small to infer anything regarding overall shape. Similarly, damage affecting large areas of both faces and/or sides, and multiple chips or flakes at the blade and butt ends obviously obscure the intended outline, making accurate classification very difficult.

Only whole axeheads/adze and chisels, some with minor damage, were used in the statistical analysis of dimensions, however, the broken and damaged axe-heads were included when possible for each shape category (see Figure 3.2a). Even so, it was still difficult to accurately classify some of the artefacts because familiarity with the collection as a whole increased as the project developed, which led to reclassification that was in part based on new data, but primarily due to a gradual appreciation for the nuance inherent within each category. In particular, there were issues with the accuracy of the face shape and blade end criteria which has led to a simplified shape classification, discussed in more detail in the Sections 3.4.1.1 and 3.4.1.2. Naturally

combining all six shape categories gives a much fuller appreciation of the overall shape than any given attribute alone.

3.4.1.1 Face Shape

All artefacts studied were ascribed to one of the fourteen face shape [FS] categories summarised in Figure 3:15a (n=186). In Ireland, ISAP considered face shape the primary morphological parameter (Cooney and Mandal, 1998, p. 44) and used six categories: ISAP FS01 'Ovate Symmetrical', ISAP FS02 'Asymmetrical', ISAP FS03 'Straight splayed sides', FS04 'Straight parallel-sided' and FS05 'Oblique butt', with the notable exception of FS02, they remain largely unchanged with the IPG update. ISAP FS06 'Any other' is comparable to IPG FS14 'Other'. In some new categories, like IPG FS08 'Symmetrical Tapered Flat Blade and Butt', the butt end is involved in the face shape classification. The remaining IPG additions are more specific (e.g. FS12 'Cumbrian Club').

Few categories are straightforward and easy to identify with little internal variation between examples. The easiest examples to identify were FS04 'Straight Parallel Sides' (n=18) (including five of the six chisels) and FS09 'Approximately Triangular' (n=37). Others, like FS12 'Cumbrian Club' (n=1) and FS05 'Slightly Tapered Oblique Butt' (n=5), are very distinctive and clearly defined, they also stand out because they represent a limited number of axe-heads in the collection as a whole. However, for several reasons most axe-heads were more difficult to assign; the difference between IPG FS01 'Perfectly Symmetrical Ovate' and FS02 'Virtually Symmetrical Ovate' is highly subjective. In Ireland, the definition of FS02 differs from the later IPG category and fits better the Manx findings; in ISAP, FS02 was defined as 'axes with one side convex in shape and the other straighter with an asymmetrical cutting edge' (Cooney and Mandal, 1998, pp. 16–17). It is the most common face shape in the Irish collection, where two distinctive subgroups were determined: FS02/01 have rounded

or pointed butt ends with the thickest point of the profile just above the blade area, and FS02/02 are small and stocky, comparable to Darvill classification of 'wedges' for Wales and mid-West England (Darvill, 1989, p. 31).

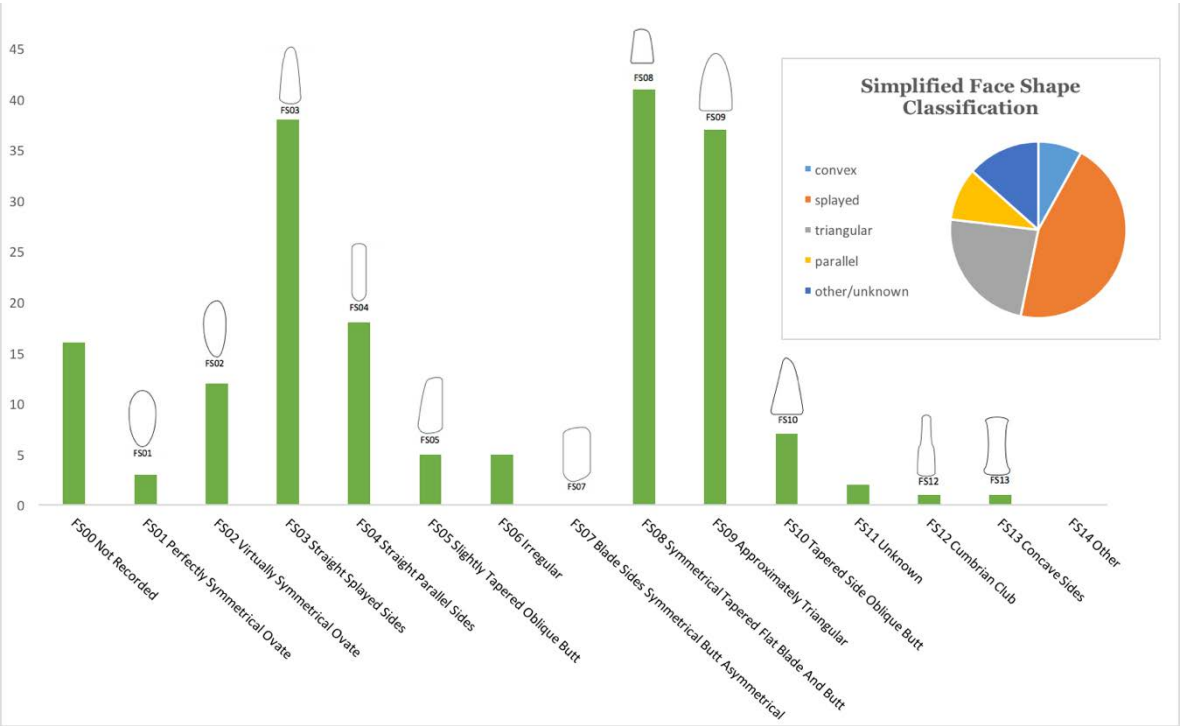
Erring on the side of caution, only a few (n=3) were classified as FS01, they are symmetrically ovate however the butt end is generally flat rather than rounded as expected from an ideal FS01; one of them is definitely missing the butt end and another appears to have been reworked from a larger implement. None of the complete FS01 examples were over 240mm, (cf. 6% in Ireland (Cooney and Mandal, 1998, p. 51)). More Manx examples (n=12) were considered FS02 'Virtually Symmetrical Ovate' because the faces curved unevenly inwards at both ends, one of them is broken and badly weathered. The defining face shape feature of both FS01 and FS02 is the convex curve giving a bulbous overall impression.

Four categories denoting splayed/tapered sides with various blade/butt shape combinations—namely, FS03 'Straight Splayed Sides' (n=38), FS05 'Slightly Tapered Oblique Butt' (n=5), FS08 'Symmetrical Tapered Flat Blade and Butt' (n=41) and FS10 'Tapered Side Oblique Butt' (n=7)—do not, in the Manx collection, satisfactorily define the variations seen in the relationship between splayed/tapered sides and the shape of the blade and butt. Within each of these groupings symmetrical tapered sides are paired with a variety of different blade and butt shapes, and there is significant variation in the impression of any given form. This is largely due to differences in length, profile thickness and blade/butt shape. For example, the small stocky examples that could be classified as wedges in Darvill's classification system (or ISAP FS02/02) have splayed sides (FS08) in the Manx collection.

As such, after analysis the key feature of the Manx face shapes in isolation appears to be whether the sides are parallel or splayed. If the shape of the blade and butt is ignored, and similar face shape categories are combined to simplify matters, most

axe-heads (excluding FS06 'irregular' (n=5), FS12 'Cumbrian Club' (n=1) and FS13 'Concave Sides'(n=1)) can be classified broadly as **convex** (FS01 and FS02 (n=15)), **parallel** (FS04 and FS07 (n=18 of which interestingly half (n=9) are cleanly broken), **splayed** (FS03, FS05 and FS08 (n=84)) or **triangular** (FS09 and FS10 (n=44)). As is to be expected there is considerable grading from one category to the next, in particular with splayed and triangular axe-heads; specifically, when a rounded butt end accompanies splayed sides it gives the illusion of a triangular shape that is less apparent when the blade or butt end is flat or oblique. Similarly, the concave axe-heads represent a relatively incongruent collection encompassing a range from narrow elliptic to broader ovate, in a range of lengths. Several of them appear to have been reworked or damaged suggesting that their rounded nature overall was not necessarily predetermined. In contrast, the parallel axe-heads are generally more consistent in form even though the majority are broken.

Figure 3:15a Artefacts by Face Shape



	No. Artefacts	
FS00 Not Recorded	16	9%
FS01 Perfectly Symmetrical Ovate	3	2%
FS02 Virtually Symmetrical Ovate	12	6%
FS03 Straight Splayed Sides	38	20%
FS04 Straight Parallel Sides	18	10%
FS05 Slightly Tapered Oblique Butt	5	3%
FS06 Irregular	5	3%
FS07 Blade Sides Symmetrical Butt Asymmetrical	0	0%
FS08 Symmetrical Tapered Flat Blade And Butt	41	22%
FS09 Approximately Triangular	37	20%
FS10 Tapered Side Oblique Butt	7	4%
FS11 Unknown	2	1%
FS12 Cumbrian Club	1	1%
FS13 Concave Sides	1	1%
FS14 Other	0	0%
Total Artefacts Studied	**186**	

Figure 3:15b below compares the simplified face shape groupings of complete axe-heads and chisels in the Manx collection (n=135) with data for the Irish collection (n=3538). It shows that the majority of Irish artefacts have an asymmetrical face shape (ISAP FS02 c.60%), whereas there the range of shapes in the Manx collection is generally more diverse, including a higher proportion of triangular (24% cf. <10%) and parallel (10% cf. c.2.5%) face shapes. In addition, in Ireland it was discovered that a quarter of axeheads categorised as FS05 'Oblique Butt' were less than 80mm in length. A review of the five Manx FS05 axe-heads found one was 81.2mm; the rest however range from 124mm to 170mm in length.

Figure 3:15b Comparison of Face Shapes in the Manx and Irish collections

Percentage of whole Manx axe-heads/chisels in simplified face shape categories (n=135)		Percentage of whole Irish axe-heads/chisels in ISAP face shape categories (n=3538) (Cooney and Mandal, 1998, pp. 44–45)	
convex	8%	c.7%	FS01 Ovate Symmetrical
splayed	45%	c.70%	FS02 Asymmetrical (c.60%) FS05 Oblique Butt (c.10%)
triangular	24%	<10%	FS03 Straight Splayed Sides
parallel	10%	c.2.5%	FS04 Straight Parallel Sides
other/unknown	13%	c.10%	FS06 Any Other

3.4.1.2 Blade Shape and Cutting Edge

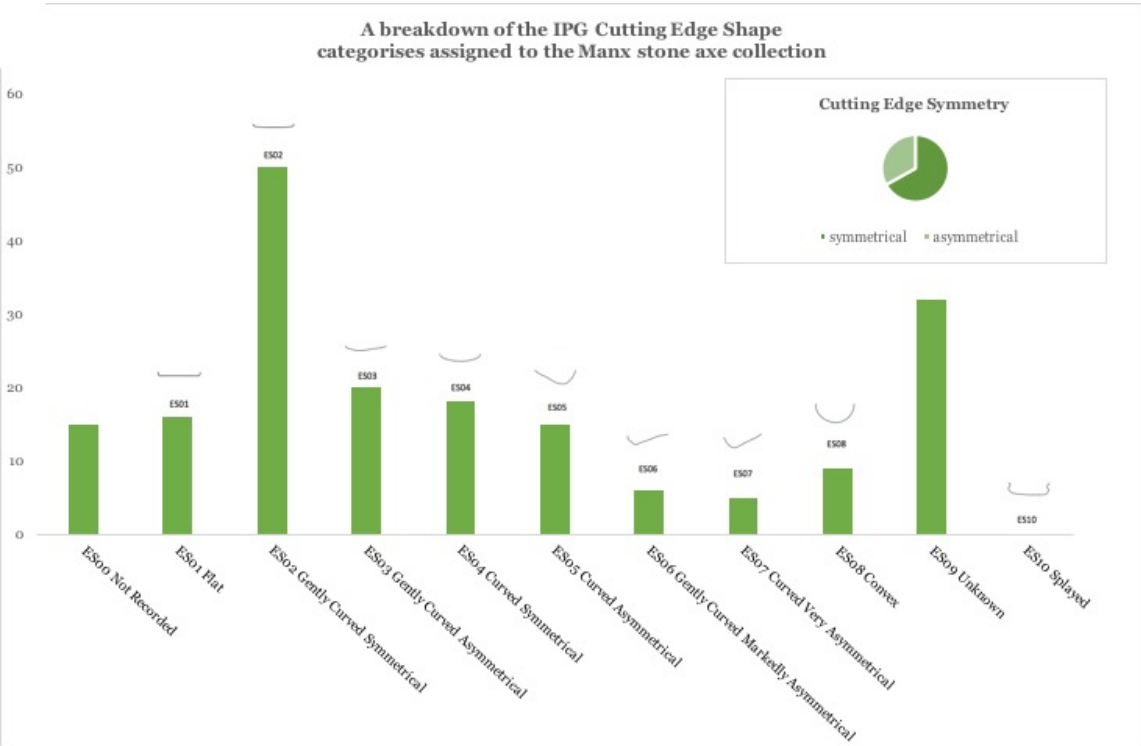
The blades were coded using two IPG shape categories (Cutting Edge Shape [ES]) and Blade Shape [BS]). As the name suggests, 'Cutting Edge Shape' considers the long edge of the blade and was a relatively straight forward way to classify the artefacts, based on the degree of symmetry and curvature of the blade from the central point. Obviously, damage to the blade limited the extent to which either category could be assigned, but minor chips generally did not affect the classification when the overall outline was visible. However, in some cases damage rather than intent is likely to have caused asymmetry. Whether this damage relates to the way in which the artefact was used, or occurred post-deposition is a matter for debate and each axe-head needs to be considered individually. Twice as many artefacts had symmetrical cutting edges (n=93/186, 50%) than asymmetrical (n=46/186, 25%) whereas in Ireland 63.2% have asymmetrical or markedly asymmetrical edges (included ES03 (34.4%), and ES04[1], ES06 plus ES07 collectively 28.8%) (Cooney and Mandal, 1998, pp. 45–46).

Of the symmetrical blades, a gentle curve (ES02) was more dominant in the Manx collection as a whole (n=50/186, 27%), see Figure 3:16 below. However, as was the case with FS01 and FS02 when examining face shape, the difference between ES05 'Curved, asymmetrical' (n=15) and ES7 'Curved; very asymmetric' (n=5) is very subjective. Similarly, separating examples of ES01 'Flat' (n=16) from ES02 'Gently Curved, Symmetrical' (n=50) casually depends on overall length and face shape. ES01 'flat' is a broad-ranging category encompassing all long, narrow artefacts defined as chisels (n=6), as well as a subset of small triangular axe-heads and adzes (i.e. those examples asymmetrical in profile), and several large examples are

[1] Confusingly, ISAP ES04 'Curved: Asymmetrical' is equivalent to IPG ES05 'Curved: Asymmetrical', and ISAP ES05 'Curved: Symmetrical' is the same as IPG ES04 'Curved: Symmetrical'. Therefore, it is worth noting that when comparing symmetrical edge shapes with Ireland the direct comparison is ISAP ES05 (8%) vs. Manx IPG ES04 (10%).

discussed in more detail below. Again, it is difficult to gauge an accurate measure of how deliberate the symmetry appears, but when considered in parallel with the overall face shape, it would seem that triangular and parallel-sided axe-heads often have flatter or more asymmetrical blades, whereas convex and splayed axe-heads generally have rounded symmetrical blades.

Figure 3:16 Cutting Edge Symmetry



	No. Artefacts	
ES00 Not Recorded	15	8%
ES01 Flat	16	9%
ES02 Gently Curved Symmetrical	50	27%
ES03 Gently Curved Asymmetrical	20	11%
ES04 Curved Symmetrical	18	10%
ES05 Curved Asymmetrical	15	8%
ES06 Gently Curved Markedly Asymmetrical	6	3%
ES07 Curved Very Asymmetrical	5	3%
ES08 Convex	9	5%
ES09 Unknown	32	17%
ES10 Splayed	0	0%
Total Artefacts Studied	**186**	

Symmetrical (n=93)

ES01 'Flat' (n=16)

ES02 'Gently Curved Symmetrical' (n=50)

ES04 'Curved Symmetrical' (n=18)

ES08 'Convex' (n=9)

Asymmetrical (n=46)

ES03 Gently Curved Asymmetrical (n=20)

ES05 Curved Asymmetrical (n=15)

ES06 Gently Curved Markedly Asymmetrical (n=6)

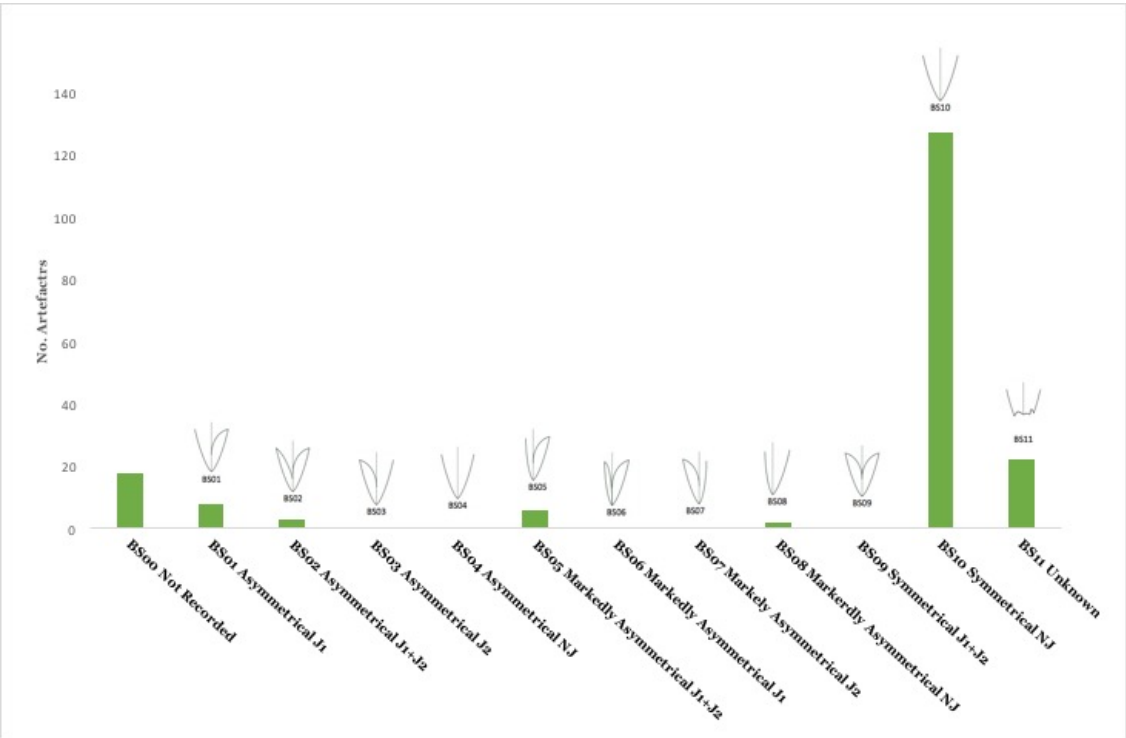
ES07 Curved Very Asymmetrical (n=5)

The Blade Shape [BS][2], i.e. how the blade is viewed in profile, was more difficult to assign. The majority were classified as BS10 'Symmetrical' (n=127/186, 68%), see Figure 3:17. In Ireland, BP10 'Symmetrical' is used for only 18% of the complete axe-heads, whereas BP4 'Asymmetrical' is more common (33.5%). Collectively the asymmetrical codes (BP01, BP02,BP03 and BP04) were assigned to 60.8% of the Irish collection—although only 2.1% are 'markedly asymmetrical' (i.e. BP05, BP96 BP07 and BP08). For the Manx collection, 6% are asymmetrical (BS01, BS02, BS03 and BS04) and a further 4% are 'markedly asymmetrical' (BS05, BS06, BS07 and BS08). However, the diagrams that define the classes do not seem to represent the range of shapes seen at the junction between the blade and the long edges. Although often symmetrical in profile, the ends of the blade in some cases merge with the edges and 'rounded off' (n=20); however, in many others examples (n=31), the blade ends at an abrupt angular contact with the edges, often deliberately flatten, see Figure 3:17a. As noted by ISAP 'a distinct junction is likely to be a deliberate feature rather than a result of wear' (Cooney and Mandal, 1998, p. 21). There were few examples that were clearly asymmetrical in the Manx collection (n=19) and only three (n=3) that could be classified as adze, see Figure 3:18a.

Another feature of the blade end is sharpness, see Figure 3:18b. Most examples were rounded at the blade (n=80), but even when combined, there are slightly more sharp blades (n=35) than blunt or badly chipped blades (n=33). Minor damage occurs even on sharp blades suggesting the majority of artefacts in the collection were used at least to a limited extent.

[2] The IPG code blade shape with 'BS', whereas ISAP referred to blade profile 'BP' to describe the same term.

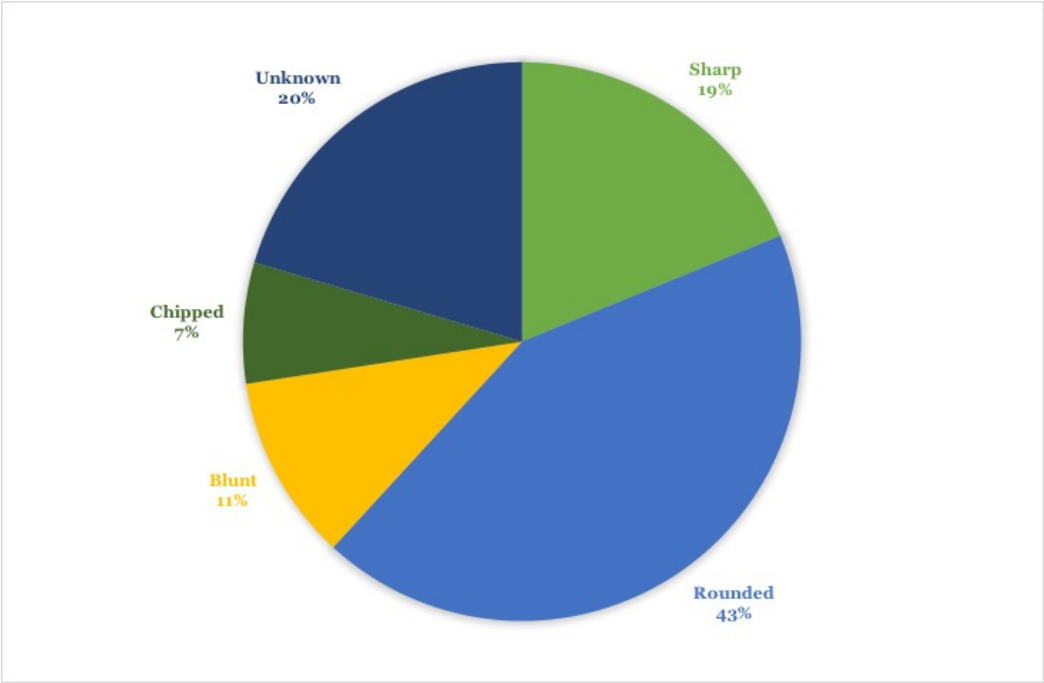
Figure 3:17 Artefacts by Blade Shape



	No. Artefacts	
BS00 Not Recorded	18	10%
BS01 Asymmetrical J1	8	4%
BS02 Asymmetrical J1+J2	3	2%
BS03 Asymmetrical J2	0	0%
BS04 Asymmetrical NJ	0	0%
BS05 Markedly Asymmetrical J1	6	3%
BS06 Markedly Asymmetrical J1+J2	0	0%
BS07 Markedly Asymmetrical J2	0	0%
BS08 Markedly Asymmetrical NJ	2	1%
BS09 Symmetrical J1+J2	0	0%
BS10 Symmetrical NJ	127	68%
BS11 Unknown	22	12%
Total Artefacts Studied	**186**	

Figure 3:18a Adzes: asymmetry in profile

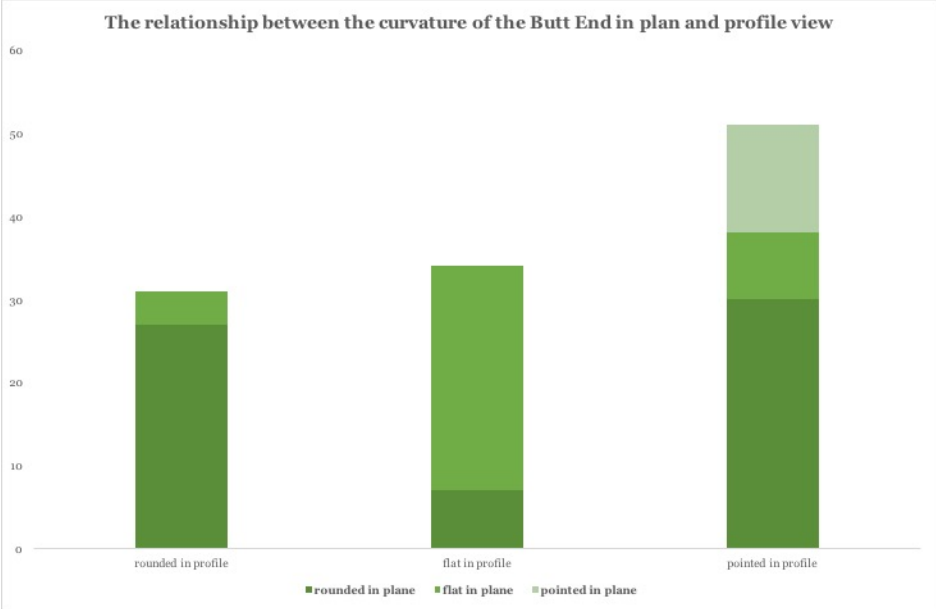
Figure 3:18b Manx Axe-heads by Blade Sharpness



3.4.1.3 Butt End Shape

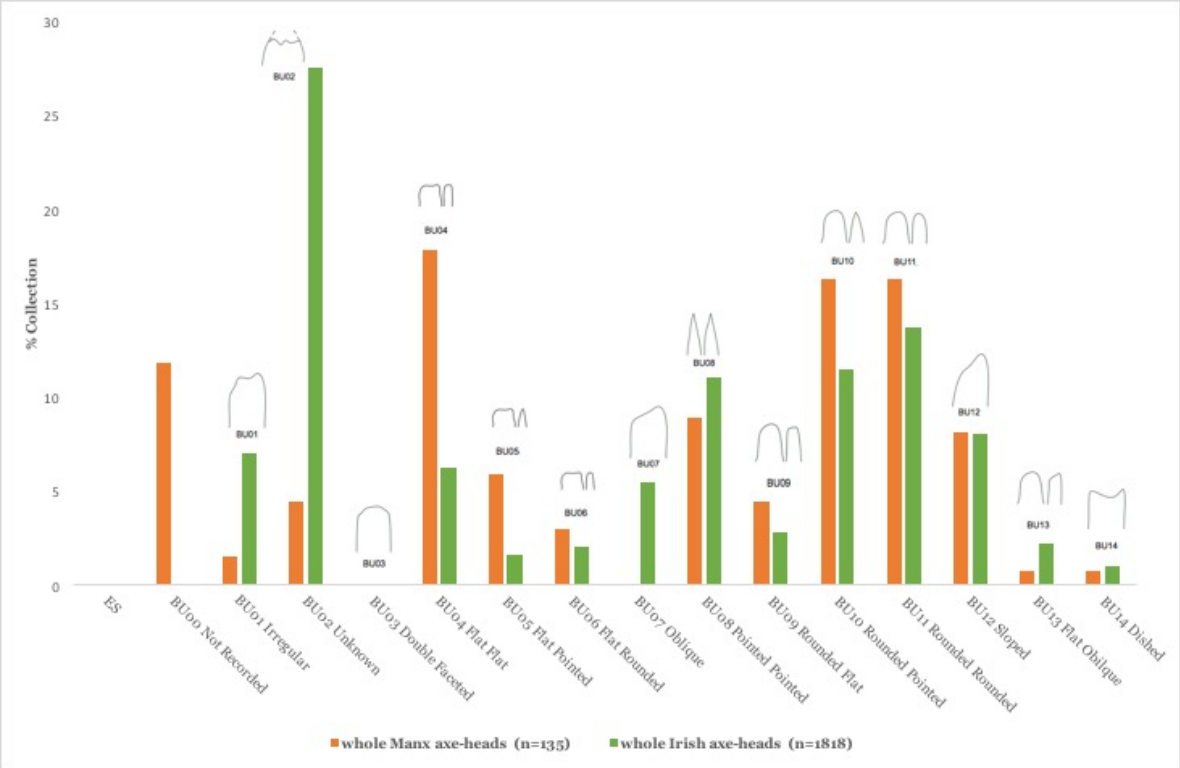
There is considerable diversity in form at the butt end of the Manx artefacts, see Figure 3:19a. Two aspects need to be considered: the view in the plane and the view in profile. The predominant butt end shapes when viewed in the plane are rounded (n=64) and flat (n=39). However, in profile view, most butt ends are pointed (n=51). The majority of these artefacts are rounded in plain view (n=30). Of the small number of artefacts that are pointed when viewed in the plane (n=13), all of them are also pointed in profile view (i.e. BU08 'Pointed, Pointed'), the remained are flat (BU09 'Rounded, Flat', n=8). Considering just artefacts rounded and flattened in the plane, most are symmetrical; that is, the majority of those rounded in the plane are also rounded in profile (BU11 'Rounded, Rounded', n= 27/31), whereas those artefacts flattened in the plane are also flattened in profile (BU04 'Flat, Flat', n=27/34). Most adzes, that is, artefacts asymmetrical in profile had pointed butts. Eleven (n=11) artefacts were sloped or oblique in the plane, but were difficult to classify because of the similarity between BU07 'Oblique' and BU12 'Sloped'. Several were oblique or sloped in profile but only one of these artefacts could be categorised since only a single category deals with oblique or sloped profiles and it specifies that the butt end is flat, i.e. BU13 'Flat, Oblique' (n=1). Likewise, only one artefact had a concave butt end (BU14 'Dished'). In Ireland, damaged or undefined butt ends are recorded for 27.5% of the complete axe-head collection (BU02). The most common shape for the butt end of complete axe-heads is rounded in both plain view and profile view (i.e. BU11, 13.7%). Flat butts in plain view (BU04, BU05 and BU06) account for 9.8%, while pointed butts (BU08) and pointed/rounded butts (BU10) are 11% and 11.5% respectively. Oblique butts (BU07) account for 5.5% of the collection. BU04 'Flat, flat' is more common on the Isle of Man than in Ireland (15% compared to less than 1% in the ISAP database), see Figure 3:19b.

Figure 3:19a Artefacts by Butt End Shape



	No. Artefacts	
BU00 Not Recorded	18	10%
BU01 Irregular	3	2%
BU02 Unknown	36	19%
BU03 Double Faceted	0	0%
BU04 Flat Flat	27	15%
BU05 Flat Pointed	8	4%
BU06 Flat Rounded	4	2%
BU07 Oblique	0	0%
BU08 Pointed Pointed	13	7%
BU09 Rounded Flat	7	4%
BU10 Rounded Pointed	30	16%
BU11 Rounded Rounded	27	15%
BU12 Sloped	11	6%
BU13 Flat Oblique	1	1%
BU14 Dished	1	1%
Total Artefacts Studied	**186**	

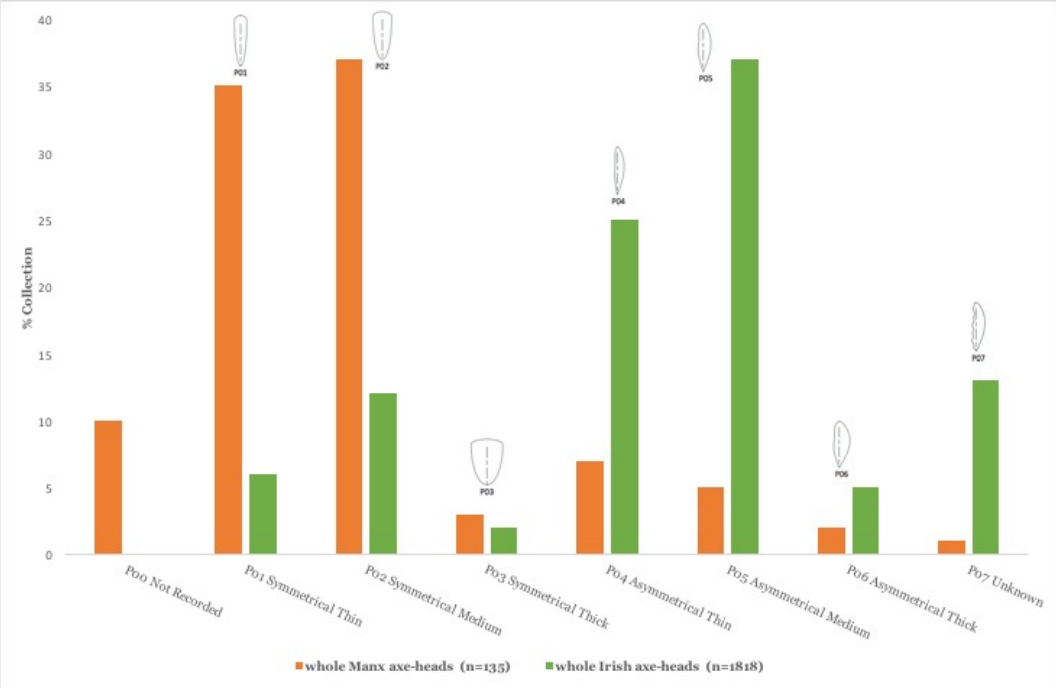
Figure 3:19b Manx and Irish Axe-heads by Butt End Shape



3.4.1.4 Profile

Superficially the IPG categories for profile shape work well for the Manx collection. The majority are symmetrical in profile (n=145/186, 78%) and they are generally narrow (n=66/186, 35%), or medium in thickness (n=67/186, 36%) see Figure 3:20. However, the RTBAs are much thicker than the general population with, as Bruce described, a 'pear-shaped' profile (Bruce et al., 1947). These RTBAs were classified as P02 'Symmetrical, Medium' or P03 'Symmetrical, Thick' depending on the overall impression given by size. In Ireland, profiles are more commonly asymmetrical (66.1% are P04, P05 or P06) but like the whole Manx examples (7/135, 5%) they are rarely thick (ISAP 7.2% for P03 and P06 combined).

Figure 3:20 Artefacts by Profile Shape



	No. Artefacts	
P00 Not Recorded	15	8%
P01 Symmetrical Thin	66	35%
P02 Symmetrical Medium	67	36%
P03 Symmetrical Thick	12	6%
P04 Asymmetrical Thin	12	6%
P05 Asymmetrical Medium	8	4%
P06 Asymmetrical Thick	4	2%
P07 Unknown	2	1%
Total Artefacts Studied	**186**	

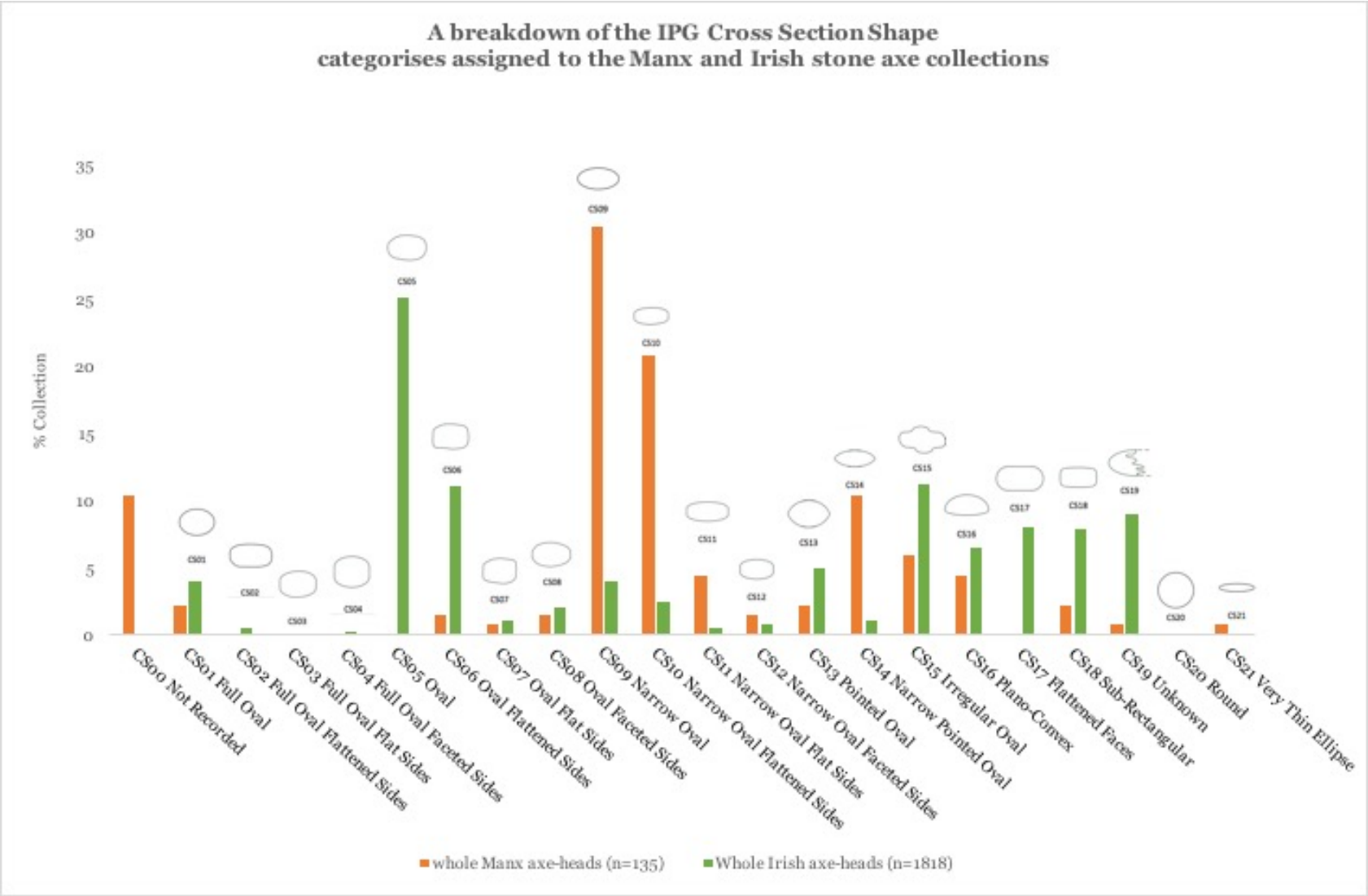
3.4.1.5 Cross Section

There are 21 different cross section shapes designated by the IPG, nineteen originally defined by ISAP and two additions: CS20 'Round' and CS21 'Very Thin Ellipse'. The Manx collection was categorised largely using only a limited number, see Figure 3:21. Most were recorded as narrow oval in cross section (n=100), a third of which (n=31) have flattened sides (i.e. CS10 'Narrow Oval, Flattened Sides' rather than CS09 'Narrow Oval' (n=55). However, it may be appropriate to revisit cross section classification given the disparity with the dimensions data, specifically the average thickness, see Section 3.4.2. Similarly, it was noticed from the photographs that a number of artefacts classified as CS09 or CS10 appeared to be CS14 'Narrow Pointed Oval' when viewed from the butt end. Only seventeen artefacts where considered

CS14 from both ends (n=17), and almost as many (n=16) had an irregular cross section (CS15 'Irregular Oval') that was in general attributed to damage, weathering or rock type. A small number of artefacts could be grouped into two other cross section shapes, namely, square or rounded. These artefacts are worth noting because they are very different to the majority of artefacts; collectively, square profiles (n=11) encompasses CS06 'Oval Flattened Sides (n=2), CS07 'Oval Flat Sides' (n=2), CS08 'Oval Faceted Sides' (n=4) and CS18 'Sub-Rectangular' (n=3) and round profiles (i.e. CS01 'Full Oval' n=5); both often indicate that the artefact will be classified in one of the rarer groups within the other categories. For example, two of the CS01 examples are classed as chisels and have long narrow faces, a third is also long and narrow but slightly convex and has no parallel in overall form in the rest of the collection. The remaining two are very large and broken cleanly in half. Regarding the square examples, most are splayed FS03 'Straight Splayed Sides' (n=3) and FS08 'Symmetrical Tapered Flat Blade and Butt' (n=2), with a symmetrical cutting edge. None are triangular in the plane, but three are parallel sided, FS04 '' Straight Parallel Sides' (n=3).

Figure 3:21 Artefacts by Cross Section Shape

	No. Artefacts			No. Artefacts	
CS00 Not Recorded	16	9%	*CS11 Narrow Oval Flat Sides*	11	6%
CS01 Full Oval	5	3%	*CS12 Narrow Oval Faceted Sides*	3	2%
CS02 Full Oval Flattened Sides	0	0%	*CS13 Pointed Oval*	9	5%
CS03 Full Oval Flat Sides	0	0%	*CS14 Narrow Pointed Oval*	17	9%
CS04 Full Oval Faceted Sides	0	0%	*CS15 Irregular Oval*	16	9%
CS05 Oval	3	2%	*CS16 Plano-Convex*	6	3%
CS06 Oval Flattened Sides	2	1%	*CS17 Flattened Faces*	1	1%
CS07 Oval Flat Sides	2	1%	*CS18 Sub-Rectangular*	3	2%
CS08 Oval Faceted Sides	4	2%	*CS19 Unknown*	1	1%
CS09 Narrow Oval	55	30%	*CS20 Round*	0	0%
CS10 Narrow Oval Flattened Sides	31	17%	*CS21 Very Thin Ellipse*	1	1%
Total Artefacts Studied			**186**		


A breakdown of the IPG Cross Section Shape categorises assigned to the Manx and Irish stone axe collections
% Collection
35
30
25
20
15
10
5
0
CS00 Not Recorded
CS01 Full Oval
CS02 Full Oval Flattened Sides
CS03 Full Oval Flat Sides
CS04 Full Oval Faceted Sides
CS05 Oval
CS06 Oval Flattened Sides
CS07 Oval Flat Sides
CS08 Oval Faceted Sides
CS09 Narrow Oval
CS10 Narrow Oval Flattened Sides
CS11 Narrow Oval Flat Sides
CS12 Narrow Oval Faceted Sides
CS13 Pointed Oval
CS14 Narrow Pointed Oval
CS15 Irregular Oval
CS16 Plano-Convex
CS17 Flattened Faces
CS18 Sub-Rectangular
CS19 Unknown
CS20 Round
CS21 Very Thin Ellipse
whole Manx axe-heads (n=135)
Whole Irish axe-heads (n=1818)

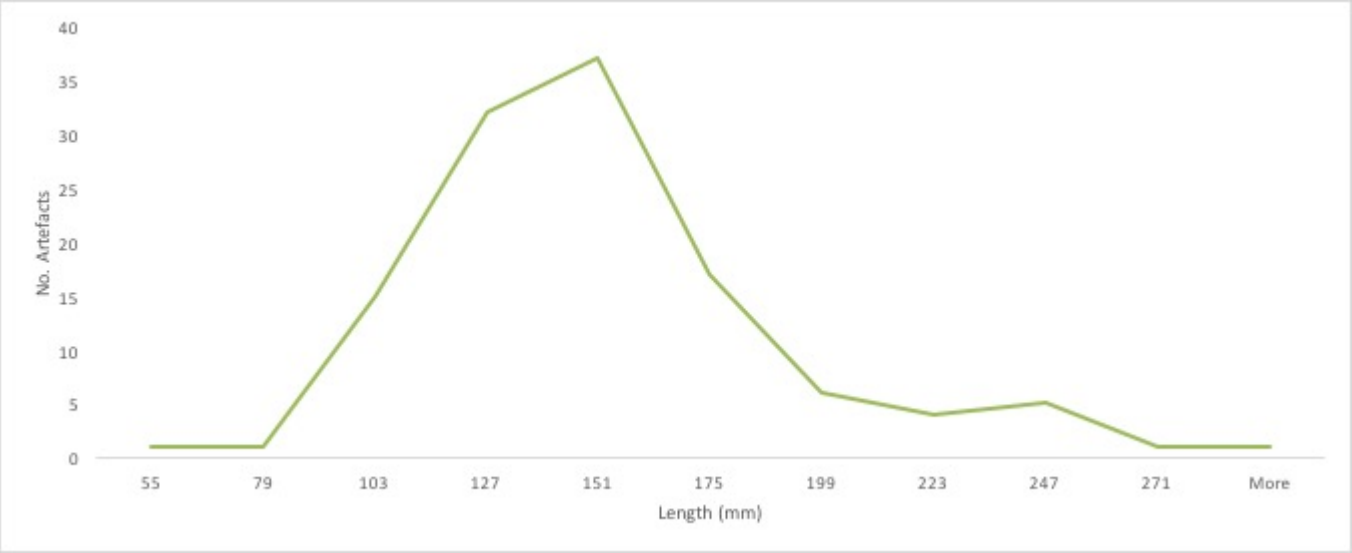
3.4.2 Dimensions

Measurements of size are often highly correlated; as such, they give few independent variables. Length has been treated first, see Figure 3:22. In Ireland, axe-heads range from less than 60mm to over 240mm (Cooney and Mandal, 1998, p. 39), although the majority of Irish examples (73.7%) are between 80mm and 160mm.

In total one hundred and twenty-two (n=121/135, 90%) of the whole Manx axe-heads were measured. Twenty-five percent were over 155mm, and twenty-five percent were under 113mm. The average length of an axe-head is 138.9mm (median=134mm). Three Manx axe-heads are under 80mm (n=3). Small axe-heads (<113mm) commonly have rounded blades (n=9); they are rarely convex (n=2) or parallel (n=2) in the plan view, instead they are either splayed (n=7) or triangular (n=8).

In addition to the whole axe-heads there are four very large axe-heads with broken blades (n=4), two that are damaged (n=2), four that have sharp blades (n=4) and eight that are rounded at the blade end (n=8). Several large axe-heads are broken (n=13), damaged (n=3) or chipped (n=4) as well, and a further three small axe-heads are broken (n=3), three are damaged (n=3) and one is badly chipped (n=1). Medium (over 113mm) and large (over 155mm) have fatter profiles than smaller axe-heads, but the very large axeheads (over 240mm) are often narrower than expected. The longest artefact is a very rounded chisel (1971-0200-C07, 295mm) at 35mm longer than the next largest axe-heads (n=1, 260mm).

Figure 3:22 Artefacts by Length (in mm)

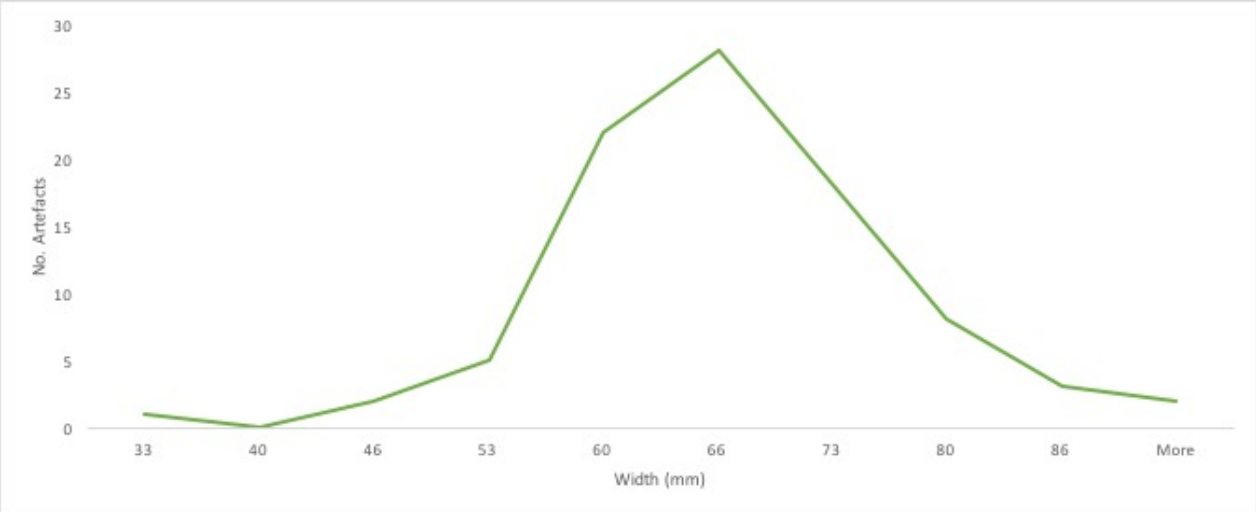


Mean	138.90
Standard Error	3.74
Median	134.00
Standard Deviation	41.17
Range	240.92
Smallest	54.08
Largest	295.00

The average width of the measured axe-heads in the Manx collection centres around 64mm, see Figure 3:23. In Ireland, 77.4% of the 2707 measured axe-heads range between 40 and 70mm width. The Manx collection deviates more: from 33mm to 93mm width. The mean thickness of the Manx collection is 37.6mm. This presents a problem. ISAP measured the thickness of Irish axe-heads to between 18mm to 34mm for 67.5% of 2328 measured axe-heads, and as mentioned above, the most common cross section shape in the Ireland is CS05 Oval. However, the Manx samples thickness range (18mm to 54mm) is at most 20mm thicker than Irish samples and yet the most common Manx cross section shape is FS09 'Narrow Oval'.

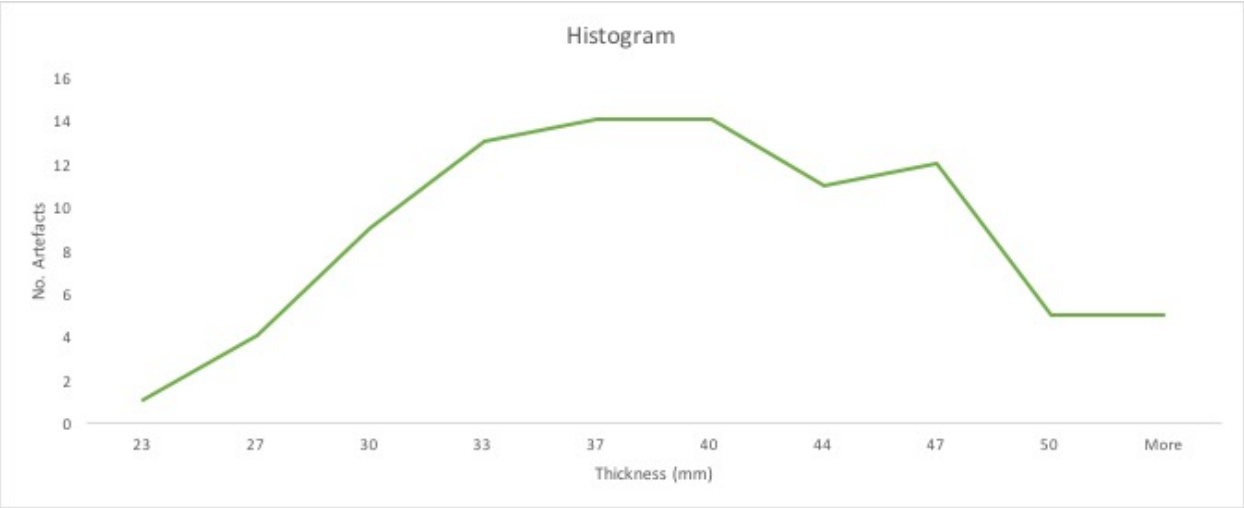
As can be seen in Figure 3:25, there are two peaks in the thickness data, the second shallower peak around 47mm represents the thicker than average cross section seen on several of the RTBAs. This peak is not noticed in the width or length data because the RTBAs are average width and length, the distinction is seen primarily in the profile thickness, rounded bladed and truncated butt end, see Figure 3:26. While this may explain some of the discrepancy in the thickness dataset compared to Ireland, it is also likely that the subjective identification criteria used for differentiating CS09 Narrow Oval from CS05 Oval has differed in the two studies done by different researchers, and may relate to the overall impression of the collection as a whole. It would be interesting to revisit the cross section groupings and re-measure the dimensions of the Manx collection to see the degree to which the datasets overlap after reappraisal. Although in theory these are practical attributes to measure, in reality the accuracy and relevance of the width and thickness measurement is dependent on face shape. If the mid-point alone is chosen for measurement, as was the case here, then triangular and splayed axe-heads are potentially misrepresented in the data, unlike parallel-sided axe-heads. Similarly, mid-point measurements of thickness do not account for the presence of tapered ends or 'the RTBAs classic 'pear-shaped' profile.

Figure 3:23 Artefacts by Width (in mm)



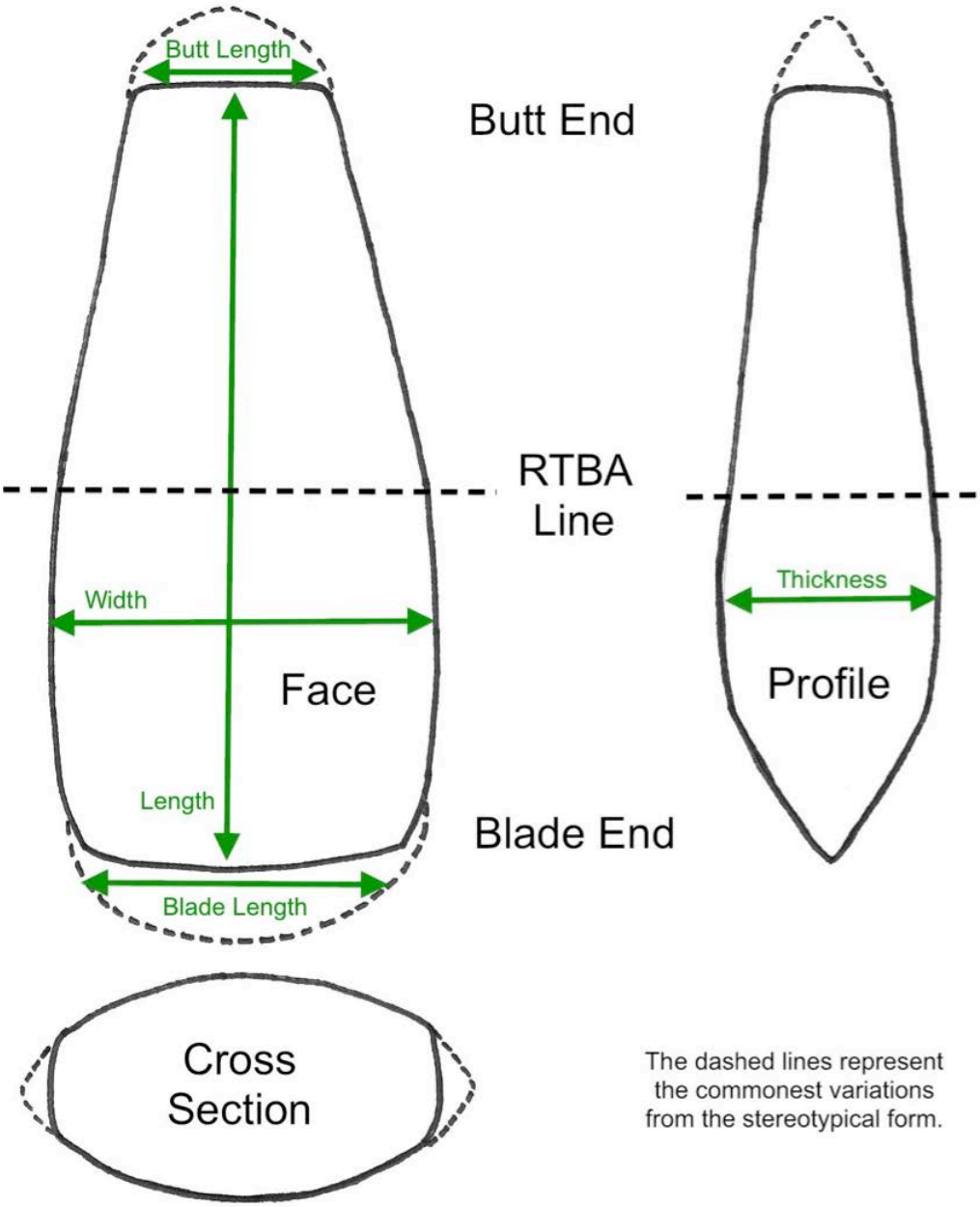
Mean	63.95
Standard Error	1.04
Median	63.18
Standard Deviation	9.82
Smallest	33.00
Largest	92.90

Figure 3:24 Artefacts by Thickness (in mm)



Mean	37.60
Standard Error	0.78
Median	37.00
Standard Deviation	7.38
Smallest	18.97
Largest	53.74

Figure 3:25 Stereotypical RTBA Form



3.5 Surface Features: the effects of petrology and context on morphology

In the Manx collection, as in Ireland (Cooney and Mandal, 1998, p. 46), the finer grained petrologies like porcellanite and tuff appear to have been flaked initially while the coarser examples, including the RTBAs, are pecked and hammered with more rounded edge profiles. Polishing has been at least attempted on all petrologies. The majority of axe-heads have been ground and polished smooth, but weathering is common and often consistent across large areas of the surface. Different petrologies react differently to a range of chemical and physical weathering agents, the dolerites for example are rarely smooth whereas the axe-heads made of tuff are almost always smooth, petrology has a considerable effect even when environment of deposition is considered (i.e. axe-heads found, for example, in agricultural land in the Parish of German, would have been subjected to similar conditions of weathering, however, the condition of these artefacts today varies greatly).

Several fine-grained artefacts that are pointed at the butt end have clearly been flaked to a deliberate point. Interestingly, this seems common amongst extremely large and extremely small axe-heads, but less prevalent on average sized axeheads and coarser examples. Likewise, several artefacts with CS14 'Narrow Pointed Oval' cross section appear to have been flaked along the long edges as well. Other axe-heads, those with faceted sides and a square cross section, have been shaped by a combination of flaking, grinding and polishing; while those with a rounded cross-section are often pecked on the long edges, occasionally entirely.

Pecking at the butt end is commonly recognised in the Manx collection as representative of a roughened late Neolithic Ronaldsway Culture axe-head (i.e. RTBA), but in many cases it is more likely that the roughened appearance is a product of damage or weathering but has been incorrectly identified as intentional. It would seem that there has been a tendency in the past to classify Manx axe-heads

that have a poor quality finish as RTBA. Deliberate roughening at the butt end is the defining feature of RTBAs so care must be taken to properly consider its' style and extent (Barrs, 2010). Previously, all roughened examples were classed as RTBA; however, after reviewing several collections in South West Scotland and North West England in became apparent that roughening appears relatively frequently. Several artefacts stood out, but have no connection to the Island, many of them would have been classified as roughened, and possibly even truncated at the butt had they been found here; however, in their own collections they are just considered rough examples, see Figure 3:26. Several more examples like this were noted in the British Museum and Glasgow Museum storage rooms as well. This suggests that perhaps roughening of the butt end is not necessarily limited to the Island, but rather it is the classification that is limited to the Island.

Although, it is also worth noting that the treatment of the butt end does appears to differs from that seen in Ireland where most butt ends are poorly finished (Cooney and Mandal, 1998, p. 50). The better condition and deliberate shaping of the butt ends (not just the RTBAs) suggests that they could have had a different significance on the island. There is a distinctive sub-group composed largely of Group XXV within the Island's broader RTBA collection (n=25) that have very clear and complete roughening meeting along a very straight line and an often sharp, neatly polished blade half, accompanied by a flat butt end. These examples do not appear to have parallels in any other collection, and have been coded as RTBA 'obvious', see Figure 3:28. In fact, as noted by Crellin the form of these very distinctive axe-heads have been mimic locally in later copper styles (Crellin, 2014, p. 340 Fig. 8-4). Axe-heads that are not as cleanly roughened were coded RTBA 'possible', and axe-heads that are likely to be damaged, unfinished, rough or weathered but not deliberate roughened as RTBA 'disputable' or 'unknown'.

Figure 3:26 Roughen axe-heads in British collections

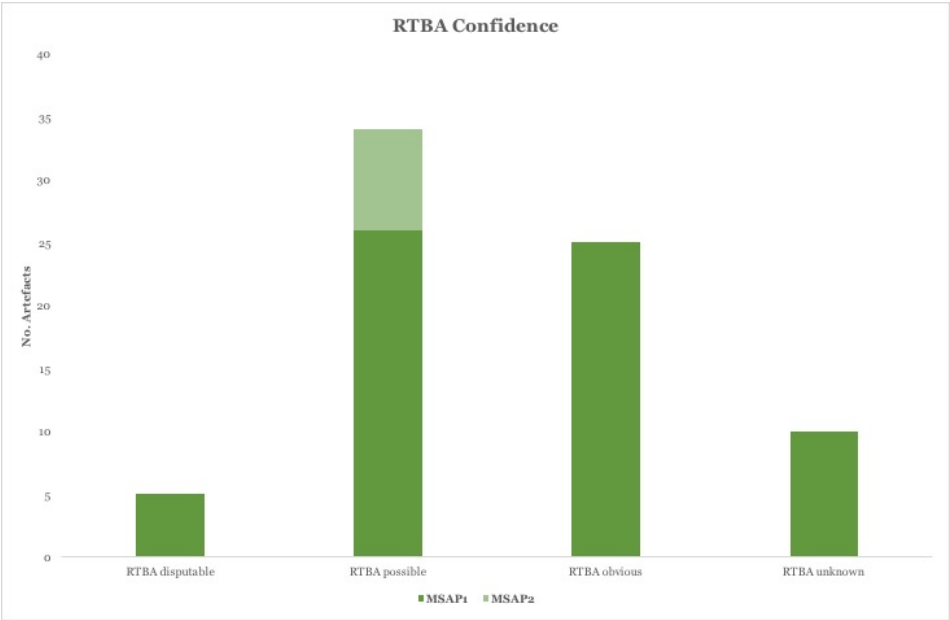
Above: a partially roughened axe-head with a clear waist found on the PAS database from Warnford in Hampshire (HAMP-938A25)

Below: a roughened example found on display at Stranraer Museum, Dumfries and Galloway

Figure 3:27 Conditions of Artefacts Studied (n=186)

Condition	Whole	Damaged	Broken
very good	2	0	0
good	57	2	0
fair	28	8	0
poor	3	6	0
chipped	32	0	0
blade end only	0	1	18
butt end only	0	2	7
mid-section only	0	0	7
unknown	13	0	0
Total	**135**	**19**	**32**

Figure 3:28 Manx Roughened and Truncated Butt Axe-heads



Many roughened examples, including those defined as 'RTBA' obvious', showed evidence of polish near the butt end indicating that they may have been polished entirely before being pecked as a secondary process. In addition, small Group XXV axe-heads that appear to have been reworked still often show the waist associated with the 'pear-shaped profile'. This suggests that there could have been some importance placed in the shape that encouraged the individuals who reworked them to maintain it. It has been offhandedly suggested in the past that the deliberate and neat roughening was simply a functional adaptation to aid in hafting, possibly due to a poor quality supply of wood on the island, however, there is no evidence to suggest that the quality of wood was particularly low and one would expect to see this roughening on a greater variety of styles and rock types if it offered a significant functional advantage. As it stands, tuffs and porcellanite axe-heads (the finer grained, even textured examples) are occasionally flaked at the butt end but never cleanly roughened, even though this would be relatively straight forward given their even mineral texture. Coarser-grained axe-heads, particularly Group XXV axe-heads which are always roughened as well as many of the dolerite examples are very clearly RTBA. In these cases, the roughening is deliberate and clearly not just the preferential weathering of phenocrysts.

CHAPTER 4

4.1 Petrology and Chemistry

The data collated by Larch Garrad and Russell Coope in the nineteen seventies and eighties relied primarily on the analysis of thin sections and macroscopic inspection of the artefact 'in the hand' (Coope and Garrad, 1988, p. 67). The authors stressed that their work represented only a preliminary investigation of the petrology of the Manx stone axe-heads; it now forms the foundation upon which this review is based. Four of the first seven axe-heads to be analysed by Frank Shotton from the University of Birmingham as part of the 'Original Manx Seven' (OM7) inclusion in SWG3 in the nineteen fifties, were identified as Group VI, or acidic tuff (MNH 1965-0001-12-Mx04-343, MNH 1965-0001-13-Mx05-344, MNH 1954-2388-Mx06-365 and MNH 1954-0583-Mx07-366) (n=4/7); two additional thin-sectioned axe-heads were recorded as weathered dolerite (MNH 1965-0001-10-Mx02-341 and MNH 1965-0001-07-Mx03-342) (n=2), while the seventh axe-head (MNH L21302a-Mx01-111) although not thin sectioned, was macroscopically identified as jade or jadeite (n-=1) (Stone and Wallis, 1951, pp. 142, 148). In SWG4, published by Evens a decade later, two axe-heads considered acidic tuff, where reclassified as just tuff; MNH 1965-0001-10-Mx02-341 was redefined a weathered quartz gabbro; and, MNH L21302a-Mx01-111 simply jade (Evens et al., 1962, pp. 245, 248–249) although a note made later by Larch Garrad in the IPG-Records for this axe-head states: 'jadeite (re-examined British Museum, Natural History Dec 1974)'.

According to Larch Garrad's paper in 1978, after visual inspection of the collection 'at least 40 Manx axes are potentially Group VI' (i.e. from Cumbria) and 'some dozen or so Tievebulliagh' (i.e. Group IX). It was also suggested that a single axe-head composed of a 'fine grained felsite (or intrusive rhyolite)?' came from the St. David's

area of Pembrokeshire in Wales, possibly within the classification of Group XXIII (Garrad, 1978, pp. 169–170). By Coope and Garrad's 1988 paper for SAS2, it had been established that there were ten Group VI thin sections (n=10), and one Group VII thin section (n=1) and Garrad felt that 'contrary to the evidence so far available from thin-sectioning, Group IX may be present in some quantity' (1988, p. 67). Ungrouped rock types were also briefly mentioned in the previous studies, as well as in correspondences and museum records, although little attention was given to them in publication because the focus of the original petrological analysis of Manx axe-heads concentrated on defining the characteristics of Group XXV (see Coope and Garrad, 1988, p. 69); they believed the source to be at either Ballapaddag in Braddan or Oatlands, in Santon.

For the author's Masters project, sixty-nine artefacts were studied for petrology and treatment of the butt end (n=69). Sixty-six were potentially RTBA (n=66, classed as 'obvious' (n=25), 'possible' (n=26), 'disputable' (n=5) or 'unknown' (n=10), see Section 3.5.). Since re-analysis of the collection, as part of this study, six (6) more possible RTBAs have been discovered including two from collections in Scotland and Northern England (n=2, see Section 5.4). As such, there are a total of seventy-two RTBAs in the database and almost half (n=35/72=49%) appeared to be Group XXV. No attempt has been made until now to verify the location of the source areas suggested by Garrad. This Chapter reports the results of analysis and categorisation of the rock types of the axe-heads in the Manx Museum collection identified during this study, and discusses the new information obtained by modern geochemical analysis of the compositional difference between the petrology of presumed Group XXV axe-heads and presumed local source areas.

4.2 Examining Axe-head Petrology

A systematic summary for each axe-head has been compiled in the database, identifying the distinguishing features of the individual axe-heads using hand specimen and thin section analysis. The database has been exported as a .csv file and converted into a series of excel documents in Appendix 1.

When possible the rock type is deduced from inspection in the hand; however sometimes it is not possible to give a specific recognised rock type, for example when the grain size is too small, or if thin sectioning has not been attempted so no fresh surface is available for inspection. Similarly, extensive weathering limits the ability to discern minerals accurately. In these cases, broader descriptive terms are used instead. This includes vague descriptive terms, as well as names which today have been renamed or reclassified.

As mentioned in Section 2.2, two hundred and six artefacts were analysed for petrology (n=206); as well as the axe-heads, adzes and chisels studied for morphology (n=186) all fragments (n=16) and debitage (n=4) were included. With the addition of the flint implements (n=31), two hundred and thirty-seven artefacts were categorised into one of the main rock types (n=237), see Figure 4.1.

The vast majority of Manx axe-heads are igneous (n=168/237, 71% including axe-heads composed of volcaniclastic material, greenstones, granophyre, and dolerites (see Section 4.3) as well as potential Manx source axe-heads (Group XXV, see Section 4.4). One artefact was metamorphic (n=1); namely, the Jadeite axe-head from the Glencrutchery 'house' site in Onchan. Excluding the flint implements (n=31), there were only fifteen implements made from sedimentary sources (n=46/237, 19%).

For ISAP, IPG grouped rocks were not specifically assigned (Cooney and Mandal, 1998, pp. 55–56), igneous (10%), metamorphic (4%) and sedimentary artefacts

(30%) artefacts account for less than fifty percent of the Irish axe-heads collection, because fifty-three percent are made from porcellanite. On the Isle of Man, porcellanite (Group IX) represents 6% of the collection, see Section 4.3.3.

Where possible, IPG Groups have been assigned (n=137), see Figure 4.2. The most common IPG Group assignment is Group VI, from Cumbria (n=54/237, 23%, see Section 4.3.1). As well as Group VI (tuff) from Cumbria, Group XI (porcellanite), from County Antrim and Group XXV (quartz diorite) from the island, there were four other groups represented in the Manx collection. Group 1 (greenstones) and Group VII (granophyre) are discussed in Section 4.3.2. Groups XVIII (quartz dolerite) and XXIII (porphyry/felsite) are discussed in Section 4.3.4. The Jadeite stone axe (n=1) and flint implements (n=31) were not given IPG Group assignments, and the remaining artefact were classified as 'ungrouped' (i.e. known rock type, unknown source, n=60, see Section 4.3.5) or 'unknown' (i.e. unidentifiable rock type, n=8). The certainty of the IPG Group classification for the axe-heads is represented by one of the following options: museum records (n=17), macroscopic inspection (n=117), microscopic inspection (n=40[1]), or geochemical analysis (n=12). For ungrouped rock (n=54), a specific area or type of area is offered instead in some instances. Any comments regarding petrology written directly onto an artefact or thin section were noted, but in several cases reallocating the thin section to an artefact has not been straight forward; for example, one thin section for a finely laminated mudstone has no label at all, and one thin section labelled '69-99', cannot relate to the axe-head of the same reference because the axe-head (MNH 1969-0099) has not been thin sectioned.

[1] When examined it was found that at least sixty artefacts had been cut for thin section analysis. Fifty-seven thin sections were repatriated from the Lapworth Museum (n=57), see Section 2.1 including fourteen thin sections for fragments (n=14), one thin section for a piece of debitage (n=1) and one thin section for a shafthole implement (n=1). Seventy-two percent of the thin sections were from axe-heads (41/57, 72%). One thin section for an axe-head was entirely missing a rock sample and of the forty remaining thin sections, six were broken and most were in poor condition making accurate microscopic analysis very difficult, see Sections 2.2 and 4.2.3.

Figure 4:1 Manx and Irish Axe-heads by Rock Category

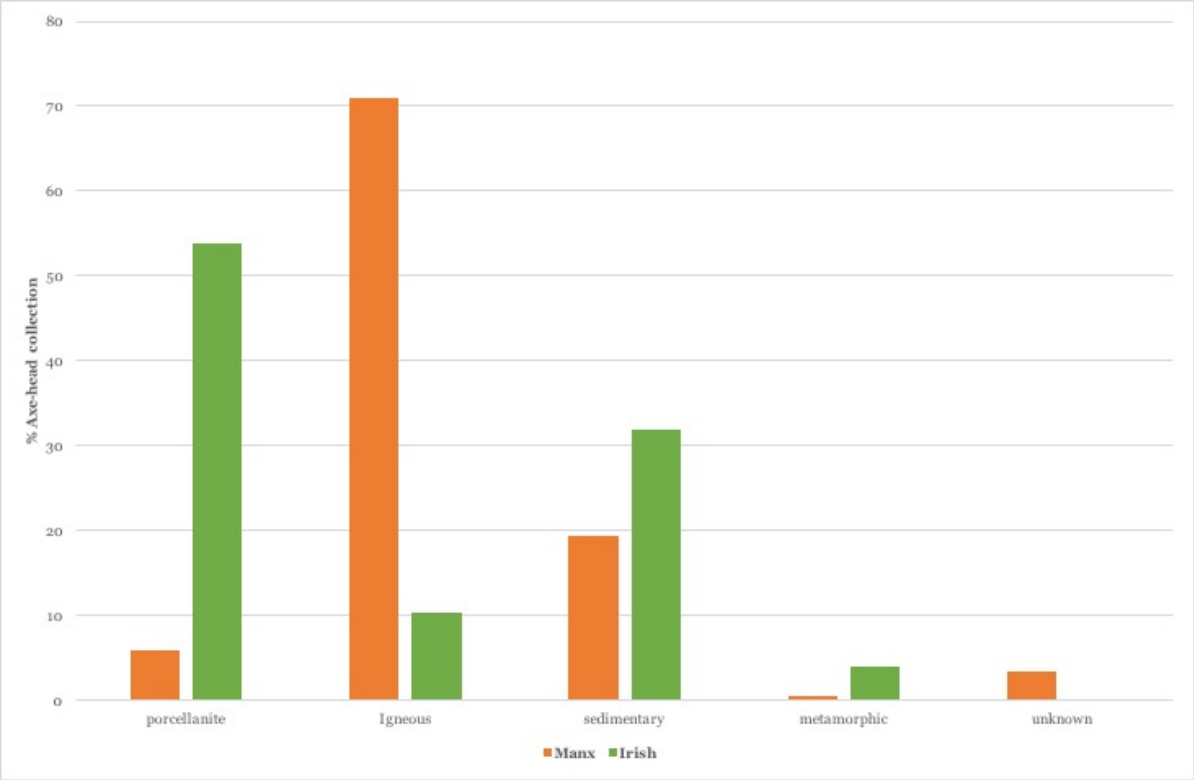
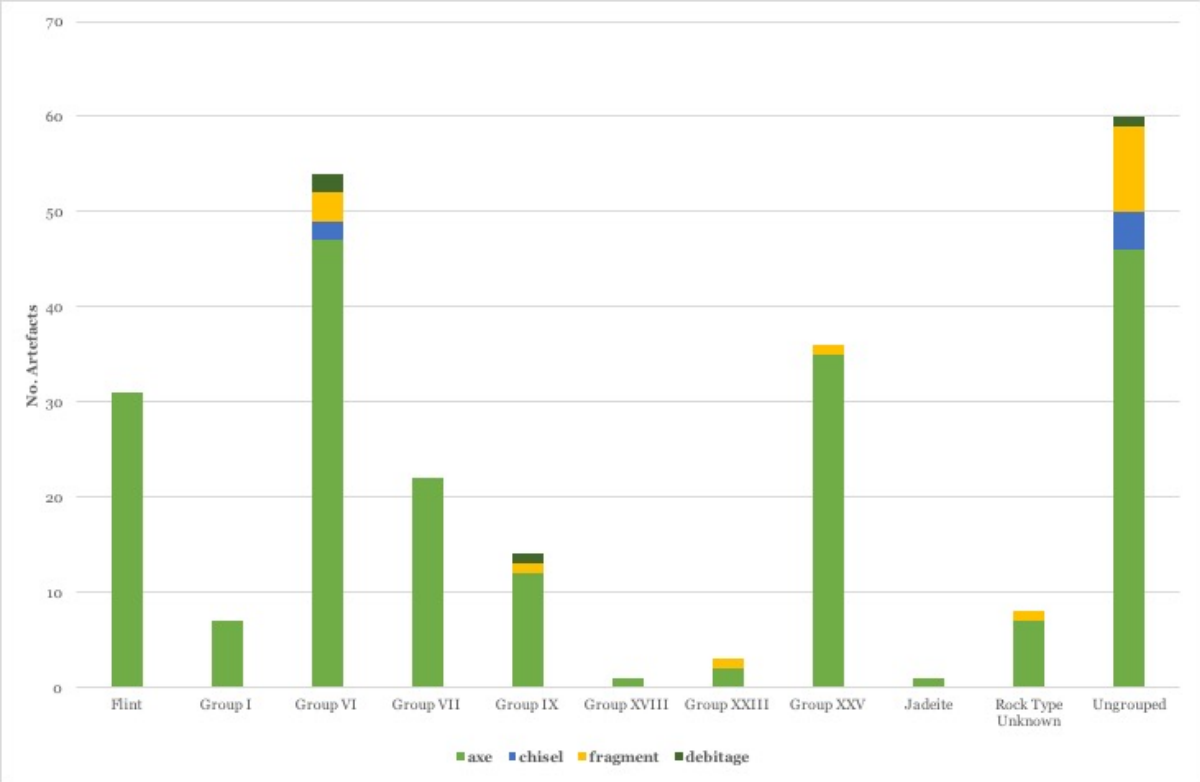


Figure 4:2 The assignment of IPG Groups to Manx axe-heads



Identifying the broad rock type of a sample—and if possible key features of emplacement history or depositional environment—is an important start to provenance studies that simultaneously allows potential source areas to be postulated, while eliminating large regions of dissimilar geology. However, as explained by Gabriel Cooney and Stephen Mandal in the second petrological report of the Irish Stone Axe-head Project (Cooney and Mandal, 1996, p. 52), it is more likely that different lithologies will look similar when examined in the hand. Analogous rock types are naturally much harder to differentiate unless it is possible to directly compare the samples to in-situ deposits on at least a microscopic level. As such additional information can be extracted using a high-powered petrological microscope. All terms used in the database are listed in the reference sheet designed to accompany the artefact record sheet, see Appendix 2.

4.2.1 Macroscopic Inspection

Historically, macroscopic examination of samples 'in the hand', coupled with destructive analysis primarily resulting in the production of thin sections, were the main tools at the disposal of the petrologists looking at lithic artefacts and monuments. The techniques that developed are now officially called Optical Microscopy (OP). Justifiably, today many archaeologists and museum curators are anxious for archaeologically significant lithic samples to be preserved; as such reliable alternatives to destructive analysis are increasingly desirable. Nevertheless, a petrological investigation always begins with a detailed analysis of the overall colour, macroscopic textures and grain size of the rock in the hand using a hand lens between x10 and x60 magnification.

At this level it is also often possible to understand basic details of the environment of deposition or formation; for example, the roundness and sorting of grains in a sedimentary rock can allude to the distance travelled between source rock and the

area of deposition. As such, grain size was an important feature to catalogue in the database, where appropriate using a standard Grain Size Chart (from Geo Supplies Ltd.).

As with the grain size, grain shape is an important diagnostic tool collected in this study. However, it is important to consider that within any single rock sample, grain size and shape can vary greatly, not only between different minerals but between crystals or grains of the same composition. The attributes collected here are only designed to reflect the most obvious and distinguishable features of the rock type in order to aid identification for the purpose of provenance study. As such there is not an exhaustive list of properties for each mineral present in the sample. Descriptive terms used include: cylindrical, discoidal, ellipsoidal, equant, irregular, angular, lath-shaped, spherical and tabular. Similarly, geologists use specific descriptive terms to convey the overall impression for the texture of the rock in the hand resulting from the specific minerals present within the sample. Likewise, mineral textures when visible can be defined.

Another diagnostic tool that can be useful to geologists is specific gravity; defined as the ratio of the density of a material to the density of water at room temperature, where density is defined as the material's mass per unit volume and is measured in kg/m^3. Specific gravity itself is a dimensionless unit. The IPG include this category on the standard IPG artefact record sheet and as such it was included on the Manx artefact record sheet. However, it was not practical to measure during this study, although in future it may be pertinent to revisit this category if more details on the specific gravity of source rocks in the IPG Atlas are analysed and considered helpfully diagnostic.

4.2.2 Weathering

With regard to morphology, weathering can at times be confused with deliberate roughening and/or the damage afflicted during the artefacts use-life. The degree of weathering was assessed in the hand and the terms negligible, minimal, partial, extensive, and unknown are used to describe the weathering of each axe-head on the artefact record sheets. Weathering is a very significant issue for researchers to consider when reviewing lithic artefacts. Superficially, the colour and surface texture of an object are often the first and most obvious ways to classify objects of similar shape. However, as geologists appreciate, colour with regard to rocks is a highly variable feature and reliance on colour differences alone is unadvisable. Since the same rock type can be affected by weathering in a variety of ways there are a striking array of possible surface features. Variations in weathering can distort the appearance of artefacts from the same source; as an example, Figure 4:3 shows a collection of images of Group VI rocks from around the Island to show effects of varying degrees of weathering on one rock type.

Figure 4:3 The variable effects of weathering on Manx Group VI axe-heads

4.2.3 Optical Microscopy

In the mid-nineteenth century, polarising microscopes were first employed to examine thin sections of rock prepared in a glass slide (Clough and Woolley, 1985, p. 92). The principles have remained relatively constant but the techniques and equipment used to examine thin sections has progressed considerably. For sample preparation, the diamond saw technique was used up until 1973, when the thin wire saw technique was introduced; then in 1979 modern coring techniques were developed and continue to be used and refined today. In the case of the thin sections prepared from lithic artefacts in the Manx collection—collected from the Lapworth Museum in Birmingham in 2010 (n=57)—it has been possible to date when many of the artefacts were cut based on the size and style of the damage to the axe-head, and thus add information to the object histories themselves. The data collected for this study have also been compared with notes taken by Larch Garrad at the time of her analysis with Russell Coope.

The microscopy was performed utilising the University of Liverpool's Central Teaching Environmental Science Lab's MEIJI Techno MT9930 petrological microscope; Dr Coope's thin sections where re-analysed and photomicrographs were taken. The condition of the slides was variable and many of the older ones were damaged by the degraded mount material which affected the refractive index of the slides. This limited the use of diagnostic petrographic techniques like birefringence; tools commonly used to identify minerals, especially minerals with slight but variable elemental compositions, including some of the feldspars, pyroxenes and amphiboles. The mineral content, and the degree of alteration, was ascertained where possible. Additionally, diagnostic details of grain shape, mineral colours, variations and textures were noted as necessary, Appendix 1.

Dr Coope's fifty-seven (n=57) thin sections were re-analysed but only a limited number were confidently cross-referenced back to polished stone axe-heads. Analysis of the axe-heads themselves suggests that at least sixty were cut for thin sectioning at some point (n=60). One thin section has no label at all (n=1), three only have a rock type ascribed to them (n=3), forty-one are annotated with a rock type and an accession number that corresponds to an artefact in the Manx collection (n=41). The remaining thin sections are only labelled with an accession number. Six thin sections were broken (n=6), only one is completely missing the thin section (regrettably MNH 1965-0001-010 from the Ronaldsway House excavation). Four broken thin sections are reportedly for RTBAs (n=4). In total, twenty-three RTBAs were cut for thin section (n=23).

4.3 The petrology of Manx stone axe-heads

A breakdown of the rock types in the Manx collection is given in Figure 4:4. Figure 4:4a shows that there are twenty-one identifiable rock types at present and axe-heads made of tuff (n=54, 23%), and Manx source quartz diorite (n=36, 15%) most commonly occurring. The comparisons with Ireland in Figure 4:4b shows that there are eight rock types recognised in the Irish collection that are not presently identified in the Manx collection. These include nominal percentages of slate, rhyolite, gneiss, dolomite, chert and diorite artefacts. Schist, shale and mudstone (3.4%, 9.55% and 13.61% respectively in Ireland) are also missing from the Manx collection, however, four percent of Manx artefacts were composed of rock types not seen in the Irish collection, including five greywacke (n=5), two grits (n=2) and three ignimbrite (n=3) artefacts.

For the majority of axe-heads in the Manx collection it was only possible to examine the petrology 'in the hand' and as such the identification of a precisely defined rock type was sometimes not achievable. This was largely due to the effects of weathering

and grain size. Nevertheless, by comparison to one another many could be divided into the broad rock types. The descriptions given in the following pages, are largely based on assessment of the 100 axe-heads taken to Liverpool in 2014 (see Chapter 2). Published photographs and photomicrographs of examples of known rock types from other axe-head collections, a limited number of which are available online, were a useful to aid identification. However, several visits were necessary to view the axe-head collections held in museums and universities in the UK (see Chapter 5) increasing familiarity with known source rocks; this considerably aided petrological identification of Manx axe-heads.

Figure 4:4a Artefacts by Rock Type

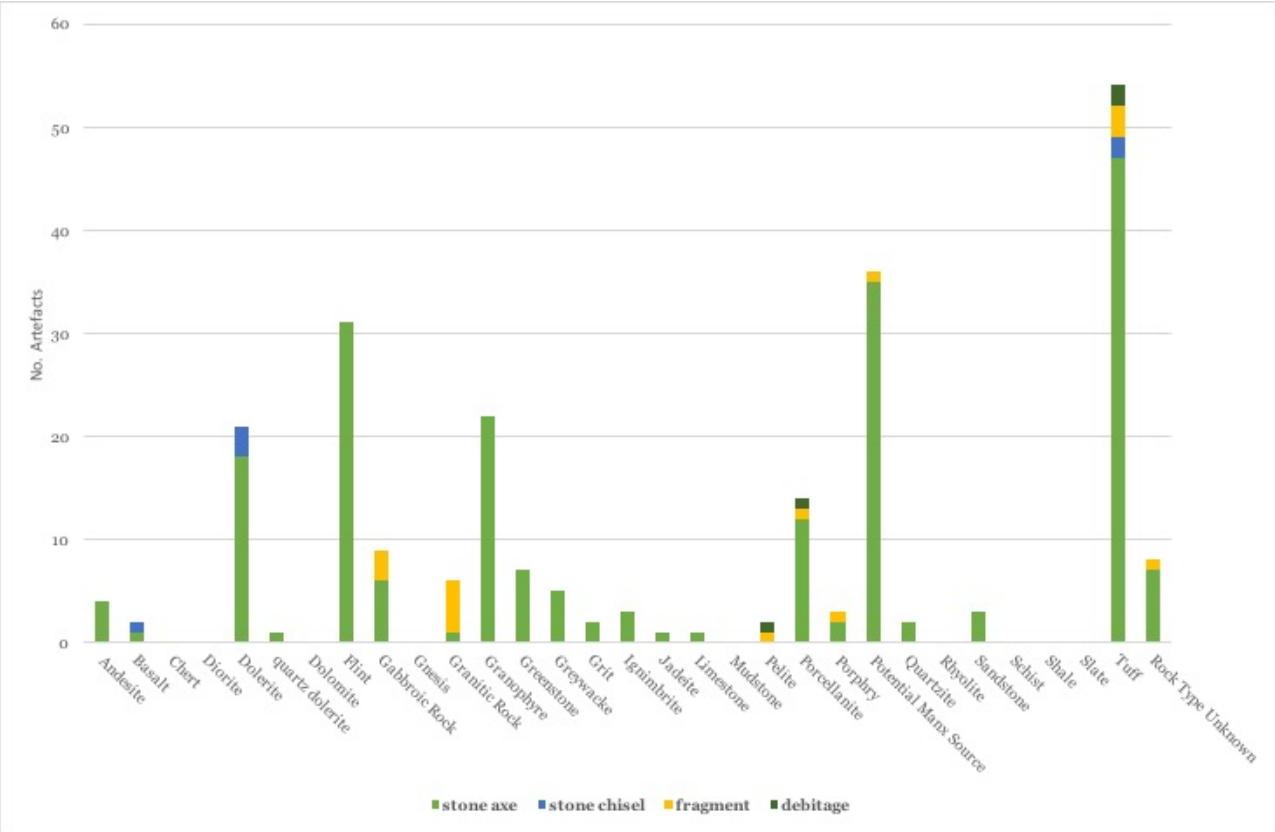


Figure 4:4b A comparison of rock types in the Manx and Irish axe-head collections

(additional data (Cooney and Mandal, 1998, p. 55)

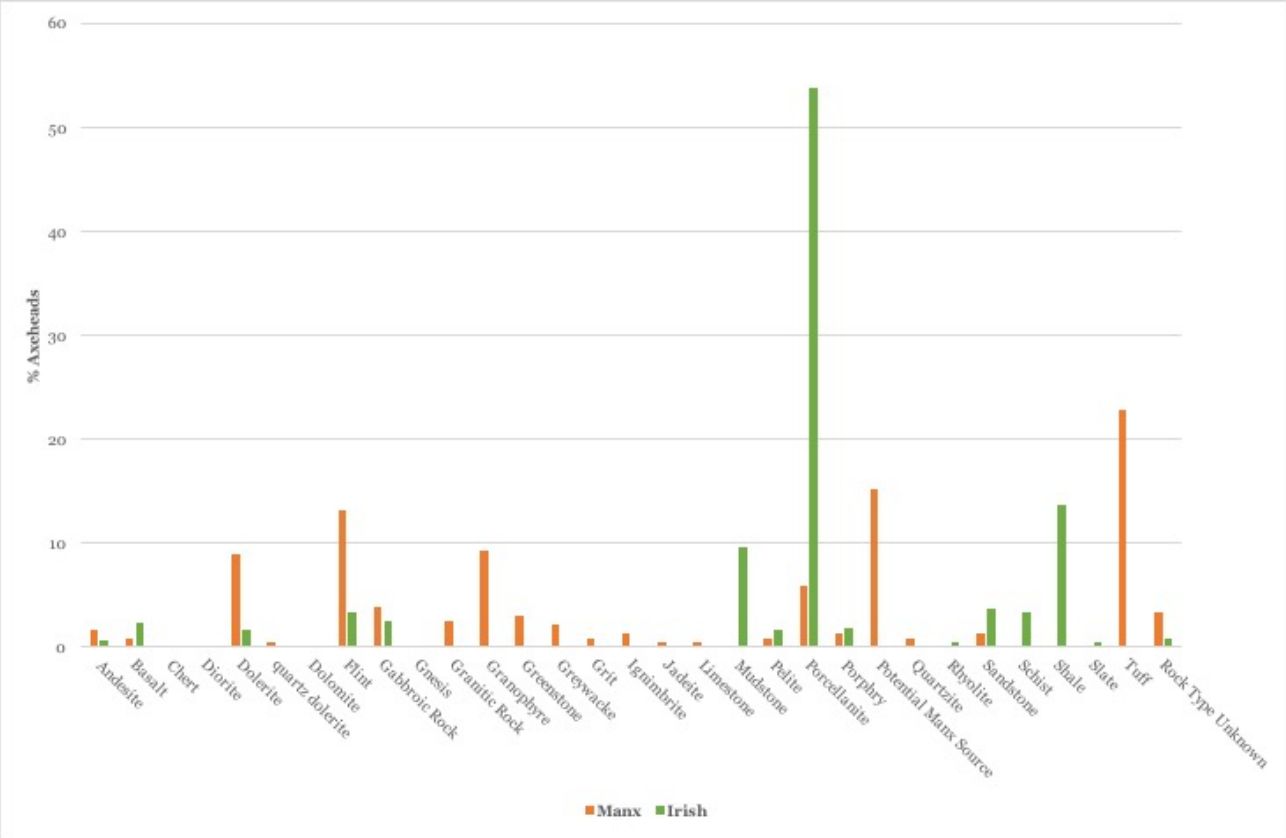


Figure 4:4c Table of Artefacts by Rock Type

Rock Type	IPG Assignment	Stone Axe	Stone Chisel	Fragment	Debitage	Total	%
Greenstone	Group I	7	0	0	0	7	2.95
Tuff	Group VI	47	2	3	2	54	22.78
Granophyre	Group VII	22	0	0	0	22	9.28
Porcellanite	Group IX	12	0	1	1	14	5.91
Quartz Dolerite	Group XVIII	1	0	0	0	1	0.42
Porphyry/Felsite	Group XXIII	2	0	1	0	3	1.27
Quartz Diorite	Group XXV	35	0	1	0	36	15.19
Flint	Flint	31	0	0	0	31	13.08
Jadeite	Jadeite	1	0	0	0	1	0.42
Rock Type Unknown	none	7	0	1	0	8	3.38
Andesite	ungrouped	4	0	0	0	4	1.69
Basalt	ungrouped	1	1	0	0	2	0.84
Dolerite	ungrouped	18	3	0	0	21	8.86
Gabbroic Rock	ungrouped	6	0	3	0	9	3.80
Granitic Rock	ungrouped	1	0	5	0	6	2.53
Greywacke	ungrouped	5	0	0	0	5	2.11
Grit	ungrouped	2	0	0	0	2	0.84
Ignimbrite	ungrouped	3	0	0	0	3	1.27
Limestone	ungrouped	1	0	0	0	1	0.42
Pelite	ungrouped	0	0	1	1	2	0.84
Quartzite	ungrouped	2	0	0	0	2	0.84
Sandstone	ungrouped	3	0	0	0	3	1.27
Total		**211**	**6**	**16**	**4**	**237**	

4.3.1 Volcaniclastic Axe-heads, including 'Group VI' tuffs from Cumbria, England

The most common rock type for the axe-heads is volcaniclastic tuff. Forty axe-heads were previously attributed to Group VI by Larch Garrad (n=40). Today there are fifty-four possible Group VI artefacts (n=54, c.23%), including two chisels (n=2), three fragments (n=3) and two pieces of debitage (n=2). Several coarser tuffs and volcanic breccia, generally grey to blue-grey, or brown overall with paler inclusions up to 5mm in length, sometimes banded, sometimes marbled, are described as simply volcaniclastic (n=6). It always remains a possibility that some of these artefacts may not prove to be from beds within the Borrowdale Formation on further inspection. Another possible grouped source for some of these examples could be Group VIII (i.e. a silicified tuff, with sources in south-west Wales (Keiller et al., 1941, p. 63; see also Stone and Wallis, 1951, p. 122), unfortunately without reference material specific sources will remain elusive and it is always likely that many artefacts do not come from formally recognised (i.e. grouped) sources at all (Cooney and Mandal, 1998, pp. 56–57). Although, they are generally dissimilar to known local sources of volcaniclastic material, i.e. the much coarser, Brigantian aged Scarlett Volcanic Member – an approximately 50m thick sequence dominated by water-lain tuffs, submarine volcaniclastic debris flows and gravity slides, as well as basaltic lavas and olistoliths of Dinantian carbonates and claystones, the base of which is found at Close-ny-Chollagh Point (54.069852, -4.6835740). Moreover, as with Group I sources found at the coast in Cornwall, it remains a possibility that suitable source areas are now submerged.

However, most of the axe-heads assigned to Group VI are indeed highly likely to be from the volcaniclastic Borrowdale formation based on comparisons to collections in Cumbria, particularly The Tullie House Museum in Carlisle; these definitely Cumbrian axe-heads are very fine grained, colour variable from dusty white patina to

finely laminated dark grey-blue. The tuff is characteristically pale blue grey colour on fresh surfaces regardless of weathering and a smooth surface is common. Minerals are generally too fine to discern in the hand although clusters and bands of coarser grained, angular clasts are present in some samples. The ten (10) Group VI thin sections reveal a very fine grained, largely opaque matrix occasionally laminated and with varying amounts (5-25%) of coarser angular fragmental grains, predominately low birefringent and up to 5mm in diameter, mostly quartz and sodic feldspar.

4.3.2 Grouped Greenstones, Granophyre, Dolerite and Porphyry Axe-heads

Group VII axe-heads in British collections, have been provenanced to Graig Lwyd, Penmaenmawr in Wales and are defined as augite granophyre (Keiller et al., 1941, p. 61): a granitic rock composed of intergrown feldspars and quartz crystals, in a fine to medium grained groundmass, with abundant secondary augite replacement (n=22). They are pale bluish grey in colour, sometimes brown. Interestingly, there are several granophyre examples that display roughening at the butt end. According to SWG 3 microscopically Group VII consists of 'sparsely distributed small phenocrysts of turbid plagioclase feldspar, small rounded crystals and crystal groups of augite and still smaller decomposed crystals of rhombic pyroxene in a microcrystalline matrix of quartz and feldspar with rods and isolated crystal of magnate' (Stone and Wallis, 1951, p. 119). The smooth overall appearance of this rock type, fine-grained nature and the pale bluish-grey colour surface, occasional dusty variable patinas plus the absence of thin sections makes the positive identification of samples as confirmed Group VII difficult. The IPG report that Group VII is widespread and abundant in some areas across Britain (Clough and Cummins, 1979, p. 127). Only one of three potential Group VII axe-head thin sections was available for study, from artefact MNH 1954-2984, - a long and thin stone axe-head, one of many from the area of Ballavell in Malew, see Section 4.

Similarly, Group I-IV samples and those generally referred to as 'greenstone' are very difficult to separate macroscopically even with significant textural distinctions (n=7); they are described in the literature as uralitised gabbros, epidiorites, greenstone and altered picrite (Watchman, 1979, p. 127). In the PAS database, there is some confusion over the assignment of axe-heads to these sources, and it would seem when in doubt many recorders default to Group VI for any smooth pale bluish grey or greenish rocks, with or without patina.

There are also two axe-heads described as by Larch Garrad as 'felsite or intrusive rhyolite possibly from the St. David's area of Pembrokeshire, Group XXIII' (Coope and Garrad, 1988). An additional thin sectioned fragment was also included in the Group XXII category (n=3). According to SAS2, this group 'ranges from graphic pyroxene granodiorite (Group XXIIIa) to quartz dolerite (Group XXIIIb)' with 'source area between Preseli Hills and St David's Head, Pembrokeshire (Dyfed)' and as mentioned previously (Section 1), one of the proposed Stonehenge sources, 'Group XIII', falls within the petrological and geographical range of Group XXIII, and would have been a sub-group had it been found later (Shotton, 1972, p. 89).

4.3.3 Group IX: porcellanite axe-heads from County Antrim, Northern Ireland

The sources for porcellanite are in County Antrim, Ireland: it is a very fine grained, dark grey blue to purple black rock, with few inclusions. Barely discernible in the hand, distinctive minerals reportedly include mullite, corundum, cordierite, spinels, cristobalite and tridymite (Cooney and Mandal, 1998). This meta-sediment was apparently formed when large masses of baked iron-rich palaeo-soil (laterite) and compact aluminium-rich white clay layers (lithomarge) separated from their position within the overlying inter-basaltic formation of the 'Tertiary Lower Basalts' of the Antrim Plateau and slipped down the footwall to be metamorphosed by contact with the inclined olivine-dolerite volcanic plug pushing its way toward the surface

(Crowther, 2003). Using destructive geochemical techniques Stephen Mandal (1997) discerned differences between two similar porcellanite sources in County Antrim while working on the Irish Stone Axe-head Project; at Tievebulliagh and at Brockley, on Rathlin Island.

In total fifteen (n=15) artefacts appear to be porcellanite (fourteen analysed artefacts plus a stone pounder). The majority are whole stone axes (n=9) one is a cleanly broken butt end only (n=1), one has an unusual scalloped edge and asymmetrical profile (n=1) and there are two small rough fragment with a clear cutting edge (n=2) both of which have been thin sectioned, as well as a single piece of debitage (n=1, see Figure 4:5. For such a visually striking, and therefore noticeable, rock type to be prolific in Ireland, and yet only represent six percent (6%) of the Manx collection is interesting, but it is perhaps worth noting that this represented approximately a quarter of the number of axe-heads that have been grouped to the most common rock type found on the Island (the presumed 'Group VI' tuffs) which represents twenty-three percent (23%) of the analysed implements.

Figure 4:5 Porcellanite axe-heads on the Isle of Man

4.3.4 Dolerites and other ungrouped igneous axe-heads

Several thin sections (1954-2881; 1954-0596A; 1954-0611 and, 1954-0613) are labelled 'X'. This was initially presumed to relate to IPG Group X; however, Group X was re-defined in 1978 as a 'Fine Dolerite. Factories near Sélédin, Brittany. Rare in Britain... Equivalent to Dolerite Type A. An earlier Group X... and Group Xa have been superseded by Le Roux (1978, p. 50) who defines Dolerite Type A as a very fine grained and strongly epidioritised dolerite which 'forms a prolific group accounting for nearly 50% of the axe-heads in Brittany and 30-40% in the rest of the Armorican massif'. Le Roux did not believe that the four examples from Southern Britain represented evidence of trade (1978, p. 50); therefore, that six of the Manx axe-heads (including four RTBAs) are Group X has been considered unlikely. Furthermore, microscopic inspection reveals that all examples labelled 'X' were in fact strikingly similar to those labelled Group XXV and much coarser than would be expected of IPG Group X. Alison Sheridan and members of both the IPG and Project Jade have recently discussed revisiting the Group X classification and other similar dolerite sources (IPG AGM 2015, pers. comm.). It may be possible that other dolerite axe-heads in Britain and Ireland can be linked to French sources, or indeed other dolerite sources in the British Isles (like the Whin Sill); since dolerite is a very common rock type thorough-out Europe it is likely that there are multiple sources being utilised on every scale. This is supported by the relatively high number of ungrouped doleritic rocks identified macroscopically (n=21, c.9%) in the collection, plus the single artefact positively identified by Larch Garrad as Group 18 (n=1, quartz dolerite from the Whin Sill).

The ungrouped examples varying in colour, and generally have a coarse weathered surface indistinguishable from deliberate roughening in many case. These medium

grained dolerites, are largely even grained and brown or grey in colour, with no discernible distinguishing mineralogical features due to the weathering.

A small number of other ungrouped igneous rock types are present in the collection; namely andesite (n=4), basalt (n=2), coarser granitic rock (n=6, including a fragment from Alisa Craig) and gabbroic rock (n=9, included a hornblendite identified by Shotton but 'source not readily relocatable' and eight called 'Camptonite ('Types A or B')' by Larch Garrad including five stone axe-heads and three rough or rounded fragments with sharp cutting edges (n=7). The term camptonite is no longer used, these are a type of lamprophyric rock which occurs in dykes, and is composed of labradorite, pyroxene, sodic hornblende and olivine. A similar rock was identified by Shotton from the East Midlands, but Garrad thought that the four (4) thin sections labelled camptonite 'may prove to have a source within the Island.... (and) the same may apply to the two axe-heads made of a very similar highly altered Diorite'. All are similar, but more even grained than several thin section classified as Group XXV and may prove to be petrologically related.

Interestingly, it was noticed that the medium grained igneous axe-heads in the Manx collection, as well as several noted in collections visited in Scotland rarely appear to be highly polished, and are often damaged or blunted at the blade end. This could be related to differences between the primary technology used in their production, coarser examples are often pecked while finer textures are flaked. However, it could also suggest that the coarser examples had more of a utilitarian function; whereas the often highly polished and sharp bladed, homogenous/fine grained axe-heads may have had a more symbolic function. This idea is perhaps also supported by the fact that many finer grained rock types, like the Irish porcellanite and the Cumbrian tuffs, have a large geographic distribution, but the dolerites—as small-scale medium grained igneous sources in the form of dykes and sills abundant across the Island, in

Britain, Ireland and Europe—would have been a familiar and commonplace material to all societies and as such were maybe less likely to gain symbolic significance than the axe-heads made from rare and prized unfamiliar rock types. However, the ease with which different rock types can be polished to produce such a smooth surface is highly variable and it may simply not have been deemed a worthwhile endeavour to polish the difficult types like dolerite, their value hinged instead on something intangible today. An exception, although still with limited distribution, is the RTBA Group XXV examples; even coarser than the dolerites, partially roughened and partially polished, they were clearly carefully crafted and highly valued.

4.3.5 Ungrouped Sedimentary and Metamorphic Axe-heads

Of the fifteen (15) sedimentary axe-heads, in the collection, there are handful of pale grey even grained sandstone examples (n=3), two quartzite (n=2), as well as a yellow coarse grained grits (n=2). Sources unknown. Other artefacts were defined as greywacke (n=5), limestone (n=1) and pelite (n=2). The only metamorphic axe-heads, the Jadeite example, was provenanced by Project Jade to Mount Viso in the Italian Alps (Sheridan, A. pers. comm.).

4.4 Hunting the Manx Source

In this review, there are 36 axe-heads (c.15%) that in the hand could be described as quartz diorite or tonalite, 'mottled in appearance, with large, occasionally zoned, subhedral phenocrysts visible in a finer matrix of dark ferro-magnesium minerals, oxides and paler interstitial crystals' (Coope and Garrad, 1988, p. 69). Diorite contains mainly plagioclase feldspar and hornblende, however, 1965-0001/010 was petrologically identified as a 'quartz gabbro' and yet was still assigned to the Manx Ballapaddag/Oatland source. After reviewing the axe-heads themselves it is clear several of the thin sections described as 'igneous' (17% - including Garrad's 'altered dolerite' axe-heads) could also be related to Group XXV. Similarly, axe-head 1965-

0001/007 has also been assigned to the Manx source but is described as a weathered dolerite by Garrad. These are just limitations of language. Dolerite and gabbro are closely related igneous rocks, differentiated through grain size and therefore position within the cooling igneous body. Dolerite is an ophitic, basic igneous rock containing plagioclase feldspars, pyroxenes and olivine; gabbro is the coarse grained equivalent. According to the New Oxford American Dictionary (Apple Mac electronic version 2.1.2, 80.3) the name dolerite is derived from the Greek 'doleros' meaning 'deceptive', because it is 'difficult to distinguish from diorite'. There are also differences between the use of the terms dolerite and diorite in Europe and America geosciences.

The presence of uralised pyroxene in the Group XXV thin section slides (i.e. a mineral with the habit of pyroxene but the structure of secondary hornblende) is an indication that the Oatland Complex described by Taylor and Gamba (1933) is potentially the location of the Group XXV quarry defined by Coope and Garrad (1988, 69). According to Deer, Howie, and Zussman (1992, p. 257), the alteration of pyroxenes to fibrous light blue-green amphiboles (secondary hornblendes) is 'generally ascribed to the action of hydrothermal solutions which may be associated with the late stage crystallisation of igneous rocks, or may be a post-consolidation process unrelated to the igneous activity from which the rocks were derived; in the latter case the uralization may be associated with either regional, contact or metasomatic metamorphism'. Either scenarios could have formed the Group XXV rock type, and both processes were involved in the creation of the intrusion at Oatlands, but without more information on the smaller Ballapaddag intrusion its emplacement history remains unknown. However, as mentioned previously, Coope believed the feldspars in the axe-heads were more altered than those at Oatlands.

4.4.1 Group XXV Axe-heads

In total, of the thirty-six Group XXV axe-heads identified in this study (n=36), twenty-two (22) axe-heads were classified from inspection in the hand only. These axe-heads have not been thin sectioned and have a weathered outer surface. Four (4) more Group XXV axe-heads have been thin-sectioned, and one (1) is known from records only. The remaining eleven (11) were selected for geochemical analysis (see below).

A mottled appearance is common in the axe-heads ascribed to the Manx source as a result of the abundant phenocrysts. There is no banding or obvious metamorphic textures, but the Group XXV axe-heads which are darker overall (e.g. Artefact 1954-1291) have very dark phenocrysts with paler reaction rims that are otherwise indistinguishable from the ferro-magnesium matrix. However, the lighter examples (like Artefact 1965-0001/010, from the Ronaldsway type site) have pale, preferentially weathered phenocrysts clearly different to the matrix, with dark reaction rims. A third group has a bluish green hue overall, and pinkish phenocrysts. As such, following the format set by the IPG when splitting other groups, these have been distinguished as Group XXVa (pale), Group XXVb (dark) and Group XXVc (green), see Figure 3.6. These differences are generally superficial; the examples appear to have a similar mineralogy, see Figure 4:7. One example, Artefact 1954-0590, is a dark example, and has a few dark phenocrysts; however the phenocrysts are brown and distinct from the matrix. If these examples are from the same source, then it is possible that this difference is related to post depositional processes and the conditions of burial, or more likely due to chemical zoning within the igneous body during formation. Regardless of the variations in colour all varieties generally appear similar in thin section. Most examples have a variety of different sized phenocrysts, from matrix sized up to 10mm x 70mm. The highly variable nature of the colour and

texture for the rock makes it difficult to determinatively define a classic physical description for axe-heads that are extensively weathered or have not been thin sectioned, as is possible with more homogenous rock types like porcellanite.

Figure 4:6 Group XXV RTBA axe-head subgroups

Figure 4:7 Group XXV Photomicrographs

4.4.2 Group XXV Source Areas

Based on the work of Garrad, Group XXV is known to have a source on the Island, and both the axe-heads and the source material from the two regions postulated look comparable in the hand, see Figure 4:8. There are several igneous bodies on the Isle of Man, the Dhoon granodiorite in the north intrudes into Lonan Formation rocks of the Manx Group; the Poortown Basic Igneous Complex on the west coast is a dolerite with pronounced zoning - from pyroxene rich dolerite at the centre to feldspar rich dolerite at the outer margin, while the acidic Foxdale granite intrudes through the Maughold Formation on South Barrule. It is possible that these igneous bodies, and the abundant smaller dykes and sills that litter the Island, could have been utilised to make axe-heads. It must also be remembered that it is possible glacial erratics were used to produce some of the axe-heads in the collection but this is difficult to confirm without an extensive survey outside the remit of this project.

The two areas proposed by Coope and Garrad—Oatland in Santon and Ballapaddag in Braddan—have not been extensively surveyed for remnants of prehistoric mining activity. No details have been found relating to Coope and Garrad's review of the samples from the Oatland or Ballapaddag areas. Unfortunately, in the 19th century the Oatlands area was quarried and has since been back filled. Very little remains exposed, and none is freely accessible. Similarly, the smaller Ballapaddag intrusion is now under an industrial estate.

Regardless of the uncertainties, each outcrop will have an identifiable elemental composition. Samples from both sites have been collected and thin sectioned, for comparison with the axe-heads. The definition, based on inspection of the axe-heads, given by Coope and Garrad (1988, p. 69) for the Group XXV source is hydrothermally altered quartz diorite, or tonalite, in which

‘the phenocrysts are seen to be largely of secondary amphibole replacing augite, which still survives towards the centre of some large crystals. Hornblende outgrowths occur round some of the phenocrysts. The matrix contains some primary hornblende, flakes of green biotite, and some chlorite. The plagioclase feldspars are sericitised. Interstitial quartz occurs in small amounts, often as clear triangular infillings between the euhedral feldspars. magnetite-ilmenite skeletons are frequent, and in some slides there is often a dusting of iron ore within the phenocrysts. Granular sphene is almost ubiquitous as an alteration product’.

Figure 4:8 Comparing axe-heads to source samples

4.4.2.1 Oatlands, Santon

The Oatland Complex is an interesting geological feature; a pluton involving at least two different instances of magma injection, creating a unique mineralogical signature for the outcrop. It was surveyed in the 1930s by Taylor and Gamba, and they produced a map of the feature. It shows a basic igneous intrusion (a gabbro), disturbed by a younger intrusion of more acidic composition (a granodiorite). The metamorphic aureole is composed of hornfels after alteration of the distal turbidites of the Lonan Formation - part of the Lower Ordovician Manx Group series into which the pluton intrudes, see Figure 4:9. According to Quirk and Burnett, at the south-western end of the intrusion ‘the gabbro grades into an even more basic (silica

poor) iron-magnesium rich rock composed mostly of pyroxene and hornblende' described by Taylor and Gamba as 'Perknite' which is the name given by H. W. Turner (1901) to phanerocrystalline igneous rocks composed chiefly of monoclinic amphibole and monoclinic pyroxene; chemically they are distinguished by being lime-magnesia-silicate rocks.

Figure 4:9 Taylor and Gamba's Survey of the Oatlands Pluton

(Taylor and Gamba, 1933, p. 357 Fig. 40)

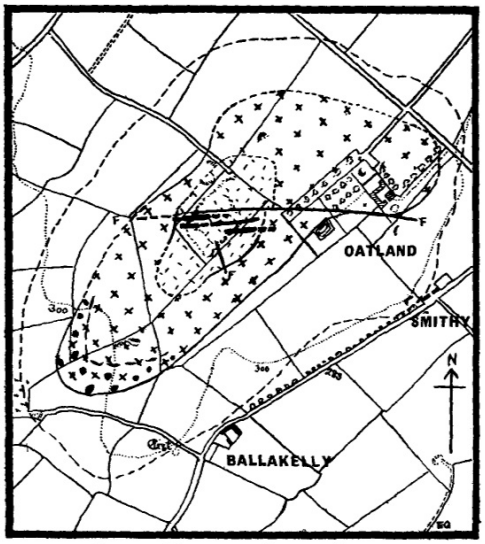


FIG. 40.—MAP OF THE OATLAND COMPLEX.
Thick black lines indicate dykes. The discontinuous line is the limit of the metamorphic aureole. Scale 6″ to the mile.

Granite Gabbro Perknite

Three of the twelve samples collected from the Oatlands area appear to be similar in the hand to the axe-heads. Some of the samples were selected on the basis of the state of the weathered crust. In many cases, the difference between the weathered crust and the internal mineralogy was striking and shows again how difficult it is to ascribe a rock type to an artefact that cannot be analysed destructively, see Figure 4:10.

Figure 4:10 Group XXV source area samples

Manx Source Sample

Surface Weathered

Surface Cut

Surface Weathered

Surface Cut

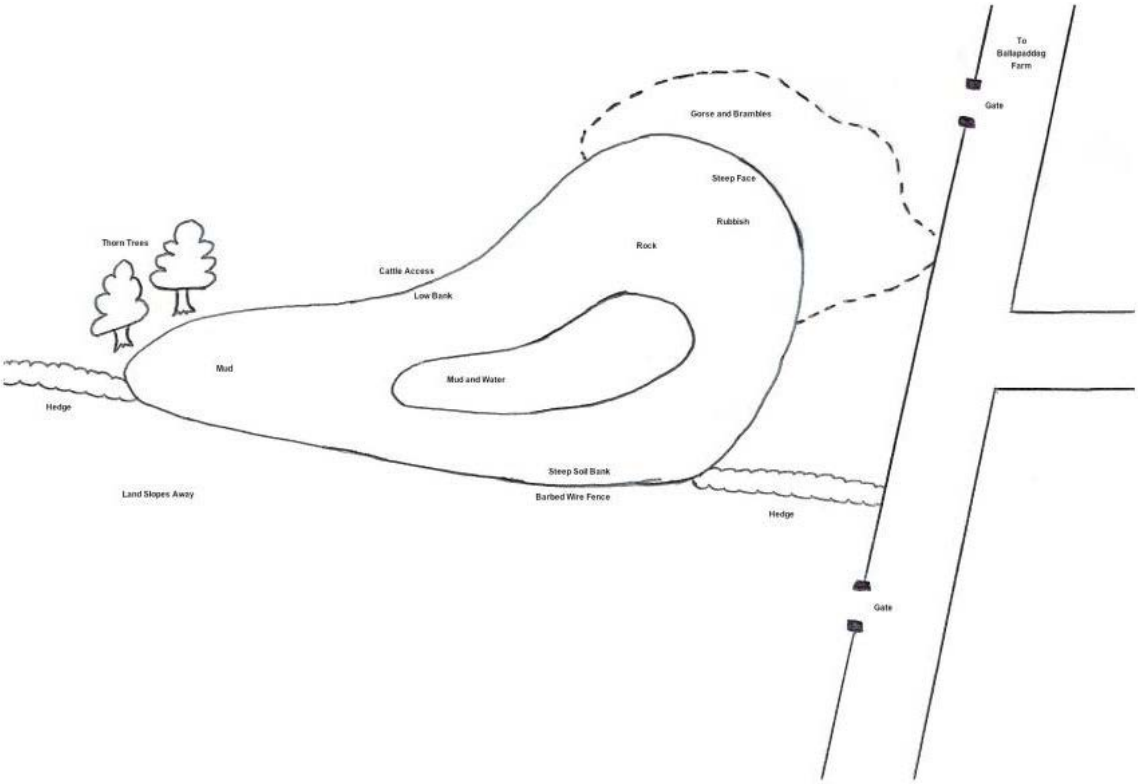
4.4.2.2 Ballapaddag, Braddan

Less is known about the basic igneous intrusion at Ballapaddag, construction in the area has permanently disturbed any evidence that could have signified prehistoric quarrying. Coope and Garrad's reason for choosing this location as the site of the Manx quarry is unclear, but presumably based on inspection in the hand. The rocks in the area are very similar to axe-heads in the collection.

An undated field sketch reproduced in Figure 4:11 was discovered in the Museum archives and is credited to J. Roscoe. The accompanying note states:

'This site is in the Cooil area approximately 300 yards (270 metre) South South West of Ballapaddag Farm. A farm lane runs in this direction immediately behind the farm buildings. The site is on the right of the lane as you proceed South at the far end of the first field behind the farm. Access can be obtained to the area by a field gate just North of the site. The land slopes away to the South West and is just below the 300 foot contour. The quarry is a considerable depression in the ground unfenced to the West with the result that cattle have got into the area and combined with a waterlogged bottom there is a considerable accumulation of slurry and mud. The Northern faces of the quarry are very steep and have been covered with farm rubbish and old motor vehicles. There is a considerable amount of undergrowth and brambles on this tipping area. The South East face of the area appears to be composed of soil and is fenced with barbed wire at the top. The depression is elongated to the South West ending in a patch of thorn trees growing out of the mud. The widest part of the quarry is approximately 22 paces and at its highest point is approximately five metres above the wet bottom. Very little bed rock is showing and this is steeply angled into the ground accompanied by a Quartz vein.'

Figure 4:11 Roscoe, J. (undated) Ballapaddag map annotated



Led by Peter Davey, members of the IPG visited the source areas in 2007 and acquired a handful of samples from the immediate area described by Roscoe. These samples (BPG-01, BPG-02, BPG-03) have been subject to both destructive and non-destructive analysis along with an additional sample (BGP-04) collected more recently from the adjacent field boundary. In the hand, these samples all bear a striking resemblance to some of the axe-heads ascribed to Group XXV.

On the weathered surfaces, the holocrystalline sample (BPG01) is a buff colour overall with anhedral, occasionally subhedral, prismatic phenocrysts ranging from pale green-grey to black in colour. These phenocrysts exhibit at least one cleavage perpendicular to the long axis and under x20 magnification with a hand lens it is possible to see a prismatic cleavage as well. There is one exceptionally large

aggregate of at least two minerals apparent on one weathered face, it is black in colour, 18mm long and 9mm at the widest point, the largest distinctive mineral in the aggregate is diamond shaped. When rotated in the light some of the phenocrysts (especially on the fresh cut surface) have a patchy, somewhat greasy, lustre. Excluding the aggregate, the phenocrysts are between 1mm and 8mm in size and make up approximately 50% of the rock. In the matrix, with the hand lens, occasional small translucent subhedral minerals can be discerned, as can minute angular and irregular shaped black patches. The majority of the matrix is buff coloured but small, paler yellow areas are also visible. No alignment of minerals is apparent. Weathering (in the form of orange discolouration) only penetrates into the rock in one area across the cut surface.

The second sample (BPG02) is very similar to BPG01. On the weathered surfaces, it is buff colour overall with similar anhedral, occasionally subhedral, prismatic phenocrysts largely mid-grey-green in colour, occasionally black. The same two cleavage direction as BPG01 are visible on some of the phenocrysts. When rotated in the light some of the phenocryst again have a patchy lustre, but unlike BPG01, the lustre on several of them reveals simple twinning. The phenocrysts are up to 6mm in size (slightly smaller than BPG01) but rather than exhibiting all sizes in a range like BPG01, there are 3 discrete sizes of phenocrysts. The smallest are anhedral and up to 1mm, others are almost pentagonal, largely subhedral between 3mm-4mm, and the largest are 4-6mm, sometimes elongated but generally anhedral. The rock is noticeably more crowded with phenocrysts than BPG01 and the matrix makes up less than half on the rock (c.40%). In the matrix, the small angular black patches and the faint yellow areas present in BGP01 are visible but less prevalent in this sample. No alignment of minerals is apparent and weathering does not penetrate into the rock.

The weathering in sample three (BPG03) penetrates up to 5 mm into the rock, discolouring the sample to orange-brown in those areas. The overall buff colour and presents of phenocrysts is similar to both BPG01 and BPG02, however the matrix is even more in the minority due to the increased abundance of small phenocrysts. In this sample there are two different grain sizes for the phenocrysts, the small angular, anhedral minerals up to 1 mm in size and the sometimes elongated larger minerals which are between 3-5 mm. The distinctive cleavage of the phenocrysts seen in other samples is also present in this rock and again the lustre is patchy and greasy. The increase in small phenocrysts helps to highlight the shape of the minerals in the generally featureless matrix, evidence of pale yellow lath-shape minerals as well as more equant grains are visible using the hand lens at x20 magnification. A few small angular dark patches are present, like BPG02. Again, there is no alignment of minerals.

The fourth sample (BPG04) from Ballapaddag is distinctively different from the other three. One face is very heavily weathered so the mineralogy is obscured. On the remaining faces the matrix is cream-white as opposed to buff, and the phenocrysts are mid-grey in colour with jagged edges that bleed into one another making an assessment of their size difficult. However, the largest patches are approximately 5mm in diameter. When rotated in the light the phenocrysts do not twinkle as they do in the other samples, but minute dots at the margins between matrix and phenocrysts become visible with an almost metallic lustre. As with BPG03 the matrix is in the minority, accounting for only about 10% of the rock on the freshly cut face. Again, the shape of the phenocrysts help the lath shape white minerals to stand out under the hand lens. Within the matrix, an overall pearly lustre dominated. No small black angular patches are evident, nor is there any alignment.

Using the microscope, the phenocrysts in BPG01 exhibit up to second order interference colours in XP, the extinction angle is 87° and some of the phenocrysts have simple twins. In the matrix between phenocrysts, lath-shaped outlines are generally completely infilled with very fine indistinguishable alteration products that have no preferred orientation. In plane polarised light (PPL), there are small, clear, angular, anhedral minerals, with no cleavage, and the Becke Line test revealed it has low relief.

In PPL, at x2.5 magnification sample BPG04 is dominate by very fine dark coloured alteration products interspersed, with clear (occasionally yellow) anhedral angular fragments making up approximately 20% of the view finder (there are also irregular shaped holes in the rock which can only be distinguished from these clear minerals under XP because they stay black for 360°). Low relief pale green anhedral minerals are also present in small quantities, as are sub-rounded opaque minerals, each making up no more than 5% of the view finder. The phenocrysts are largely replaced by alteration productions and under cross polarised light (XP) only the low order interface colours of the clear minerals are visible.

All samples collected from Ballapaddag are igneous. The phenocrysts in BPG01, BPG02 and BPG03 are identified as augite. The patchy lustre seen in the hand is reminiscent of mica, suggesting secondary replacement by clay minerals, under the hand lens it became apparent that these areas are not limited to the phenocrysts and show interference colours which infer they are likely to be muscovite. The lath-shaped mineral outlines would have originally been plagioclase, now sericitized. BPG04 appears to be much more highly altered than the other samples. The clear minerals with low relief and first order interference colours are quartz, the yellow colour of some of them is due to the thickness of the slide. The angular and irregular shaped black patches are probably Ilmenite ($FeTiO_3$) in all samples.

4.5 X-Ray Fluorescence Spectrometry

Best practise continues to evolve, but it is generally accepted that Portable X-Ray Fluorescence Spectrometry, a common geochemical technique for provenancing studies, works well as a non-destructive method for determining a geochemical signature when the material being analysed is homogenous. A representative signature for the material is possible regardless of sample orientation; as is the case with the obsidian artefacts. Unfortunately, the heterogeneous nature of many coarse igneous rocks means that every igneous body produces a unique and variable chemical signature so the use of X-Ray Fluorescence Spectrometry has its limitations. The Manx axe-heads of the potential local source are heterogeneous (i.e. they have a variety of different minerals, often of different sizes) so the signature recorded from the PXRF beam will change depending on what part of the axe-head is analysed. As such a novel method was explored for gaining a representative signature to compare to the Manx source samples.

4.5.1 Chemical analysis techniques in archaeology

In the last forty years a variety of techniques have been applied to the analysis of archaeologically important lithic samples, to describe mineralogy, and estimate chemical composition. Neutron Activation Analysis (NAA) (Glascock, 2011; Hughes, 1984), Induction Coiled Plasma Spectroscopy (ICPS) (Speakman et al., 2002) and Atomic Absorption Spectrometry (AAS) (see Spoery 1989) are all common tools in provenance studies. NAA is the most widely used. Other techniques, including Spark Source Optical Emission Spectrometry and Gamma Spectroscopy, have also been adopted for analysis of archaeological samples. However, Spark Source Optical Emission Spectrometry is only useful for conductive materials (which rules out lithics), and Gamma Spectroscopy requires large samples (i.e. m^3),(Piorek, 2008, pp. 2–4). Isotopic Geochemical Analysis 87Sr-86SR discrimination using TIMS

(specifically a VG 54E single collector thermal ionization mass spectrometer – see (Curran et al., 2001, p. 719) is also being used in modern studies. Laser Induced Breakdown Spectroscopy is a recent technique, similar to Spark Source Spectroscopy – however without being limited to conductive materials, also see Piorek, S. et al. (2008 4).

In Cathodoluminescence (CL) a sample is irradiated with a high energetic electron beam. This causes specific colours of light, produced by chemical impurities and/or structural defects that reflect the crystallization process, to be emitted (Chapoulie and Daniel 2007) and aids in the identification of distinct mineral phases so it can be used as an indicator of the provenance of detrital quartz grains. It is a particularly useful tool for discriminating quartz and feldspar types (Götte and Richter, 2006), and has been adopted by archaeologists to provenance a wide variety of ceramics (see Weiss et al., 2015) and Akridge and Benoit (2001), Robert et al. 2008, Zech and Weiss (2008).

At the International Symposium of Archaeometry in 2014, Nino Del Solar described how the Université Bordeaux Montaigne (France) in conjunction with Pontificia Universidad Católica del Peru (Peru) recently took an archaeometrical approach to understanding technical traditions of the pre-Columbian (c.7-11th Century AD) Mochica and Cajamarca Cultures in Peru as part of the 'San José de Moro Archaeological Program' (SJM) (Del Solar, 2014). First Optical Microscopy (OP) and Cathodoluminescence (Cl) analyses helped to substantiate the observed typological differences between pottery types and clustered the samples before performing Scanning Electron Microscopy-Energy Dispersive X-Ray Fluorescence Spectrometry (SEM-EDS) and Portable X-Ray Fluorescence Spectrometry. The results indicated three different chemical and technical traditions in ceramics for the late Mochica periods in SJM. In this example the SEM-EDS and PXRF data were exported as

spectra and analysed using a principle components analysis (PCA) with centring and no weighing of the data. Software that perform Principle Component Analysis (PCA) use linear algebra, specifically orthogonal transformations (see Todd, 2015), to create principal components (i.e. a set of values of linearly uncorrelated variables) from a set of observations of possibly correlated variables.

Other methods of elemental analysis or chemical characterization (atomic absorption, inductively coupled plasma spectroscopy, wavelength dispersive XRF) are either destructive, require massive units, are limited in function, or are too expensive when compared to the energy dispersive x-ray fluorescence model. Energy Dispersive X-ray Fluorescence (ED-XRF) technology is relatively affordable, minimally destructive and easy to use. The benefits of EDXRF make it the preferred method for a variety of applications, and the increasing sophistication of portable XRF versions has, as mentioned previously, increasingly gained popularity in provenance studies in recent years.

4.5.2 The application of PXRF in Provenance Studies

For archaeologically sensitive materials there is a desire that non-destructive techniques take precedence over microscopic analysis (Williams-Thorpe et al., 1999, p. 226). Research into non-destructive methods is on-going (among others, see Frahm et al., 2014; Glascock, 2011; Shackley, 2010; Williams-Thorpe et al., 1999, 2003), and portability is also an issue; fortunately continuing progress in precision engineering has led to the miniaturisation of components, while advances in data storage and processing speeds streamline technology. This has enabled techniques that once required expensive bulky equipment to be undertaken with relative ease, although costs remain a limiting factor. Generally, the choice of technology is also limited by availability of equipment, analysis time and the destructiveness of the technique. Ideally, the choice of technology should also be selected on the basis of the

experience and expertise of the users. Each method has its advantages and disadvantages depending on exactly what needs to be accomplished.

Although there are several other non-destructive techniques, PXRF was chosen because it has a long history of use in lithic research and has been compared favourably to other techniques. As Liritzis writes 'the non-destructive advantage of the PXRF should be emphasized parallel with their portability because other non-destructive methods of analysis are available with even superior capabilities that measure a large number of elements (e.g., particle induced X-ray emission (PIXE), neutron activation analysis (NAA), infrared photoacoustic spectroscopy (IRPAS), fourier transform infrared spectroscopy (FTIR), secondary ion mass spectroscopy (SIMS)), but they are not portable. The portability coupled with the non-invasive capability makes the PXRF systems more favoured by archaeometrists and, especially, archaeological scientists' (Liritzis and Zacharias, 2011, p. 110). Although portability was not of prime concern in this study, since all samples were analysed in the lab, this feature nevertheless means that many other researchers have used the technique and as such there are many papers discussing the technique in detail. However, no technique is infallible and as Glascock states 'the accuracies of elemental concentrations determined by XRF are affected by many factors including surface texture, sample thickness relative to kiloelectron volt energies, inhomogeneity within the sample, particle size, and matrix effects' (Glascock, 2011, p. 163).

For this study, further destructive analysis was not desirable. Initially, a complete macroscopic inspection of each axe-head, and a review of the 57 available thin sections was undertaken. This was coupled with archival research into the work of Garrad and Coope and it was established that there are a variety of rock types used in the production of axe-heads on the Island, and most of them are not available locally.

However, in the hand the axe-heads categorised as Group XXV show a striking similarity to rock samples collected from Oatlands and Ballapaddag and as such a deeper look at the geochemistry was desired.

According to Olwen Williams-Thorpe work a decade ago 'analytical uncertainties should be small, typically 1-10% rsd for major elements (Potassium (K), Calcium (Ca), Titanium (Ti), Manganese (Mn), Iron (Fe), Rubidium (Rb), Strontium (Sr), Yttrium (Y), Zirconium (Zr), Niobium (Nb), and Barium (Ba)) and 4-13% RSD for trace elements... (But) while PXRF is capable of giving analytical data to precisions of 1±10% rsd and a high degree of accuracy on prepared (crushed and pelleted) samples (Potts et al., 1995), the non-destructive analysis of implements gives rise to additional analytical uncertainties.' (Jones and Williams-Thorpe, 2001, p. 3)

These additional uncertainties include spectrum analysis uncertainty (see also Williams-Thorpe et al., 1999), and to 'sampling uncertainty on multiple analyses of individual implements, related to the mineralogical variability within an implement' (Jones and Williams-Thorpe, 2001, p. 3; see also Potts et al., 1997).

X-ray Fluorescence Spectrometry works by projecting sufficient energy (x-ray or photon) at a sample to be absorbed by an atom. The x-ray source known as an x-ray tube (generally 40-60kV, 50-300W) emits an x-ray beam into the sample being analysed. The inner shell electrons are excited to an outer shell or removed completely and the empty inner shell that remains is 'filled' by electrons from an outer shell of the atom. The difference in energies between the two shells is emitted as radiation (i.e. it fluoresces) and the wavelength of the light is captured on the detection system. For any given element the energy difference between two specific orbital shells is characteristic of that element and as such is diagnostic; by determining the energy emitted by a particular sample XRF analysers software are

able to identify the element(s) involved after taking into consideration the mass absorption effects.

In 2011, Glascock explains that 'Matrix effects are caused by the absorption of fluorescent X-rays by coexisting elements in the sample which result in reduced intensity and/or enhancement of fluorescence radiation due to secondary radiation emitted by the fluorescing element or a coexisting element which yields an increase in intensity. The matrix effects observed in XRF are sometimes referred to as mass absorption effects. In general, every element exerts a mass absorption effect on all other elements present in the sample, but some of the elements are more affected than others due to absorption edges. When combined, these effects result in curved rather than linear calibration lines for each element. By using the intensities of the primary X-rays scattered by the sample, which are proportional to the effective mass absorption coefficient, corrections to the absorption/enhancement effects can be calculated resulting in a more accurate quantitative evaluation of sample composition. However, it is essential that the samples (i.e. standards) used for XRF calibration be as similar to the unknowns as possible to properly correct these matrix effects' (Glascock, 2011, p. 164).

In 1995, Philip Potts, Peter Webb, Olwen Williams-Thorpe and Richard Kilworth published a report on the 'performance of a field-portable energy dispersive X-ray fluorescence analysis system using 55Fe, 109Cd and 241Am excitation sources and a high resolution mercury (II) iodide detector' made by TN Technologies (now defunct) (Potts et al., 1995, p. 1273). As part of the study, they analysed 70 compressed powder pellets of international reference materials, primarily of silicate composition. 'Detection limits were estimated from the results obtained from the analysis of a wide range of reference materials using a live time of 200 s per source. Each set of results listed the analysed concentration and associated standard

deviation derived from a combination of counting statistics and the spectrum fitting error. This fitting error took into account the uncertainty attributable to background subtraction as well as the effect (if any) of spectrum overlap interferences. The results file for each sample was examined to identify circumstances where an elemental analysis had a value equivalent to or less than that of the corresponding fitting error. The value of this fitting error was then recorded as the standard deviation representing the uncertainty in fitting a background to the spectrum of the fluorescence line of interest. After examining results files for all 70 samples, a small range of standard deviation values was recorded for each element, ranging from 3 to 12 values (the number varied according to the number of samples in which the element abundance was at or below the detection limit level). The detection limit of the technique in silicate rock analysis was calculated as three times the average value of this standard deviation.' (1995, p. 1275)

In 2008, Williams-Thorpe continued to use the older Spectrace TN 9000 X-Ray Fluorescence Analyser used at the Open University since the mid-1990s. With a reliance on manufacturer recommendations for counting time compensation - 'Counting times for our work on silicate rock artefacts are generally between 100–200 s for the Fe source, 50–100 s for the Cd source and 20–40 s for the Am source. The counting times selected also depend on the age (and activity) of the sources, and the manufacturers' guidelines on increasing counting times to compensate for the radioactive decay of the sources should be followed'(Williams-Thorpe, 2008, p. 178). At Berkeley, where Shackley works, they use the Laboratory based EDXRF Quant'X system and test it 'semi-annually' through its software with a pure copper pellet for 24 hours at the same instrument settings, as well as analysing a known standard in each run of 20 samples, hoping that all measurements are 'within 1% standard error' (Shackley, 2010, p. 19). Shackley claims to have been criticised for the use of

international standards that were previously published in Govindaraju (1994) 'because of matrix issues (powdered versus glass matrices)' (Shackley, 2010, p. 19). According to Ferguson (2012, pp. 408–409) 'most standards are only available as powders (and) while the powders can be pressed into pellets there is the potential for analytical differences when analysing solid glass samples using a calibration based on pressed powders.'

According to Shackley (2011) lab-based X-Ray Fluorescence Spectrometry (XRF) 'enables chemical compositions to be determined in seconds. For an analysis of the elements Ti-Nb on the Berkeley Spectrace and Thermo desktop instruments, at 200 live seconds per sample it takes about 5–6 min per sample depending on mass.' and based on the work on obsidian in Peru by Craig et al. (2007), Shackley (2011, p. 13) determined that:

'(1) While there was a general, statistically significant agreement between the studies overall, significant differences occurred between EDXRF and PXRF in certain mid-Z elements; and

(2) The error rate was noticeably higher, giving larger dispersions about the mean in bi-plots with PXRF (Craig et al., 2007)'

Whereas, Morgenstein and Redmount established optimal exposure time for 'the study samples, powdered standards and test pottery sherds' by analysing them for 'exposure times ranging from 60 to 400 seconds'. Then this detection-limit data was 'plotted against time of exposure to determine where the detection-limit curves changed slope'. They found that past the inflection point on the graph at 240 seconds, 'additional exposure time did not markedly improve detection limits, so in the field they analysed each sample for a minimum of 240 seconds (Morgenstein and Redmount, 2005, p. 1614). However, their only reference to calibration is as follows: 'Calibration standards were used prior to analysis', highlighting the problems

mentioned by Ferguson (2012, p. 405) that without relevant matrix-specific calibration their data is unreliable. As Shackley points out 'internal consistency alone is not enough to validate results (Shackley, 2010, p. 19). Similarly, the issues associated with qualitative analysis in ED-XRF include problems of 'inter-observer error and when ratioing qualitative data the potential for mis-assignment to source' (Hughes, 1984; Shackley, 1995, 2005, 2010, p. 19).

Nevertheless Field Portable X-Ray Fluorescence Spectrometry (PXRF) is increasingly being used as a tool in archaeological provenance studies, although as mentioned above, several writers have highlighted the need to understand the importance of correct calibration and to be cautious when interpreting the data and its significance (Shackley, 2010). Goren writes 'A major development of the last decade was made in terms of the sensitivity of these units, as the limits of detection (LOD) of the previous generations were rather restricted, making them almost impractical for quantitative analysis of composite materials such as ceramics. Today, however, most manufacturers equip advanced models of PXRFs with Silicon Drift Detectors (SDD), lowering the LOD by an entire order of magnitude relative to the previous Silicon Pin Detectors and by up to four times relative to the Hg-I technology that existed over a decade ago' (Goren et al., 2011, p. 685).

As such, Shackley (2010, p. 19) proposed a protocol for conscientious Archaeometrists to observe when using X-Ray Fluorescence Spectrometry. Namely;

- Standards and analytical conditions must be explicitly stated: instrument settings, and parameters used should be justified. Standards need to be analysed periodically and the results published to establish validity. Internal consistency is not enough; the basic scientific premises of repeatability and full disclosure must be followed if the resultant conclusions are to have any merit. In regular reports Shackley 'includes the instrumental protocol and

analysis of at least one international standard comparable to the material measured'.

- Errors of artefact size and surface configuration: Shackley's experience with various models of PXRF, as well as the fundamental principles of x-ray fluorescence, suggest that there is a minimum sample thickness required to gain accurate elemental composition data.
- System reliability and stability: Shackley believes that the system used should be tested 'outside the corporate venue' (2010, p. 19) so that users are not reliant of vendor claims of stability.
- Qualitative versus quantitative analysis: Shackley does not believe that qualitative analysis i.e. 'directly observing and comparing spectra from source standards and artefacts' is on its own an appropriate way to differentiate sources. However, quantitative analyses, that is, comparing weight % and parts per million (ppm) measurements 'through empirical calibration' (Shackley, 2010, p. 20) is considered much more reliable.

Most recently, Frahm, Doonan and Kilikoglou (2014, p. 232) have compared the same model available at the University of Liverpool's Central Teaching Environment Science Lab (Thermo Scientific Niton XL3t GOLDD+ XRF Analyser 2010) with an older model by the same vendor (Thermo Scientific Niton XL3t XRF Analyser 2007). They found that 'Using the XL3t GOLDD+ analyser, we were able to markedly decrease the analytical time. With the XL3t, we analysed specimens for 300 s. This is fairly typical of recent studies (Forster and Grave, 2012; McCoy et al., 2011; Nazaroff et al., 2010). Using the XL3t GOLDD+ analyser, our time was 120 s in one mode ('mining') and 90 s in the other ('soils'). Furthermore, for our data analysis, we used the mean of three measurements with the XL3t and only two measurements with the XL3t GOLDD+ analyser. Thus, the total time per specimen was cut from 900 s to

180–240 s. This difference greatly affects the proportion of an assemblage that can be analysed in a specific time period (cf., four artefacts per hour with the PiN versus 15–20 artefacts per hour with the SDD).'

According to the Thermo Scientific Product Brochure (2010) 'GOLDD technology delivers vast improvements in sensitivity or measurement times – as much as 10-times faster than conventional Si-PIN detectors, and up to 3-times more precise than conventional silicon drift detectors (SDD). (They) achieved this improvement by uniquely combining an improved Niton XL3t 50kV, 200 μA x-ray tube, closely optimized geometry, and patented signal processing hardware and software. These advantages are coupled with (their) proprietary drift detector, one of the largest area drift detectors that is commercially available in a handheld XRF analyser, providing (the user) with superior performance in the form of faster analysis and lower detection limits. … (T)he instrument's low detection limits allow (the user) to identify anomalies near the averages naturally found in the earth's crust, something previously not possible with handheld XRF. … Additionally, you can achieve enhanced Mg-S performance with the optional He purge.'

However, Ferguson (2012, p. 401) notes that PXRF 'requires an understanding of x-ray physics, igneous petrology, the calibration process and the ability to test a sufficient variety of homogenous and well characterised reference materials suitable for developing a valid calibration curve' and that these factors restrict PXRF's ability to be the go-to 'point and shoot' handheld analytical tool the manufacturers would like us to believe it is. Ferguson criticises Morgenstein and Redmount's work on ceramic sherds in Egypt (2005), and Goren et al.'s paper on cuneiform tablets (2011) for publishing misleading data without a 'proper matrix-specific calibration', blaming it again on some instrument manufacturer's biased claims (2012, p. 405)

The work of Shackley, Ferguson, Glascock and others is largely based on work with obsidian. Obsidian is a type of homogeneous glassy rhyolite, used extensively throughout history as a tool because it is easy to work with, and capable of providing a sharp knife-like edge. It can also be strikingly beautiful. For an archaeometrist, obsidian is valued because there are a relatively limited number of source areas worldwide, and the elemental composition of individual exposures is restricted by regional geological history and geochemistry, therefore characteristic 'fingerprints' for source areas can be established with comparative ease, although unsurprisingly confusion between sources areas is always still possible (see Shackley, 2010, p. 19). Incompatible elements can be used as key indicators of specific sources, as Glascock clarifies in the case of obsidian, 'The incompatible elements are those that have difficulty entering the cation sites of minerals in volcanic magma and, instead, have higher concentrations in the liquid phase of the magma' (Glascock, 2011, p. 172). There are two groups of elements that don't easily enter the solid phase, namely, light-ion lithophile elements (LILE) with large ionic radius, such as Potassium (K), Rubidium (Rb), Caesium (Cs), Strontium (Sr), Barium (Ba), Rare Earth Elements (REEs), Thorium (Th), and Uranium (U) and high-field strength elements (HFSE) with large ionic valences such as Zirconium (Zr), Niobium (Nb), Hafnium (Hf), and Tantalum (Ta). As with all magma derived rock types, the 'initial composition of the magma, thermodynamic properties experienced by the magma (i.e., pressures, temperatures, partitioning coefficients), and the age of the magma' all effect the finally composition (Glascock, 2011, p. 172).

In the case of non-destructive analysis of heterogeneous coarse-grained igneous rock like those studied in this project, all of the issues affecting homogenous rock types are magnified. Portable XRF is generally considered a useful tool for determining bulk composition, so when element concentrations are clusters (as they are for

heterogeneous rock types) the viability of PXRF is brought into question. In order to overcome issues of surface irregularity, non-homogeneity, particle size and matrix effects, PXRF becomes even less of a 'point and shoot' technique and instead repeated readings on several different areas of the sample are required.

Portable X-Ray Fluorescence Spectrometry (PXRF) has been adopted in a non-destructive attempt to generate a distinctive geochemical signature for the Manx axe-heads that have been assigned to IPG Group XXV on the basis of macroscopic inspection or analysis of thin sections.

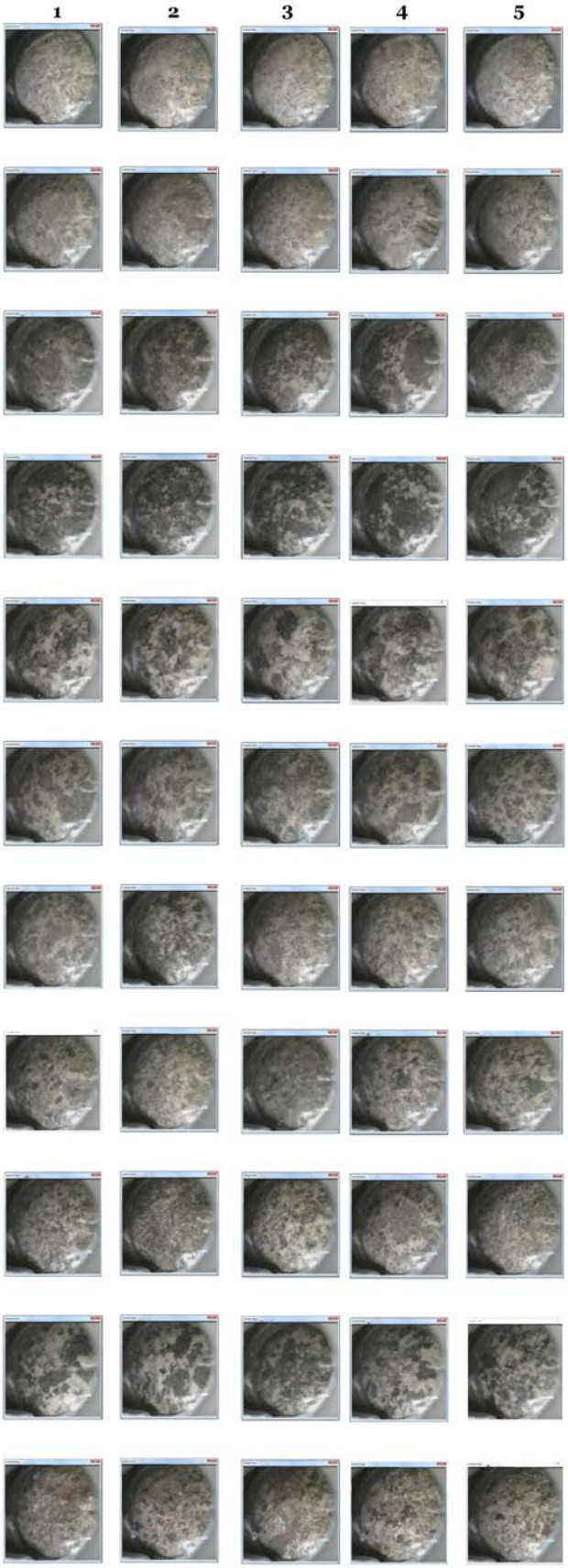
Several authors have discussed sample thickness (notably Cesareo et al., 2008, pp. 207–213; Ferguson, 2012, pp. 413–418; Liritzis and Zacharias, 2011, pp. 130–131, 132, 138; Markowitz, 2008, pp. 15–16, 18, 28–31; Williams-Thorpe, 2008, pp. 175, 181) and since x-ray penetration depth is also limited to 10 mm (Williams-Thorpe, 2008, p. 181) larger samples (e.g. columns, statues, rock samples, alloys etc.) are said to have 'infinite thickness', which is defined by Ferguson as 'the thickness at which additional sample thickness does not result in additional fluorescent x-rays (Ferguson, 2012, p. 413; see also, Cesareo et al., 2008, p. 207). He also notes 'infinite thickness is different for each element in direct correlation with the excitation energy and varies between matrices'. Similarly, surface relief needs to be considered and according to Potts et al. (1997, p. 775) in 'analysis of rock samples with irregular surfaces by portable XRF, large errors will arise even for small air gaps of 1–2 mm between analyser and sample, unless an appropriate correction is applied to measured intensities', however, more recent PXRF models (including the one utilised in this experiment) have an optional Helium (He) Purge (hereafter, He Purge) which the vendors claim is designed to minimise this problem.

For the Manx axe-heads, the PXRF was used in the lab, supported by its frame, and the axe-heads were placed in the static examination chamber. In order to eliminate

the air gap as far as possible, non-reactive foam packaging was used to support the axe-heads in the chamber so that a polished surface was in contact with the beam at all times, this—along with the roughened butt on several samples—limited the choice of location considerably in some cases, but five unique locations were analysed and each spot was photographed in the chamber using the in-built camera (see Figure 4:12).

In general, the accuracy of PXRF is only considered well-tested on homogeneous rock types. The purpose of my test study is to determine the reliability of modern Portable X-Ray Fluorescence Spectrometry (PXRF) as a non-destructive method for determining the elemental composition of these coarse-grained, heterogeneous lithic samples of archaeological importance. Ideally, given the right methodological parameters, PXRF can be used to reliably determine the bulk composition of non-homogenous rock types.

Figure 4:12 PXRF Location Shots



4.5.3 Calibration and analytical method development

To get results from PXRF that are comparable to destructive methods the length of time the sample is exposed to the x-rays is crucial. It was hypothesised that when using PXRF there is an optimum exposure length time to gain results that are comparable to destructive methods. At this optimum exposure time, results for all methods tested should be within the range of 1% rsd for major elements and 1-5% rsd for trace elements, as established by Jones and Williams-Thorpe (2001, p. 3). The concentration (ppm or wt. %, and atomic wt. %) of immobile elements are key to identify bulk composition. However, it is very hard to directly compare the methods used here with the published literature because most of the previous work has been done on different machines using different detectors, exposure times and calibrations.

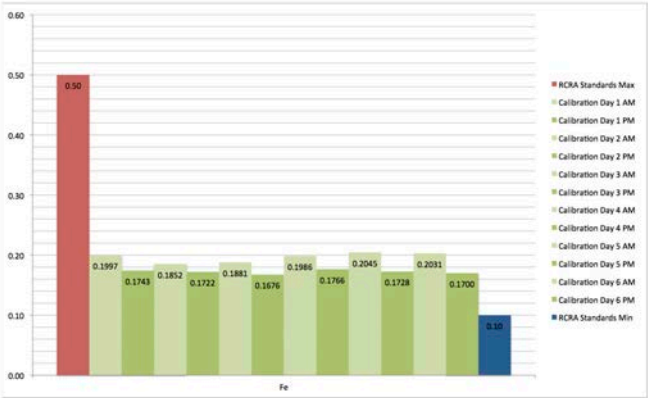
The analysis was carried out at the University of Liverpool Environmental Science Lab, using a Thermo Scientific NIT XL3T GOLDD+ XRF Analyser. The same instrument was allocated for all the analyses carried out for this project. In order to provide a check on the accuracy of the instrument, and to provide an external calibration, the standards (see Figure 4:13) were analysed before and after sample analysis. Over the course of analysis of the axe-heads, the variations in elemental concentrations of the standards varied only within the parameters outlined by the vendors, see Figure 4:14. Similarly, when the source samples were analysed the same method of calibration was repeated and again always fell with expected parameters, see Figure 4:15, with the minor exception of Copper (Cu) which was consistently slightly under the minimum concentration established by the vendor during both sets of analysis, with the exception of two readings during the source sample set.

Figure 4:13 Calibration Standards for AL6061, provided by ThermoScientific Ltd.

%	*Al*	*Si*	*Fe*	*Cu*	*Mn*	*Mg*	*Cr*	*Zn*	*Ti*
Max	98.50	0.80	0.50	0.40	0.15	2.00	0.20	0.06	0.01
*Average XRF**	97.09	0.61	0.30	0.29	0.09	1.39	0.11	0.04	0.00
*Average OES***	97.47	0.70	0.32	0.31	0.08	0.93	0.10	0.03	0.02
Min	96.50	0.40	0.10	0.20	0.00	0.50	0.05	0.00	0.00

*These data were generated from 3 samples (Al 6061) from the same lot which were analysed 5 times on 3 different Thermo Scientific Niton XL2 GOLDD XRF analysers and 3 different Thermo Scientific Niton XL3t GOLDD+ XRF analysers (our model). Analyses were run at 10 seconds on main filter and 50 seconds on light filter
**These data were generated from 6 samples (Al 6061) from the same lot which were each analysed 3 times on an optical emission spectrometer performed by Thermo Fisher Scientific.
Data downloads from www.thermoscientific.com/niton

Figure 4:14 Daily calibrations during axe-head analysis



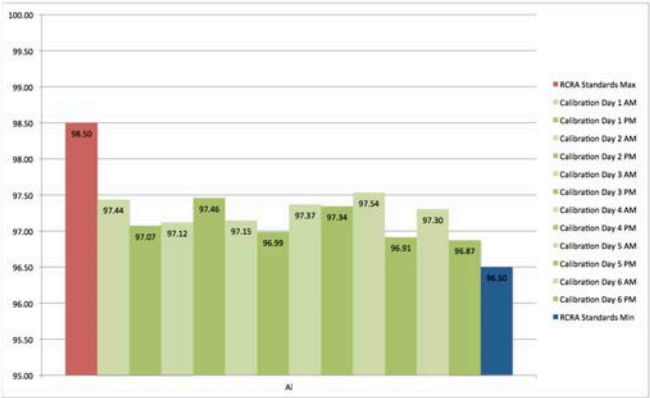
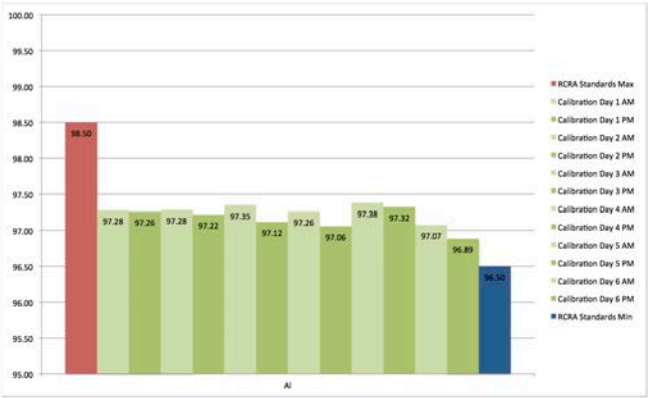
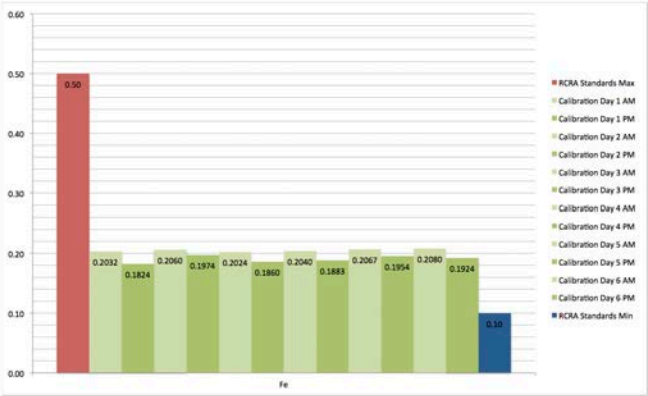


Figure 4:15 Daily calibrations during source sample analysis





The samples were analysed by PXRF without any surface preparation or pre-treatment. It is important that the technique developed is completely non-destructive so that it is a valid method for determining the composition of archaeological significant lithic samples when any kind of alteration is not permitted (as in the case of the Manx axe-head collection). By analysing the same sample several times and varying the element range exposure times, the optimum time needed to gain accurate results was determined. Once reliable parameters had been set this methodology was used to analyse the composition of the axe-heads in the Manx collection, then to make comparisons between the results from the axe-heads and results from rock samples collected from outcrops on the Isle of Man.

4.5.4 Setting PXRF Parameters

The three key parameters that need to be established before utilising PXRF are count times, element ranges, and repetition. First, it was essential to establish the minimum exposure (count) time needed to obtain valid results to expedite data collection. Shackley, (2010) suggests analysis for 200s; more recent work by Frahm (2014) proposes that this can be reduced with more modern equipment such as the GOLDD+ analyser used in this case to between 80-120s. For coarse-grained material a balance need to be struck between adequate exposure and overall run time. A count time of 200s per location equates to almost ten minutes after only three readings have been taken. As such, especially for coarser grained material, it is important to establish at what point further exposure produces no further data.

The second parameter is element range. This sets the length of time each section of the spectrum is analysed, i.e. how long the analyser attempts to detect elements within each of the following ranges: main (Cl-U) high, low, light (Mg, Al, Si, P, S). The GOLDD+ analyser has three bulk modes: soils, metals and TestAll™. On the advice of the University's Lab technicians, the light range was double the length of the other ranges and the analyser was used without optional He purge in the TestAll™ mode.

The third parameter, repetition, depends on grain size. Williams-Thorpe decided that the number of measurements per implement chosen, following information and guidelines in Potts et al. (1997), as 1-2 for fine-grained implements, and 2-5 for the coarser-grained implements. However, for the variation inherent in coarse-grained material, this did not seem adequate so samples of the Loch Dhoon granodiorite were used to test the parameters[2].

[2] These samples were originally collected in Scotland during a fruitless review of potential erratic sources of the coarse igneous material.

To compare parameters, the sample was run for a series of six sets, on three locations on the sample. As can be seen in Figure 4:16 below, sets 1 and 2 were run on location 1; sets 3 and 4 were run on location 2, and sets 5 and 6 were run on location 3. The odd numbered sets were set to counts of 201s and element ranges: main, high and low for 40s, light for 80s. The even numbered sets had these parameters halved. The data collected was plotted using the same element ratios and at the same scale as various analyses in the published literature, see Figure 4:17, further examples were plotted and included in Appendix 3.

Figure 4:16 PXRF Test Parameters

Location on Sample:
Sets 1 & 2 = Point 1
Sets 3 & 4 = Point 2
Sets 5 & 6 = Point 3

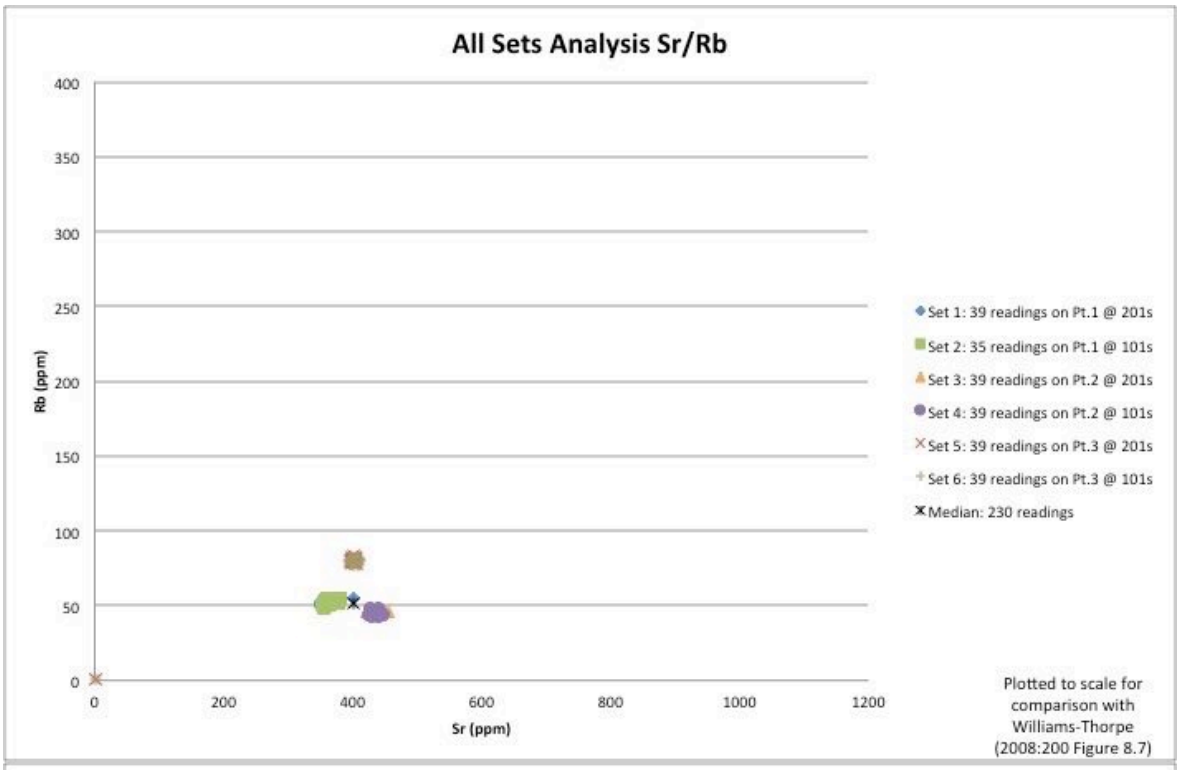
Total Count Time:
Sets 1, 3 & 5 = 201s
Sets 2, 4 & 6 = 101s

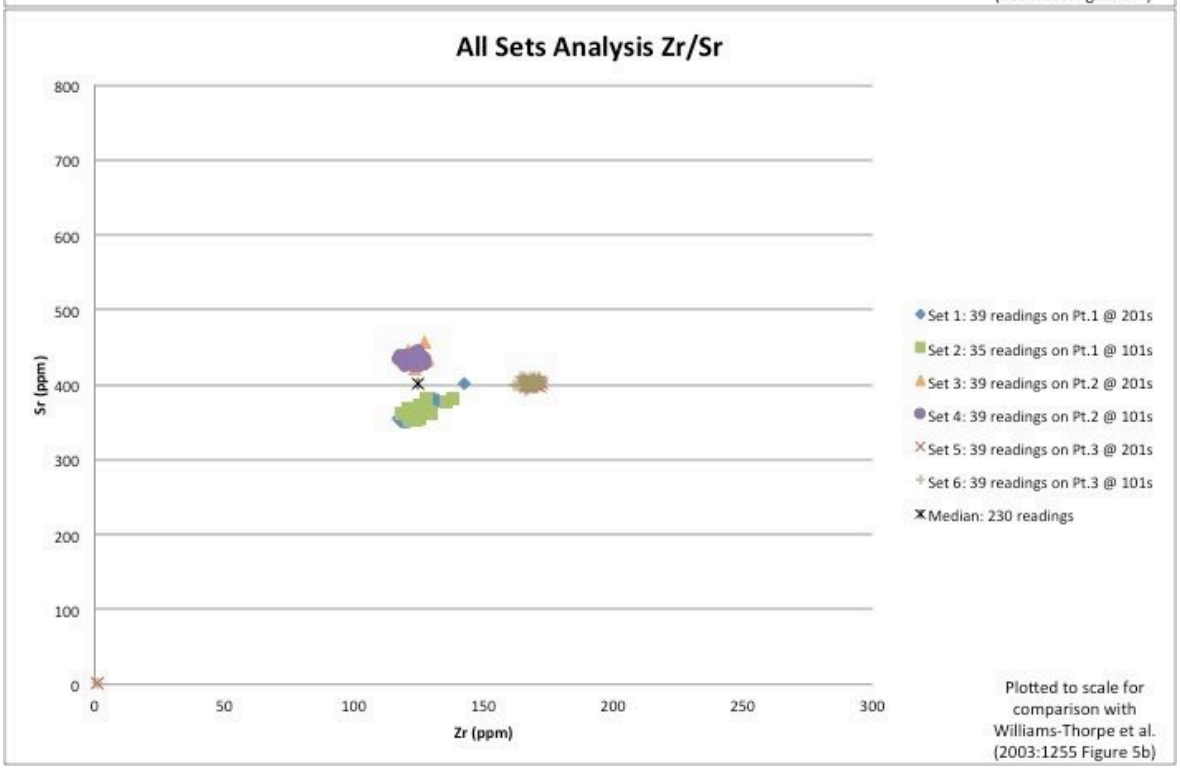
Element Range:
Sets 1, 3 & 5 = Main 40s; High 40s; Low 40s; Light 80s
Sets 2, 4 & 6 = Main 20s; High 20s; Low 20s; Light 40s

Total Number of Individual Readings: 230
Set 1 = 39 readings
Set 2 = 35 readings
Set 3 = 39 readings
Set 4 = 39 readings
Set 5 = 39 readings
Set 6 = 39 readings

The results obtained indicate that there is no discernible difference in count times and element ranges; overall, sets on the same location plot as a cluster. The location, however, as expected is significant; discrete clusters are apparent for each location tested and this confirms that to get a representative result, as many locations as practical need to be analysed. To that end, after these preliminary runs on the PXRF, it was decided that the Manx axe-heads and source samples would be analysed 20 times on 5 locations, giving 100 readings per axe-head, in an attempt to account for the heterogeneity of the samples. It took 40 minutes per location, 3.5 hours per axe=head/source sample.

Figure 4:17 Results for the Loch Dhoon samples used to test PXRF parameters





4.5.5 The result of PXRF analysis of Manx axe-heads and sample sources

Once the data was collected it was compared to the results obtained from published reports, primarily the work of Williams-Thorpe (2008; 2006; 2003; 1999) but also Markham and Floyd (1998) and (Liritzis and Zacharias, 2011). The main bulk of the data derived from analysis of the axe-heads and source samples is given in Appendix 3, but a selection of elemental ratios comparable to those found in published reports have been plotted for both the axe-heads and source samples, see Figure 4:18.

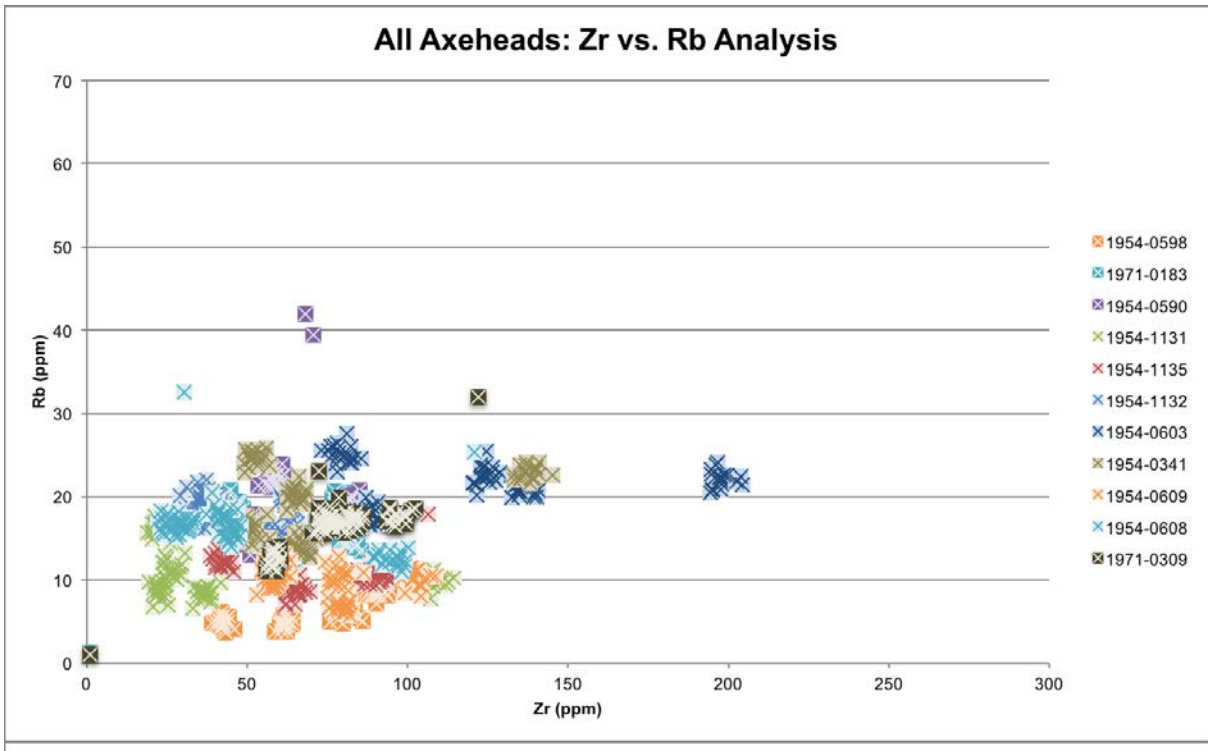
The results achieved, when coupled with the analysis of axe-heads and source samples in the hand and under magnification, indicate that the Group XXV axe-heads are likely to be made from a Manx source. However, the results indicate that the two areas suggested, Oatlands and Ballapaddag, are geochemically related. Further in-depth analysis utilising principal component analysis (PCA) is desired to discriminate a diagnostic geochemical composition; PCA allows for in depth appraisal of the key elements under scrutiny by revealing which proportions of these elements significantly digress from the norm. This simplifies data assessment, and allows for target analysis. Unfortunately, this has not been possible to date. Instead, a simpler comparative analysis was completed. The elemental ratios considered are given in Figure 4:18, it was found that there is some considerable overlap between source areas and axe-heads, but interestingly clusters are apparent that deserve further scrutiny; the clarity of these clusters is dependent on the elemental ratios selected. When zirconium (Zr) is plotted against rubidium (Rb) the axe-heads plot well with all Oatlands samples (except OAT-05) as well as with BPG03 from Ballapaddag, see Figure 4:19. However, titanium (Ti) vs. strontium (Sr) does not show any clustering. PCAS would help to clarify the significance of each elemental ratio.

It seems likely, from this limited analysis that the similarities seen in the geochemistry of the two source areas are the result of a common volcanic origin. When considered together, the three discernible groups identified macroscopically: Group XXVa (pale), Group XXVb (dark) and Group XXVc (green), were initially believed to be evident when the data was plotted. However, when the clusters are traced back to the axe-heads, the groups based on colour alone are not confirmed. Instead, the main petrological difference seen in the clusters between any individual axe-heads and either source is the variability of the grain-size, and crucially the matrix to phenocryst ratio. Mineralogy at least macroscopically appears largely consistent, although some axe-head examples, as noted by Clough (1988) exhibit more alteration.

Figure 4:18 Considered Elemental Ratios

Elemental Ratios	*Apparent Groupings*		
	Axe-heads	*Source Samples*	
Zr vs. Sr	3 possible	2 possible	(Williams-Thorpe et al., 1999, 2006)
Zr vs. Rb	2 possible	3 clear	
Nb vs. Zr	2 dubious	2 dubious	(Williams-Thorpe et al., 2004)
Nb vs. Zn	2 dubious	2 dubious	
Zr vs. Zn	3 possible	3 possible	
Zn vs. Sr	3 possible	3 possible	
Ti vs. Sr	2 possible	unclear	(Liritzis and Zacharias, 2011)
Ba vs. Sr	unclear	2 possible	(Williams-Thorpe et al., 2006)

Figure 4:19 Apparent data clusters in PXRF data



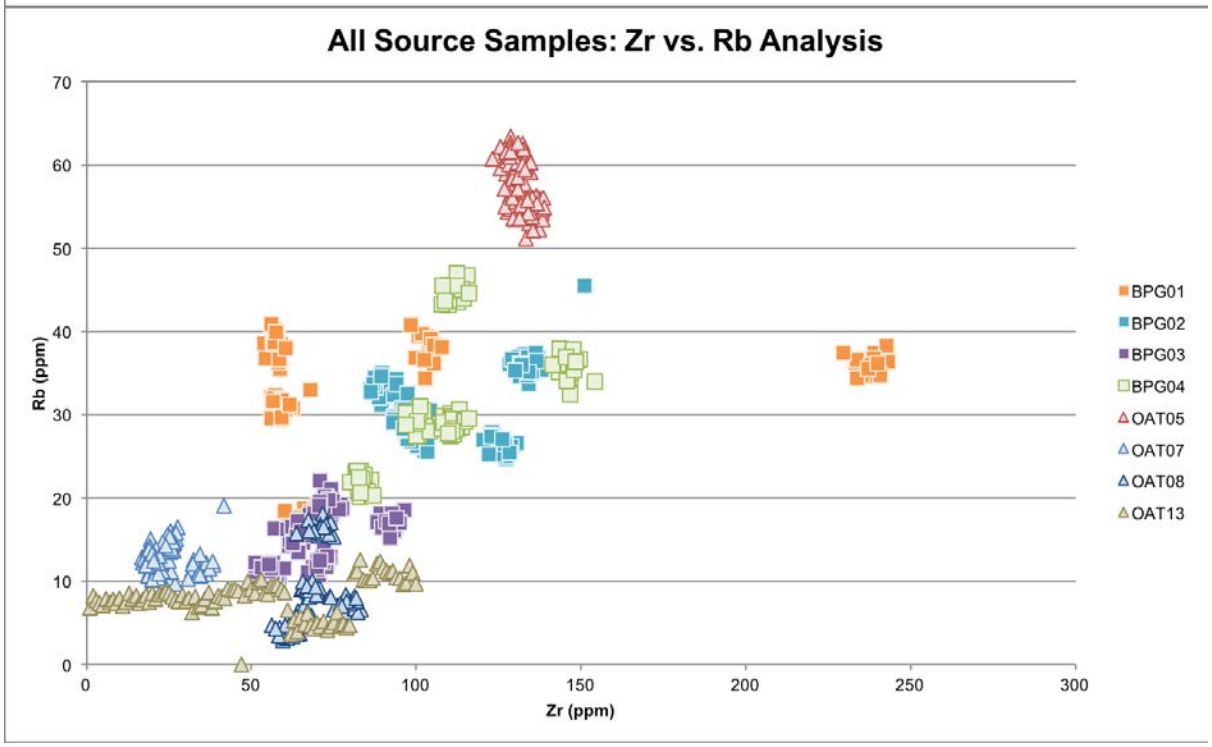
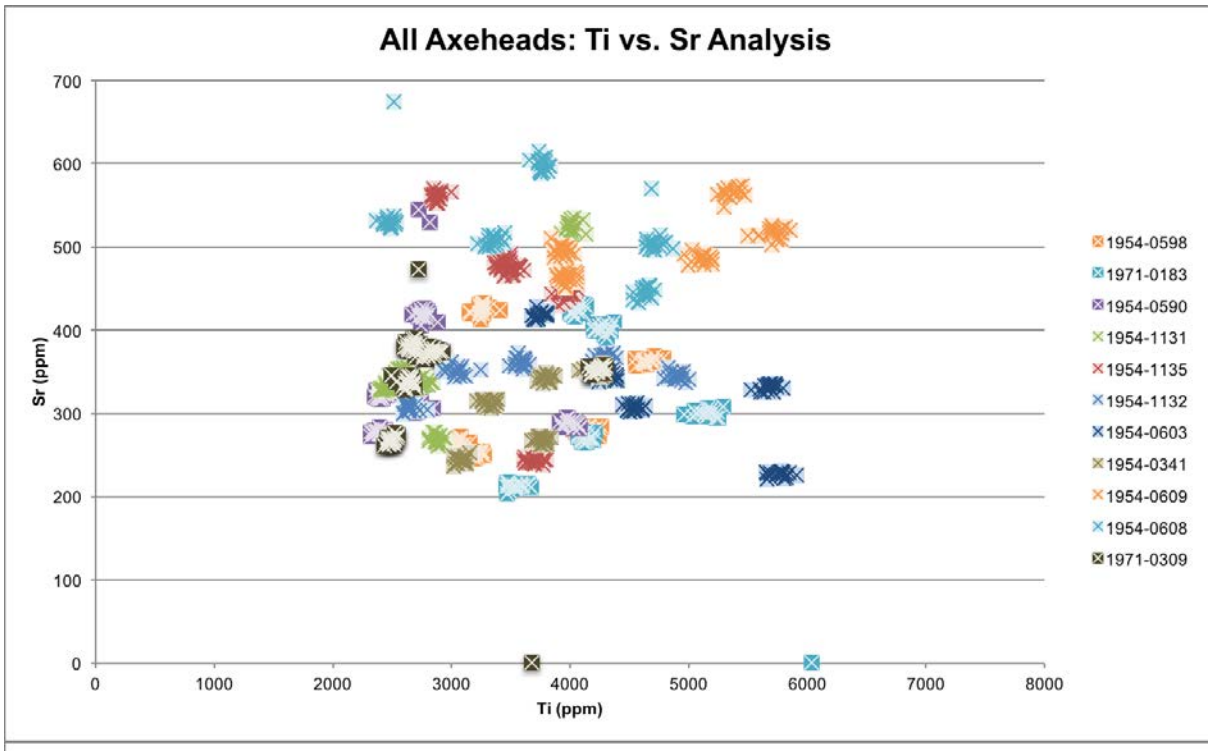
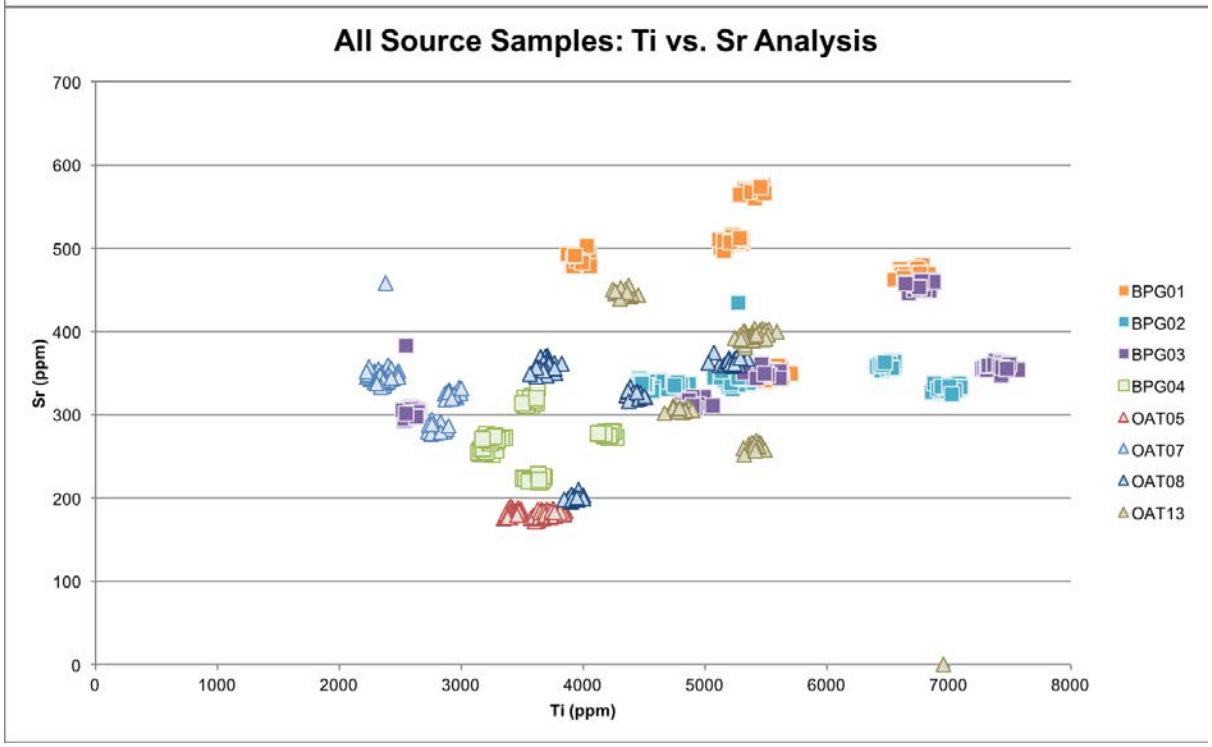


Figure 4:20 Poorly correlated elemental ratios in PXRF data





CHAPTER 5

5.1 Gathering Contextual Information

In general, the purpose of gathering information on the contextual setting of any artefact aims to define a chronology for the various styles and materials used through a given period. Identification of potential reasons for, or influences on, how and why the designs may have changed informs our understanding of the actions and priorities of individuals and groups in the past. On the surface, collating data about the circumstance of discovery of axe-heads seems to be a reasonably easy task to accomplish. However, anyone who has ever attempted archival research will confirm that there are many hurdles to overcome in order to understand and, if lucky, verify the myriad forms of contextual information potentially available. A recurrent issue is the veracity of the data. Often it must be taken at face value with inherent uncertainty in the data accepted. In most cases, the artefacts were recorded as chance finds, and many of the donors are long deceased. It has therefore been necessary to assume that the Museum's information is fundamentally correct for the purpose of this review. As discussed in more detail in the following pages, the contextual information collected for this project focuses on 'find spots', i.e. locations, and 'find types', i.e. the circumstances of discovery.

5.1.1 Find Spots

The Isle of Man is divided into six Sheadings: Ayre, Michael, Glenfaba, Rushen, Middle and Garff. These Sheadings are currently subdivided into seventeen parish districts: Andreas, Arbory, Ballaugh, Braddan, Bride, German, Jurby, Lezayre, Lonan, Malew, Marown, Maughold, Michael, Onchan, Patrick, Rushen, and Santon; as well as four town districts: Douglas (Borough), Castletown, Peel and Ramsey, and five village districts: Onchan, Kirk Michael, Laxey, Port Erin and Port St. Mary, see

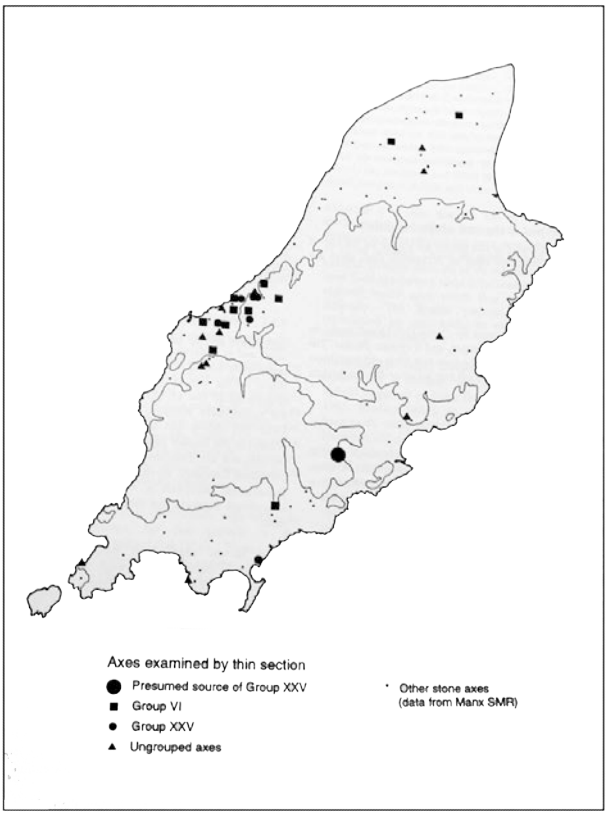
Figure 5:1. Generally, find spots can be grouped into the following types (in increasing size order): field/plot, farm/village/town, area, Parish, region, Sheading. The level of precision depends on the information available for each artefact. A few of the finds, mainly those found by field walker C.H. Cowley, (see Garrad, 1978b) have plot numbers that refer to the specific field in which the artefact was located. Others have descriptive references (e.g. 'found in wall'). In some cases, extra information is included on the particular area in which an axe-head was found, for example – 'the Lhen', 'Cain's axe field', 'near the big tree' or just 'long field'. Accordingly, sometimes this information is now redundant and cannot be relocated, but in the case of old farms, many colloquial area names and known landmarks like 'The Lhen'*[a] these references can help to restrict the find locale considerably.

As part of Stephen Burrow's PhD, the distribution of Manx axe-head finds were plotted using the information available on the Manx Sites and Monuments Record (SMR) (Burrow, 1997, p. 31 see also Figure 5:2.). For the author's Masters Project in 2010, the SMR data for the RTBAs was recorded; however, the SMR records for the Isle of Man have not yet been digitised and there appears to be several omissions and errors, many of which are noted in the museum records. As such, it is believed that the ambiguity requires further clarity before the SMR data is of practical use to the study of axe-head distribution around the Island. Nevertheless, the distribution, based on museum records was analysed, see Section 5.3.

a The Lhen was a post-glacial outwash river in the north of the Island, which was dug out in the 18th Century CE to improve drainage in the surrounding curraghs (English: wetlands).

Figure 5:1 the Sheadings, Parishes and Towns of the Isle of Man

Figure 5:2 Burrow's distribution map of Manx stone axes (1997, p. 31)



5.1.2 Find Type

Since the quality of the contextual data collated varies, where possible data was checked against multiple sources and where conflicts arose a note was appended explaining contradictory information. For the purpose of data manipulation, the author had to make a subjective assessment of the accuracy of the data and use the most reliable source when producing statistics.

Many artefacts were chance finds, defined as artefacts discovered accidentally. The finder's details are sometimes included in the records, but not often —it is more common to have a record of the donor's name. Where possible this information has been recorded because it helps to highlight any patterns in the data that might at first appear to relate to distribution in the Neolithic, but is actually the result of a common form of collection bias. For example, the largest number of axe-heads have been found in the parish of German (n=33). While this could be a result of a number of factors in the Neolithic, such as; a concentrated population in the area; a longer period of axe-head use in the area; a specific area of production or trade; an inclination to preserve or venerate axe-heads, etc. In actual fact, Charles Cowley dedicated a lot of his time to field walking in the Parish (Garrad, 1978b), and this would not only have potential skewed the statistics, it would likely have also made local residents more aware of the existence of these otherwise inconspicuous finds. Similarly, field walkers Alan Skillian and Rob Farrer have collected finds in the north and south of the island respectively and contribute significantly to the Manx Museum's collection (Garrad, 1999).

Where known, the donor's details and the date of donation are recorded. However, sometimes it is not clear whether the axe-head was found or donated at the date recorded —in these instances it has been presumed to be the latter.

5.1.2.1 Context Code

A standard method for dealing with contextual information is to assign codes representing the environment of discovery. This helps to quickly identify what percentage of the collection might genuinely be useful for discussing axe-head usage and/or discard in the Neolithic. The context codes used by the IPG in their analysis of axe-heads in the UK were assigned to each Manx axe-head. These are based on the context codes established by ISAP (Cooney and Mandal, 1998, p. 9) and are used to define the environment in which the axe-heads were found. The importance of this information was originally highlighted by Sheridan's recognition that recording the potential ceremonial significance of wetland deposition and hoards would be advantageous, (Sheridan et al., 1992, pp. 392–395) as well as Gabriel Cooney's previous work in Leinster, Ireland (Cooney and Mandal, 1998, p. 5).

The list of context codes used in this study is given in Figure 5:3a it includes the IPG codes and two further context codes ('CD80 Grave and CD81 Unprovenanced) suggested by Vin Davis, late Chairman of the IPG (Davis, pers. comm.). After reviewing the collection, it was decided that CD81 Unprovenanced should represent those artefacts with a disputed find local, (n=13/206, 6.3%) whereas CD14 Unknown (n=89/206, 43.2%), is reserved for artefacts without contextual data, see Figure 5:3b. No artefacts were classed as CD03 Bog, CD04 Cave, CD17 Gravel Quarry, or CD18 Seabed. There are several reasons for this; gravel quarries do not occur on the Island, the coastal caves are inaccessible from the land, and no surveys have been documented. Similarly, no official marine archaeological surveys have taken place in Manx waters. The peat bogs found on the hills are on undeveloped land, future development may reveal axe-heads in this setting in the same way that development of infrastructure in Ireland revealed much for Neolithic archaeology.

In total, nineteen (n=19/206, 9.2%) includes six RTBAs (n=6) have been found during building work or the destruction of field boundaries (CD05 Disturbed) and six artefacts (n=6/206, 2.9%), including four RTBAs (n=4), have been found while gardening (CD06 Garden). Environments like CD19 Lake, CD08 Lake Shore and CD11 Riverbed are not easily ascribed either. Modern water courses are largely irrelevant; many have been augmented, damaged, restricted, enlarged or diverted. Areas like the Lhen and Port Cranstal in the north of the island were known water courses close to areas of archaeological interest during the Neolithic, two from the Lhen at the border between Jurby and Andreas were classed as CD10 Riverbank (n=2) but many of the artefacts found in this area (n=6) are instead better categorised in other classes (i.e. CD16 Monument/Feature). In Ireland, CD11 is by far the most common context code assigned (c.45%, see Figure 5:3c), whereas on Mann most axe-heads are found on agricultural land.

Sixteen percent of the collection have been found in plough-soil (n=34/206, 16%) and two more where found in wasteland and classed as CD12 Rough Pasture (n=2/206, 1%). Three axe-heads were found in the curraghs (i.e. English: 'wetlands') and classed as CD09 Marshy Ground (n=3/206, 1.5%). Two others were found near Manx beaches, i.e. CD13 Seashore (n=2/206, 1%). In addition, the two known Group XXVa (pale) artefacts found off-island, were also reportedly found on beaches, see Section 5.2.

Two axeheads and related finds where found in the preparation of the granite quarry at Oatlands in 1905, at the site of one of the Group XXV sources. These were classed as CD02 Axe Quarry Site (n=2), neither were RTBA. Another axe-head which could have been classed as CD15 because it was found during an excavation was instead categorised as CD07 Island (n=1); it was found out of context during the multi-period Peel Castle excavations on St. Patricks Isle, Peel in 1984.

Regarding axe-heads in graves (CD80 n=1), a Group XXV RTBA was reportedly found along with perforated slate objects (IOMMM 2781 and 2874) and a partially perforated, elongate artefact classed as a shafthole implement, but possibly a modified axe-head (see Figure 3:8) in a burial at Spanish Head by the Keggin family in the 1885 (@54.060591, -4.7746731, - a site recorded by William Cubbon as in the 'top field (XVIII/4 Plot 2341)').

In Patrick, a perforated axe-hammer from a Cist, near the Knockaloe Interment Camp was found in 1916 (see letter in Museum archives from T.A. Glenn, dated 6th Oct 1937.). Also at Knockaloe, on the same hillside as the cist, a hoard of four axeheads were found together and are classed as CD20 Hoard (with other axes) (n=4, 2%). Several axeheads were found buried with related Ronaldsway Culture material under the floor at the Ronaldsway House Site by Bruce and the Megaws in 1943, during an excavation where 12 axe-heads in total, of which nine (9) were RTBAs, were found across the whole site (see Chapter 1, Figures 1:11 and 1:12).

One axe-head, MNH 1972-0060, was found by Peter Gelling during his excavation of the Close Ny Chollagh roundhouse in Malew. This axe-head was out of context; found in an Iron Age drainage ditch, and had an unusual shape. Unlike any other axe-head in the dataset, axe-head 1972-0060 has an asymmetrical profile with a plano-convex cross section. There is a large dent in one face, with some evidence of pecking and scratches at the butt end, but no definitive RTBA features could be distinguished as a result of post depositional weathering. The thin section was originally analysed by Frank Shotton at the University of Birmingham. He designated the rock type as 'pure hornblende' i.e. a hornblendite, but no implement group or source was suggested. The unique morphology of this axe-head, and the circumstance of its discovery, might allow speculation that it was reshaped from a larger implement at some point, and subsequently discarded during the Iron Age

occupation of Close Ny Chollagh, however no independent verification of this is likely to be forthcoming. It should also be highlighted that the butt end of a ‘regular' polished axe-head was found during the BNLP excavation (mentioned in Section 1.5 and Figure 3.3, and Darvill assigned it, as well as three other ‘fairly substantial’ fragments, to Group XXV (Darvill and Chartrand, 2004, p. 18); however, none showed any RTBA traits. Fourteen more artefacts were found near to other reported monuments or features in the landscape and classed as CD16 Monument/Feature (n=14, 6.8%), including three RTBAs.

Figure 5:3a Artefacts by Context Code

	No. Artefacts	%
CD01 Agricultural Land	34	16.5
CD02 Axe Quarry Site	2	1.0
CD03 Bog	0	0.0
CD04 Cave	0	0.0
CD05 Disturbed	19	9.2
CD06 Garden	6	2.9
CD07 Island	1	0.5
CD08 Lake Shore	0	0.0
CD09 Marshy Ground	3	1.5
CD10 Riverbank	2	1.0
CD11 Riverbed	0	0.0
CD12 Rough Pasture	2	1.0
CD13 Seashore	2	1.0
CD14 Unknown	89	43.2
CD15 Archaeological Excavation	14	6.8
CD16 Monument/Feature	14	6.8
CD17 Gravel Quarry	0	0.0
CD18 Seabed	0	0.0
CD19 Lake	0	0.0
CD20 Hoard (with other axes)	4	1.9
CD21 Hoard (mixed content)	0	0.0
CD80 Grave	1	0.5
CD81 Unprovenanced	13	6.3
Total	**206**	

Figure 5:3b Context Codes in the Manx collection (including unprovenanced and unknown)

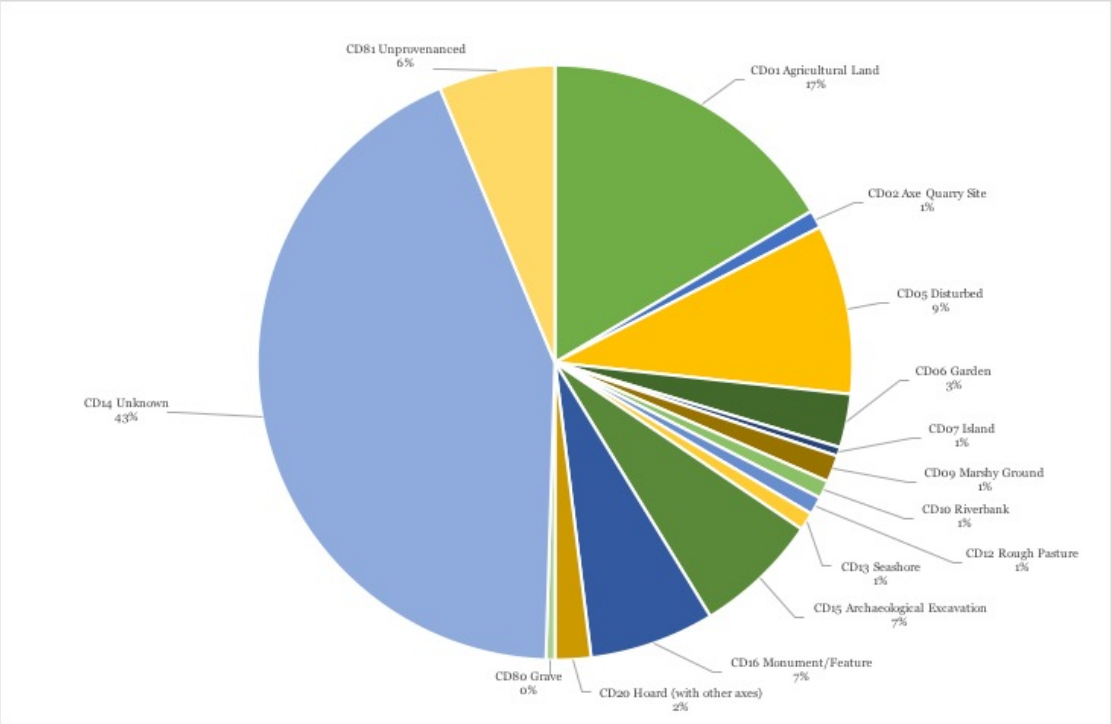
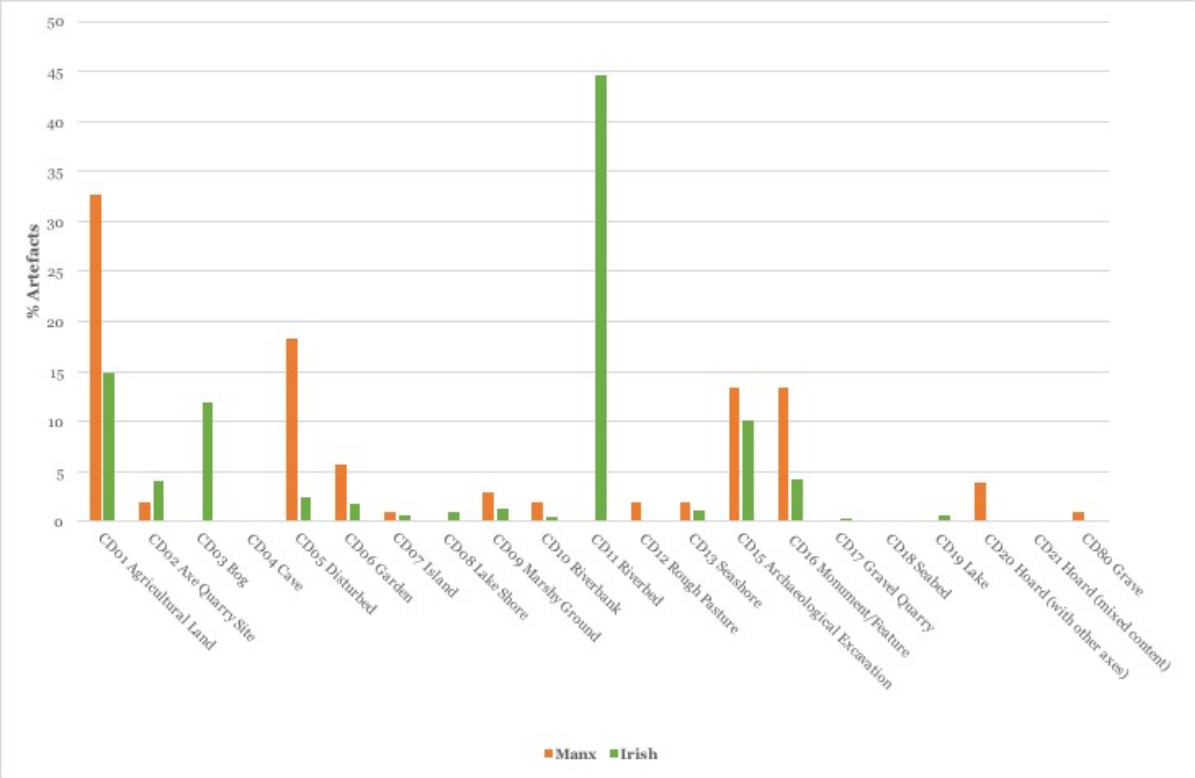


Figure 5:3c Context Codes in the Manx and Irish collections (excluding unprovenanced and unknown)



5.2 Dating the Manx Neolithic

In 1997, Stephen Burrow and Tim Darvill obtained consistent radiocarbon dates for Ronaldsway culture material; establishing that the Ronaldsway ceramic tradition spanned the 3rd millennium BCE, see also Figure 5:4. However, they also noted that the 'determinations from some of the sites studied appear to bunch together while others are more spread', and 'the total number of dates available is insufficient to provide an internal chronology for the tradition as a whole' (Burrow and Darvill, 1997, p. 415). As mentioned in the Section 1.5, Darvill's work since then has concluded that the evidence of activity starts to appear in the Billown area around the 38th-37th century BCE. Similarly, Rachel Crellin's research has placed the later Neolithic between 3000-2500 cal BCE. More radiocarbon dates are pending from Killeaba, near Ramsey and at Port Cranstal, Bride (Davey, pers. comm.). and a finer chronology could be on the horizon.

Axe-heads themselves are inorganic, and many were cleaned, scrubbed and handled in ways that today might be considered inappropriate; as such the opportunity to extract organic residue for analysis must wait until further axe-heads are uncovered on the Island. One date obtained by Darvill from material associated with a broken axe-head (that is apparently Group XXV) is dated to the early middle Neolithic, i.e. five thousand years ago (4980±4040 BP, Beta-140098) (Whittle et al., 2011, p. 558). Focusing specifically on dating the axe-heads, since only a limited number were found in a secure context during excavation there is no way to date the majority of the collection directly. It is therefore necessary to utilise relative dating methods to give an approximate date range in which the artefact would have likely been in circulation on the Island. This is achieved by noting any association with datable artefacts and/or features, allowing an estimate of the likely use-/end- date to be postulated. A note was made if the artefact was found with other artefacts, at a

specific site, or in an area where other items have been found at different times. It was found that thirty-five artefacts (n=35/206, 17% of the total collection studied) have been recorded with an archaeological association (i.e. CD02 Axe Quarry Site (n=2), CD15 Archaeological Excavation (n=14), CD16 Monument/Feature (n=14), CD20 Hoard (with other axes) (n=4) and CD80 Grave (n=1).

Figure 5:4 A summary of available radiocarbon determinations for Ronaldsway related material

site	material	laboratory reference number	uncalibrated determination b.p.	calibrated date BC/AD†
Ballaharra	charcoal	BM-768	4225±67	3027–2600 BC
	charcoal	BM-769	4233±59	3026–2616 BC
Ballavarry	charcoal	GU-2696	4140±50	2887–2584 BC
Killeaba	charcoal	BM-839	4381±58	3309–2905 BC
	charcoal	BM-840	4300±52	3089–2704 BC
Ronaldsway House	animal bone	GU-2694	3490±150	2274–1451 BC
	animal bone	GU-2695	1310±130	AD 452–986

† Dates BC are expressed at two standard deviations (95·4% confidence) and were determined using the OxCal computer program (1996) and the 1986 bi-decadal calibration curve (Pearson *et al.* 1986).

Above: readings made prior to 1995

(taken from Burrow and Darvill, 1997, p. 413)

Below: readings made since 1995

(taken from Burrow and Darvill, 1997, p. 415)

site	laboratory reference number	uncalibrated determination b.p.	calibrated date BC†	$\partial^{13}C$ (‰)
Ballacottier	OxA-5886	3790±50	2460–2040 BC	−27·9
	OxA-5887	4415±55	3330–2910 BC	−28·7
	OxA-5888	3945±50	2590–2300 BC	−26·7
Ballalheaney	OxA-5892	4075±50	2880–2490 BC	−28·6
	OxA-5893	3980±55	2900–2300 BC	−28·9
	OxA-5894	3775±50	2460–2040 BC	−26·8
Ballateare	OxA-5884	3955±70	2900–2200 BC	−28·1
	OxA-5885	4240±55	3030–2620 BC	−25·5
Ballavarry	OxA-5331	4035±40	2861–2467 BC	−29·8
	OxA-5332	4185±55	2914–2608 BC	−27·0
	OxA-5333	3830±80	2559–2040 BC	−27·4
Glencrutchery	OxA-5427	3950±55	2844–2293 BC	−28·6
	OxA-5334	3915±35	2561–2313 BC	−30·3
	OxA-5335	3930±40	2571–2316 BC	−28·7
Ronaldsway House	OxA-5328	3925±35	2567–2327 BC	−25·8
	OxA-5329	3985±35	2650–2458 BC	−25·7
	OxA-5330	4010±55	2697–2398 BC	−27·6
West Kimmeragh	OxA-5889	4260_50	3040–2960 BC	−28·9
	OxA-5890	4255±70	3040–2610 BC	−28·9
	OxA-5891	4280±50	3040–2700 BC	−26·8

† Dates BC are expressed at two standard deviations (95·4% confidence) and were determined using the OxCal computer program (1996) and the 1986 bi-decadal calibration curve (Pearson *et al.* 1986).

A comparison to similar artefacts and their datable associated finds in the encircling isles could potentially narrow down a use-life timeframe. The hafted porcellanite axe-head found in Scotland was dated to the Middle Neolithic, c.4470±95 BP (3490–2910 cal BCE at 2σ, OxA-3537) (Sheridan, 1992, pp. 198–201), see also section 3.3. Torben Ballin cited an Early Neolithic date for pitchstone movement across northern Britain and Ireland with a later Late Neolithic distribution more restricted to the west but as far north as Orkney (Ballin, 2015, p. 1).

According to Bradley and Edmonds (1993) the Cumbrian sites saw the peak of their production late in the Neolithic, although Whittle et al.'s reanalysis casts some doubt on a renewal of non-local circulation in the later part of the period, see Section 1.5. Evidence exists for continued use of the distinctive Group VI rock into the Bronze Age; for example, Group VI arched bracers (i.e. wrist guards of concavo-convex section) have been found in Cambridgeshire, Yorkshire, Hertfordshire and Wiltshire (Woodward et al., 2006). The geographic distribution and popularity of the Group VI axe-head was very apparent in the collections reviewed in Britain (see below). Interestingly, a far larger proportion of axe-heads in the British collections conform to the standard large size and 'Cumbrian club' style morphology than the Manx collection. In general, there is more diversity in the range of shapes and styles in the UK than is apparent on the Island.

Detailed analysis of the evolution of local morphological forms, and attempts to define an internal stylistic chronology would benefit greatly from access to a centralised database, linked to raw data on axe-heads found in other national collections. The IPG are currently preparing funding proposals for such a database in Britain; the Irish database is already available in Ireland, and Torben Ballin's pitchstone catalogue can be accessed in Scotland. It is hoped that eventually the

Manx axe-head collection will be searchable online alongside the Irish, Scottish, Welsh, English and perhaps even mainland European collections.

Within the chronological framework provided by Darvill and Crellin the Manx axe-heads can be considered as prevalent through the 4th millennium BCE. Certainly from the activities at Billown that involved broken axe-heads, through the cluster of axe-heads (n-10) found at various times in the vicinity of the Meayll site at Balnahowe (see Section 5.3.4, although there is no direct evidence of a link with the Meayll megalith) to the activities involving axe-head deposition at the Ronaldsway type site, it is clear that axe-heads were a durable phenomenon on the island.

5.3 Distribution Patterns

Most of the axe-heads (n=186/206, 90%) were recorded to at least Parish level in the museum records, although eleven were disputed (n=11/186, c.6%). Figures 5:5 and 5:6a give a breakdown of the number of axe-heads found in each of the Sheadings and Parishes respectively.

Many of the grid references recorded by the Museum, use Ordnance Survey Grid References with the 'SC' or 'NX' prefix. As part of this review, these references have been converted to the National Grid Reference (NGR) Easting (x) and Northing (y) format, as well as latitude and longitude in Decimal Degrees (i.e. ddd.ddd) using the WGS85: EPSG 4326 geodetic datum. Inevitably, contextual data has not been recorded in a systematic way, but it was possible to establish what percentage of the axe-head collection had come from reliable archaeological contexts (n=35/206, 16% i.e. CD02, CD05, CD06, CD20, Cd201 and CD80). Given such a small percentage, meaningful analysis of the data is limited if the aim is only to understand the distribution of axe-head disposal and discard after their initial use-life on the Isle of Man. However, regardless the data has merit as an exercise in converting disparate physical data types into a preliminary digital database, and attempts to establish a

simple but consistent way to display the credibility of the raw data are discussed in Section 6.3.1.

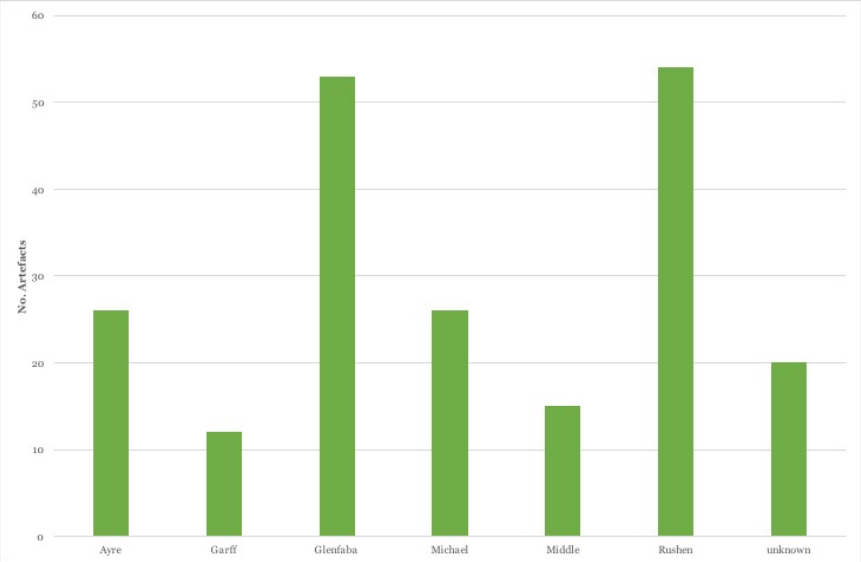
For the purpose of creating simplified density maps from Parish data in Figure 5:6b, Douglas has been incorporated into the Braddan parish district, axe-heads found in Castletown are included in the Malew parish district; Peel's axe-head are labelled as in German, Ramsey is in Maughold, Laxey is in Lonan and Port Erin and Port St. Mary are included in the Rushen figures. Therefore, each axe-head is categorised into one of 17 parish/village districts, or labelled unknown (n=20/206, 9.7%).

The contextual information, once inside Scrivener, was used to compare axe-heads found in specific areas as well as to compare the morphological traits and petrology of axe-heads found in different areas of the Island. The website gridreferencefinder.com allows users to open Ordnance Survey maps of any area pinpointed, and converts a variety of co-ordinate systems. This website and the linked historic maps were used to locate specific areas and farms referenced in the museum records. However, the assigned co-ordinates of any given artefact in the database only represents a broad area in which the artefact may have been found, and this must be taken into consideration when interpreting the data. Inference is limited not only because of the unverifiable nature of the data, and the plotting inaccuracies, but also because of the likelihood of secondary movement since initial usage.

The latitude and longitude points thus selected were used to create maps with an Open Source Geographic Information System (GIS) called Quantum GIS (QGIS). The Manx Axe-head Database created in Microsoft Excel (.xlsx) was saved as a comma separated value file (.csv) that could be converted into a relational database management system. QGIS uses SQLite, a popular and widely deployed relational database engine, as its embedded database software (see SQLite website). QGIS is

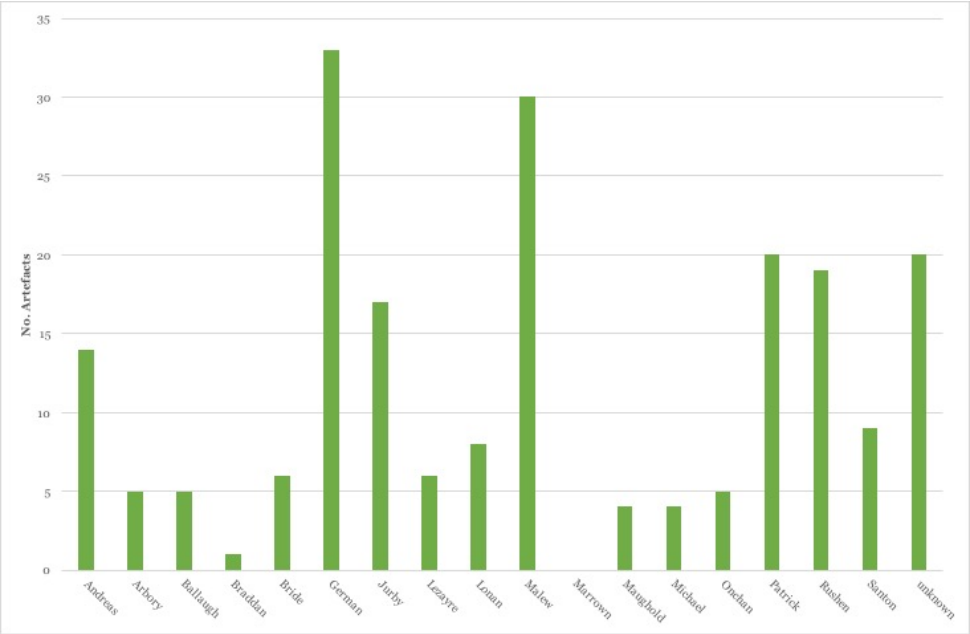
licensed under the GNU General Public License and is an official project of the Open Source Geospatial Foundation (OSGeo). It runs on Linux, Unix, Mac OSX, Windows and Android and supports numerous vector, raster and database formats and functionalities (see QGIS website). The axe-head database was subsequently superimposed in QGIS onto open source relief maps provided by the United States Geological Survey (USGS) EarthExplorer, an online interface that allows users to search and download Global Multi-resolution Terrain Elevation Data (GMTED) (see USGS website). GMTED is a global terrain dataset developed by USGS with a 30-arc second resolution (approximately 1 km), stored in the USGS Digital Elevation Model (DEM) geospatial file format (see Wikipedia).

Figure 5:5 Artefacts by Sheading



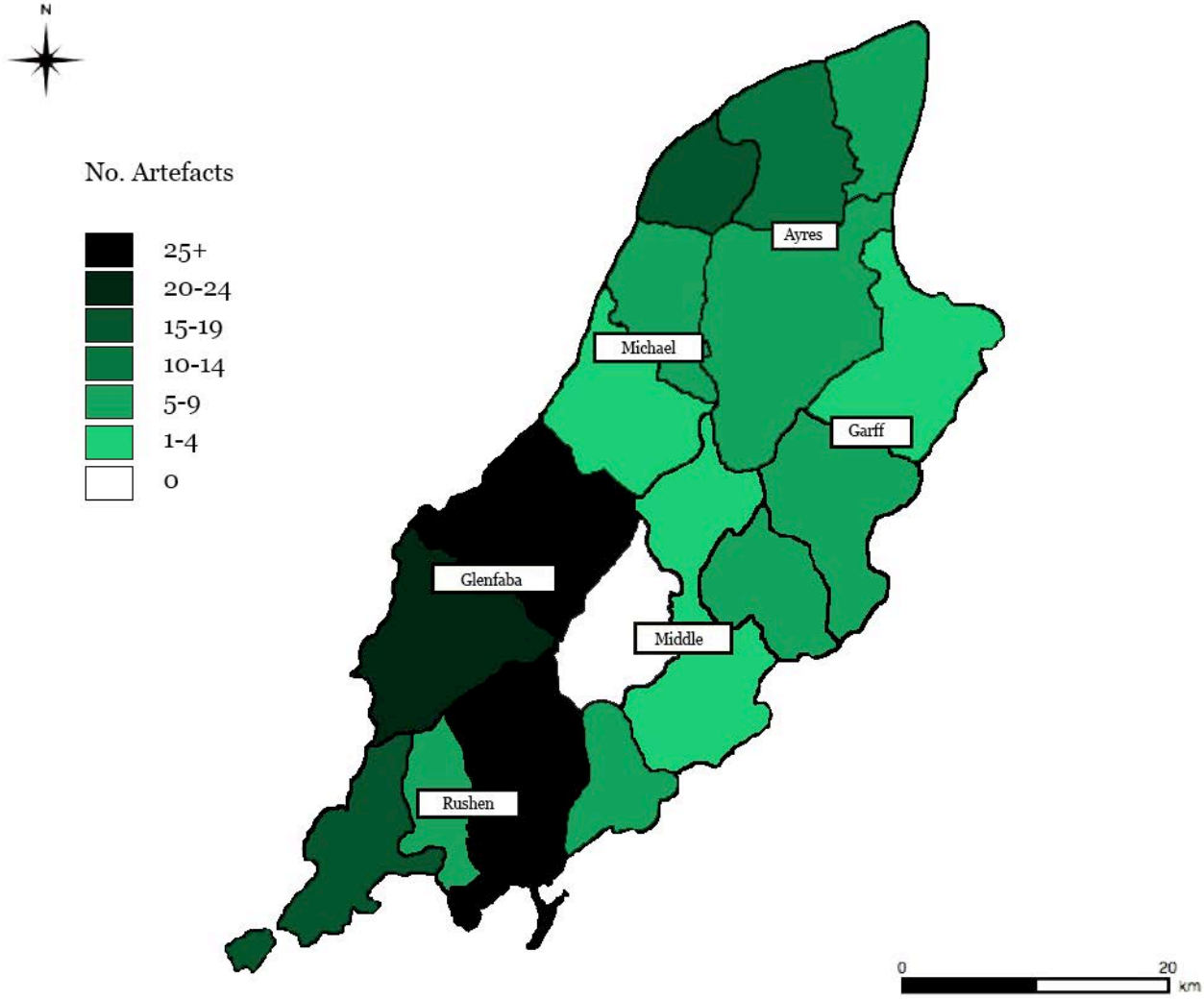
	No. Artefacts	%
Sheading: Ayre	26	12.6
Sheading: Garff	12	5.8
Sheading: Glenfaba	53	25.7
Sheading: Michael	26	12.6
Sheading: Middle	15	7.3
Sheading: Rushen	54	26.2
Sheading: Unknown	20	9.7
Total Artefacts	**206**	

Figure 5:6a Artefacts by Parish



	No. Artefacts	%
Parish: Andreas	14	6.8
Parish: Arbory	5	2.4
Parish: Ballaugh	5	2.4
Parish: Braddan	1	0.5
Parish: Bride	6	2.9
Parish: German	33	16.0
Parish: Jurby	17	8.3
Parish: Lonan	6	2.9
Parish: Lezayre	8	3.9
Parish: Malew	30	14.6
Parish: Marown	0	0.0
Parish: Maughold	4	1.9
Parish: Michael	4	1.9
Parish: Onchan	5	2.4
Parish: Patrick	20	9.7
Parish: Rushen	19	9.2
Parish: Santon	9	4.4
Parish: Unknown	20	9.7
Total Artefacts	**206**	

Figure 5:6b The density distribution of Manx Axeheads



5.3.1 Axe-heads in Ayre

Of the twenty-six (n=26, 2 disputed) axe-heads found in Ayre, over half (n=14, 1 disputed) were found in Andreas and six in each of the Parishes of Bride and Lezayre (n=12). Figure 5:7 shows most of them (n=18) in Scrivener. One RTBA was found by F.R. Rowley, on pile of fieldstones alongside the keeill at Knock y Doonee. An area known to be rich in archaeological finds; most notably, the Norse boat burial and earlier keeill site, but abundant Ronaldsway Culture style flints and related artefacts have also come from this farm at different times. In the same Parish at Ballaheaney, the axe-head fragment 1986-0143A was a surface find, 'in the vicinity of a suspected Ronaldsway habitation site (Plot 1688)' according to notes from field walker Alan Skillian. Two of the axe-heads from Andreas, the fragment from Ballaheaney (1986-0143A), and one from Ballabeg Gate, that is missing its butt end (1954-1251 Manx 43), have the appearance of roughening which might be a result of weathering. The possibility remains that they are RTBAs, but neither are referred to as such by Garrad (1988a), and 1984-0143A might arguably not be an axe-head at all. Nevertheless, it has been thin sectioned, and according to the annotations on the slide, it is made of siltstone (i.e. pelite). Coope and Garrad listed Manx 43 as 'Camptonite type A' and suggested that it 'may prove to have a source within the Island' (1988, 69), see Section 4.3.4. Axe-head 1987-0445/1 is also from Andreas (the Ballacottier area). It is a fine grained, grey volcanoclastic axe-head with a triangular shape, and rounded, roughened butt, classed as Group VI.

Artefact 1954-0610 is worth mentioning because it is a small, damaged axe-head that appears to have been reshaped. The blade is very thin and flat and petrologically, it resembles Group VI rocks from Cumbria. Unfortunately, it has not been accurately provenanced but is labelled 'Lhen, B'heaney 1920' which would situate the find locale within the Parish of Andreas, however, the museum records indicate that it could

have been found in Jurby (in the Sheading of Michael) since this farm straddles along the Sheading boundary. Garrad claimed that this axe-head, along with 1954-0598 and 1954-0596A (both RTBAs) and a small, fine grained axe-head (1954-0599), came from Cronk Mwyllin, Ballachurry – a keeill site in Jurby (Garrad 1978a, 167) where several axe-heads have been found at various times (n=6). Artefact 1954-0596A, as well as 1954-0612, which according to the museum records was found 'centred around' the same area, are both missing their butt ends at very clean breaks.

Figure 5:7 Artefacts in Ayre

5.3.2 Axe-heads in Michael

Twenty-six (26) axe-heads have been found in the Sheading of Michael, not to be confused with the Parish of the same name where only four (4) have been found; most of the axe-heads were found in the Parish of Jurby (n=17, 3 disputed), and five more were found in Ballaugh.

A beautifully made small triangular adze was found in 1921 in the Railway cutting, in the parish of Michael and donated to the Museum by Mr. T. Stowell in 1922. Garrad labelled this axe-head as 'greenstone' i.e. igneous, even medium grained, but she thought it is likely to be Group VII from Graig Lywd, a granophyre. Also in Michael parish, an axe-head made of greywacke with an asymmetrical and rounded blade is

one of only a few axe-heads found on any of the higher hills; it was found on Slieau Freoghane above an old reservoir (MNH 1978-0114-Mx46).

Another axe-head from Jurby, 1954-3619 has been macroscopically identified as dolerite, reportedly from near to the house at Ballahasney. It was a chance find, from the same Quarterland as a collection of 'Heavy Bladed Mesolithic' flints (IOMMM 3620), close to the Cronk Mwyllin site. Its shape is atypical, it has a 'virtually symmetrical ovate' face shape (i.e. FS02) and rounded butt (BU11) with a well-rounded blade (ES04) and very straight sides.

5.3.3 Axe-heads in Garff

The smallest number of axe-heads were found in Garff (n=12, 5.8%) in the north east of the Island (Maughold (n=4), Lonan (n=8). All are unusually large (particularly, 1954-0613 and 1944-3052), unfortunately none were found in secure contexts. One is possibly Group XXV (1954-0613), two are made of sedimentary rocks (1964-0155 and 1954-0579) and one is an ungrouped rock, possibly a meta-sediment, that is very wide and flat (1954-3052). Only one was obviously RTBA, but three are broken blade ends only and two are badly damaged at both ends. A dolerite axe-head fragment, from Lonan, 1954-0611, is unusually large—at least 70mm long—even though it is missing the butt end. The blade is smooth but blunt. It has a very rounded profile, and deep sides similar to Artefact 1969-0095. The surface is weathered, resembling the weathering of 1954-0595, i.e. only mildly weathered but continuous across all sides. Neither 1954-3619 or 1954-0611 were mentioned by Garrad, although 1954-0611, as a fragment, was thin sectioned and labelled 'X'.

5.3.4 Axe-heads in Rushen

The parish of Malew has produce the largest number of axe-heads in total terms (n=33), but if one excludes the excavated Ronaldsway House axe-heads[b] (n=12) then Malew no longer stands out. According to the Museum records, RTBA axe-head 1971-0144 was found by 'D. Trillo... in the broogh near the causeway' on St. Michael's Isle. A small rocky landmass, located just across the sheltered bay of Derbyhaven from the Ronaldsway House site, at the tip of the Langness Peninsular. Axe-head 1954-3107 was reportedly found at the same site as a 'sling-stone' (IOMMM 3113), on a tumulus (burial mound) at 'Fairy Hill, in Herristal (Orrisdale), Malew', by William Cubbon. It has a gouge on one face, which is 80mm in length, and deepest at the blade edge. Garrad includes this example in her list of RTBAs (1978a, 168), however, the presence of roughening is debatable - only one face is roughened, and the butt has possibly been broken, or reused as a pounder leaving a thin, square, stubby appearance. When examined in the hand, the axe-head seems to be composed of similar minerals to the matrix of Group XXV specimens, i.e. ferro-magnesium minerals and plagioclase feldspars, which give a green colour to the rock when wet, however this axe-head is coarser, and more even grained, than any other example. The museum records states that 'according to A. Lee per J. F. Cowley', an axe-head from Malew, 1954-5980, was found 'on top of a hedge in Grenaby' by Tim Taggart sometime before 1948. It is a very large and heavy triangular dolerite axe-head, with a rounded butt, and wide but blunt, asymmetrical blade. Roughening is difficult to determine, and there is evidence of polish near the butt end which could indicate that the axe-head was initially polished all over and any roughening was a secondary process; although, the evidence of roughening could be mistaken for weathering and

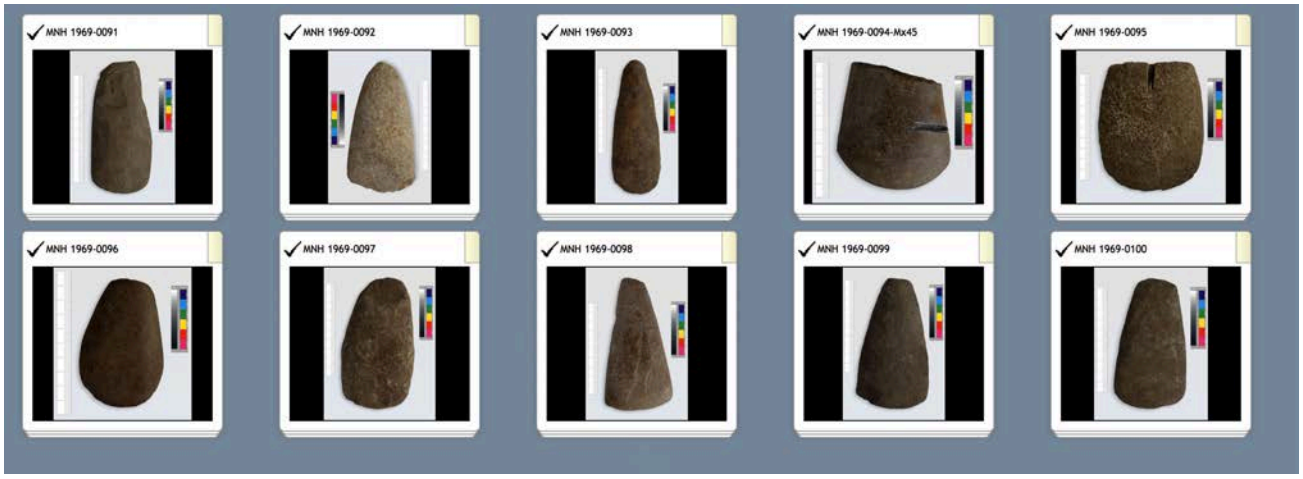
[b] Note that the Ronaldsway house site is in the Parish of Malew, in the Sheading of Rushen, and not the parish of Rushen.

vice versa. Interestingly, two potential RTBAs found in Ireland (Rynne, 1992, p. 98) also appear to have been polished first as well. According to Coope and Garrad (1988, p. 69) another dolerite axe-head ('81-46'), 'from (the) rubbish dump at Ballacottier, Andreas' was 'reshaped from (a) larger tool'. Unfortunately, it has not been possible to locate this axe-head however, 1954-0598, also identified as dolerite, was also mentioned, and reassessment confirms the apparent reuse of the butt end.

In the 1890s an RTBA (axe-head 1954-2782) was found by the Keggin family in a burial cist, and (an) axe-head-like implement' in a grave on Spanish Head, Rushen (context code 'CD80 Grave')

Ten axe-heads, see Figure 5:8, have been found on the farm of Charles Nixon and family at Balnahowe, in Rushen, which is located on the same peninsula as the Meayll circle. The site is presumed to have been utilised in the Neolithic, but according to the notes of Garrad, the precise find site has never been relocated. A single thin section in the collection was made at the Manchester Museum, and labelled 'polished axe-head; Port Erin I.O.M. 0.2077; Manch. Mus'. Enquiries at the Museum in Manchester revealed it was in storage and photographs were received.

Figure 5:8 Ten axe-heads from Balnahowe, Rushen



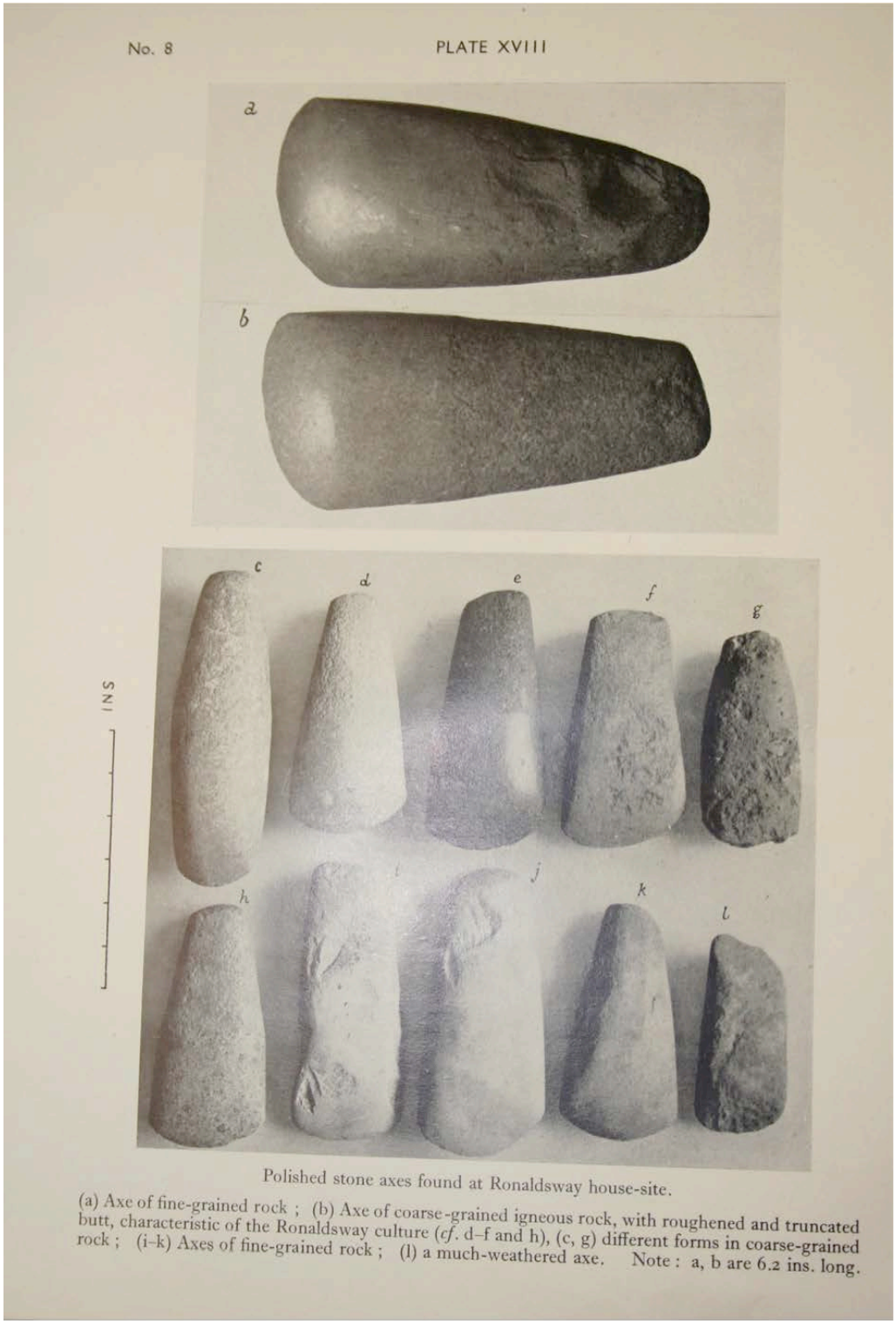
Several axeheads have been found at Ballavell, Malew, including axe-head 1954-2881, which was donated by Mrs. Crellin in 1930. According to Garrad's analysis (1978a, 168) this axe-head is ‘possibly not Ronaldsway, but shape appropriate’. The axe-head is speckled grey in colour, and has an even grained texture. There is evidence of polish on one face only and even though the butt is missing, the surface appears to have been roughened for the majority of both faces. This could also be accentuated by weathering. The blade is blunt, and the fracture at the butt end is oblique. Axe-head 1954-2792 was also found at Ballavell, in 1885, ‘in (an) earthen floor when making a new cow house on the site of an older one’ by E. Quine. It has a flat butt, the blade is sharp, but overall the axe-head is badly weathered. No polish is visible, except in a small area in the centre of one face. Roughening cannot be distinguished from weathering, however like 1969-0099, the axe-head exhibits the thinning at the waist that was noted by Bruce as characteristic of RTBAs (1947, 147). On macroscopic inspection it looks like it could have been made from Group XXV although it has weathered in a very similar way to 1954-3217 from Santon, which has been assigned to Group I and is believed to be a 'greenstone' from the Mount Bay area of Cornwall. The blade is missing, but overall it is a large triangular axe-head with a rounded butt and thin profile. Weathering has removed much of the grey outer surface of the axe-head revealing a flaky, fine grained brown rock underneath. The axe-head was thin sectioned, but no rock type was postulated in Coope and Garrad's publications. The only Group VII thin section came from axe-head 1954-2984 - a long and thin 'regular' polished stone axe-head also found at Ballavell, in Malew, if correctly sourced made from rocks at Penmaenmawr, North Wales (see Chapter 4.3.2). There are several different rock types found in this area the Ballavell area and it is near to both presumed sources for the Group XXV.

A recent accession, seemingly unknown to Coope and Garrad, is L21888. According to the museum records, it was also found in Malew in 1985, with 'two oddly shaped pieces of slate, similar to the slate found at the Ronaldsway type site… downstream of Fairy Bridge Cottage… during the mechanical digging of a pond'. A note with the artefact in the museum records indicate that a concentration of Neolithic flints has been found since at Ballalona, c.800m north of the cottage. The axe-head has very clearly defined roughening and a flat butt, and it is possibly Group XXV, although it has not been thin sectioned.

In Bruce's original report (1947, pp. 146–147) he states that there were eleven axe-heads found at the Ronaldsway House excavation: seven coarse grained igneous axe-heads that were roughened and truncated at the butt, and four fine grained examples. However, in the appendix of the same report there are 12 axe-heads photographed (1947 No. 8 Plate XVIII), see Figure 5:9. Notice axe-head 'b' is the axe-head used to originally define the group. The twelfth axe-head (axe-head 'l') is labelled 'much weathered' but is not mentioned again. Similarly, although in her 1978 paper (1978b, p. 165) Garrad quotes Peter Moffatt's Ronaldsway Culture review (Moffatt, 1978), which refers to seven RTBAs from the site: her list of RTBAs, only includes six Ronaldsway House RTBA axe-heads (MNH 1965-0001-05, MNH 1965-0001-06, 1965-0001/007, MNH 1965-0001-09, MNH 1965-0001-10-Mx2-341 and MNH 1965-0001-13-Mx5-344). There is also some confusion over which axe-heads were originally thin sectioned as part of the review; Garrad claimed the four axe-heads studied were 1965-0001/007, MNH 1965-0001-10-Mx2-341, 1965-0001/012, and 1965-0001/019, however, there does not appear to be a 1965-0001/019 in the Museum records. This report suggests that this could be a typographic mistake, and it was 1965-0001/009 i.e. MNH 1965-0001-09 that was analysed. Unfortunately, the original thin section analysis revealed the debated axe-head to be a 'tuff' (Garrad,

1978b, p. 169), whereas this study finds that MNH 1965-0001-09 is in fact most likely to be Group XXV. Therefore, it remains a possibility that Bruce's 'much weathered' twelfth axe-head is Garrad's missing 1965-0001/019.

Figure 5:9 Ronaldsway House Axeheads



Polished stone axes found at Ronaldsway house-site.

(a) Axe of fine-grained rock ; (b) Axe of coarse-grained igneous rock, with roughened and truncated butt, characteristic of the Ronaldsway culture (*cf.* d–f and h), (c, g) different forms in coarse-grained rock ; (i–k) Axes of fine-grained rock ; (l) a much-weathered axe. Note : a, b are 6.2 ins. long.

Below is a summary of the information gathered from each of the type site RTBAs:

MNH 1965-0001-04 (axe-head 'a'): this axe-head is triangular with a rounded butt and rounded asymmetrical blade. There are several large dents and chips, plus one large radial fracture at the butt end. There is also some polishing near the butt, and clear evidence of sporadic pecking on one face. While there is more complete roughening on the other face; as well as striations on both the polished faces and edges. This axe-head appears to have been partially roughened and abandoned; it may be true that attempts to roughen the butt end resulted in the large dents and fracture still visible. This axe-head was not discussed by Bruce, nor included in Garrad's list of RTBAs, however, the treatment of the butt necessitated its characteristics to be highlighted in this review. It is fine grained (more fine grained than MNH 1965-0001-12-Mx4-343), and has an even texture, with irregular lamellae of fine clay, which also occur as patches of mottled dark material. Under the hand lens, the clasts appear angular and a volcanoclastic origin is suspected, probably Group VI.

MNH 1965-0001-05 (axe-head 'b'): a third of the axe-head, nearest the blade has been polished; the asymmetrical blade is sharp but chipped; the sides are slightly tapered and the butt is oblique. There are chips around the butt end, one dent in the edge, and another dent across the centre of the face near the blade. Unlike in the description given by Bruce (1947, pp. 146–147), the blade and butt are oblique, but the line marking the roughening is straight. It has not been thin sectioned, however visual inspection corroborates Garrad's petrological analysis and classification as Group XXV.

MNH 1965-0001-06 (axe-head 'c'): this axe-head is the longest from the Ronaldsway House excavation. It has straight splayed sides and a flat butt, with a sharp, curved asymmetrical blade and thick profile. Over half of the axe-head has been polished

and the butt is obviously roughened. There are two small dents, one on a face; and the other on the edge. The morphology of this axe-head is unique for the selection analysed: it is very long, rounded and thin in comparison. It is made from a porphyritic igneous rock, which is very likely to be Group XXV. In Garrad's notes at the Museum this axe-head is referred to as 'a suspected Oatland/Ballapaddag type' i.e. Group XXV.

MNH 1965-0001-08 (axe-head 'd'): this axe-head is symmetrically tapered with an asymmetrical, curved blade which has been chipped repeatedly. The butt is rounded. The axe-head appears to have been roughened up to the blade. One face is partially polished, and the other has suffered from the effects of weathering, however, there is a clear roughening line. Macroscopic inspection confirms a Group XXV source. However, it was not mentioned at all by Garrad.

MNH 1965-0001-09 (axe-head 'e'): this axe-head is symmetrically tapered with a sloped butt and an asymmetrically curved blade, which is sharp but chipped. This axe-head has a very similar morphology to MNH 1965-0001-13-Mx5-344. Inspection indicates it is also made from the Group XXV source.

MNH 1965-0001-10-Mx2-341 (axe-head 'f'): like MNH 1965-0001-08, MNH 1965-0001-09 and MNH 1965-0001-13-Mx5-344, this axe-head has slightly tapered sides, but it has a thinner profile. The butt is flat when viewed face forward, however, it is sloped when viewed from the opposite face. The sharp, chipped blade is gently curved but markedly asymmetrical. The faces are half polished but weathered, and there are small patches of polish at the roughened butt end. This axe-head was part of the 'Original Manx Seven' analysed for the third publication of the report (Stone and Wallis, 1951, p. 148). By the fourth report, it was categorised as 'weathered Quartz Gabbro' (Evens et al., 1962, p. 249) but it was also assigned to Group XXV by Garrad (1988, p. 69). Unfortunately, the slide was damaged and the thin section is

missing, so further analysis at this stage is not possible. However, visual inspection confirmed the similarity of this axe-head to other known examples of Group XXV.

1965-0001/007 (axe-head 'g'): Unfortunately, axe-head could not be located. The caption under Bruce's Plate XVIII reads '(c, g) different form of coarse grained rock', and shows that this axe-head was one of the smaller examples found at the Ronaldsway House. The sides appeared to be splayed, the butt and blade are rounded and it is extensively weathered. The original petrological analysis of the thin section determined it was a weathered dolerite (Evens et al., 1962, p. 249) yet Garrad included it in her list of RTBAs made from Group XXV.

MNH 1965-0001-13-Mx5-344 (axe-head 'h'): this axe-head has slightly tapered sides, sloped butt and symmetrical blade with minor damage to it. The butt end is clearly roughened, overall, it is very similar to MNH 1965-0001-09 (see above). Whereas, petrologically, in the majority of the Group XXV artefacts examined the ferro-magnesium minerals are dark green in colour in the hand, they appear brown in this example. There is one very fine dark vein running obliquely across the blade end of one face of this axe-head, the other face has a smaller vein near to the edge - this could be an example of the veins mentioned by Coope and Garrad as 'fine, more or less aligned cracks (which) occur up to 1mm across, filled with mineral matter' (1988, p. 69).

MNH 1965-0001-12-Mx4-343 (axe-head 'i'): this axe-head is different to the other examples from the Ronaldsway House. It has a thin profile, the butt is sloped and the blade is symmetrical. In cross section, it is sub-rectangular whereas most of the examples in the dataset are narrow ovals with rounded or slightly flattened sides (see page X). The sides are tapered but it is damaged; there are several large dents in both edges, chips on both of the faces and around the butt, as well as one large dent across one face near to the butt end. Although this axe-head is heavily weathered, the butt

has clearly been roughened, however, like several other examples, there is some evidence of polish near the butt end as well, and on one face, the polish appears to continue lower down the face than on the other side. It is a pale brown colour, with a fine grained, even texture. Occasional dark coloured angular clasts are visible. This axe-head was also one of theOM7 analysed by the SWG. The thin section was identified as a tuff but no geological provenance was attached to it; Group VI is presumed.

Overall, the axe-heads from the Ronaldsway House excavation show distinctive characteristics that are noticeable in axe-heads found across the Island. However, the classic RTBA features first appreciated at Ronaldsway are not consistently exhibited in all RTBA examples found thoughout the Island. In particular, roughening of the butt and truncation do not necessarily always occur together. Evidence of deliberate polish in areas of roughening suggests that it is possible roughening was a secondary process conducted on 'regular' polished stone axe-heads. Likewise, the sources used to produce RTBAs at this site are common in the RTBA collection as a whole; however, roughening is not limited to these Group XXV examples. Similarly, after looking at the collection as a whole, as well as axe-heads in Scottish and Cumbrian collections (see below) it would appear that although many RTBA examples are clearly and distinctly roughened and truncated at the butt end on the Island and warrant enquiry, some of the examples that have be ascribed to the group would unlikely to be identified as unusual in other collections, and more likely be considered an incomplete or simply unrefined utilitarian example. The clear and definite roughened ends are disproportionately represented at the Ronaldsway site, and given their overall limited number and prevalence in the south of the Island, could represent very limited phenomenon in both time and distribution.

5.3.5 Axe-heads in Middle

Axe-heads MNH 1954-0453, MNH 1954-0591, and MNH 1954-0600, as well as a 'utilised stone fragment' and a 'spindle whorl' and 'pounder' were found in the preparation of an early 20th Century granite quarry at Oatlands. A flint axe-head found by R. Lace 10 years previously at the same site and a possible stone circle are also mentioned. There is another stone circle (Ballakelly) nearby and this whole area is of interest because it is one of the two likely areas mentioned by Garrad for the Group XXV source rock. The geology of the area is dealt with in Section 4a. Interestingly, only one of the axe-heads (1954-0591) appears to be Group XXV; 1954-0600 is weathered and gritty, possibly an even grained meta-sediment or volcanoclastic rock. Neither of the axe-heads have definitive RTBA traits. Few axeheads have been found elsewhere in the Sheading. In the Parish of Braddan, only one axe-head was found and perhaps significantly none were found in the only landlocked Parish, Marown.

5.3.6 Axe-heads in Glenfaba

At least twenty-two (n=22) axe-heads were found by Charles Cowley in the Sheading of Glenfaba; the majority came from within the parish of German (n=17) although a smaller number were found to the south in Patrick (n=5). Seven (7) are RTBAs. Six (6) of which are classed as from 'CD01 Agricultural Land', one (1) was CD05 'disturbed'. Cowley also found a well-formed blade fragment (MNH 1971-0209-Mx13-C37) in a field at Knocksharry near to the site of a recorded tumulus (Plot 0253 Sheet 6/15 'Cubbon's field' @54.238679, -4.6489012). This axe-head is incorrectly labelled in the Museum's museum records as '71-209'. Only the blade remains, and therefore since the condition of the butt could not be established, it was not included in the 1978 RTBA list by Garrad (1978a, 167-168). However, in the same report (1978a, 170), referred to as Manx 13, it is listed as an 'altered intermediate igneous

rock'. Later, it was one of the fragments thin sectioned and classified as Group XXV for Coope and Garrad's 1988 paper and more recently it was analysed geochemically in Liverpool and classed as Group XXVa (pale).

Axe-heads MNH 1954-0603, MNH 1954-0607, MNH 1954-0608, and MNH 1954-0609 were found together at Knockaloe, Patrick in 1905, by workmen digging drains. MNH 1954-0603 is the biggest overall, and MNH 1954-0609 is the smallest. However, MNH 1954-0608 and MNH 1954-0603 are similar in size, and they both have a flat butt end. MNH 1954-0609 and MNH 1954-0607 are smaller, approximately the same size, with sloped butt ends. MNH 1954-0608 and MNH 1954-0607 have angular sides, MNH 1954-0603 is more rounded, while MNH 1954-0609 appears to have been reshaped or shaved on the sides. They all have pear shaped profiles, and sharp blades that do not appear to have been damaged. MNH 1954-0607 has an asymmetrical blade whereas, all the others are well rounded (ES02). There is no damage on MNH 1954-0608 and MNH 1954-0603, but MNH 1954-0609 has one chip out of the polished face near the blade on one side, and MNH 1954-0607 has a similar chip on the roughened end of both faces near to the centre. All four butt ends also have evidence of polish on them. In colour, MNH 1954-0608 and MNH 1954-0609 look the most similar in the hand, both are mottled grey. MNH 1954-0603 has very large phenocrysts. Three of the four axe-heads appear to be Group XXV (MNH 1954-0603, 1954- 0608, and MNH 1954-0609), although Garrad did not consider MNH 1954-0609 to be the same as the others. The thin section of the fourth axe-head (MNH 1954-0607) is labelled 'erratic'.

Likewise, 1971-0183 from German is an exceptionally large example from an area reportedly rich in archaeological finds. Approximately half the axe-head is missing (unusually, it is the blade end in this case), yet it still weighs 1381g, and measures

163mm long by 97mm by 52mm wide. It has not been thin sectioned but is clearly very similar to known Group XXV examples.

Knocksharry, in German is another area rich in archaeological finds (Crellin, 2014, p. 84; Cubbon, 1934), where 'deposition of partial bodies, with some parts possibly removed' were dated to the late Neolithic (Fowler, 2001, p. 152) but according to Crellin could perhaps be considered younger; similar to later practises, an Earthfast jar was reportedly found inverted. Another potential Group XXV axe-head from the same area 1954-1135 (Manx 11) was 'found in (a) hedge at (the) West side of Gowan field (sic), near (the) site of (a) tumulus'. Likewise, axe-head 1971-210 (45) Manx 18, is a thin sectioned fragment, originally described as 'Dark Granite A' (Garrad, 1978b, p. 170), but subsequently confirmed as Group XXV (Coope and Garrad, 1988, p. 69) again from the Knocksharry area (labelled '6/5 plot 568/570' i.e. Plot 6 Sheet 5 SMR: 568/570). Cowley also recorded another fragment (1971-0184) from 'Bellellis, long field'; a disputed location in German that is thought to relate to an area now under the housing estate Ballawattleworth. It was mentioned by Garrad, in 1978 as a 'major Ronaldsway site, (whose) precise location (was) unknown' (1978b, p. 168). This fragment was thin sectioned, and recorded as 'ash, thermally metamorphosed', but nothing remains of its form to identify any characteristics.

5.4 Comparative Axe-head Survey

As with looking at the morphological (Chapter 3) or petrological features (Chapter 4), a broad lateral view is a prerequisite when considering context; with few axe-heads found in reliable, datable contexts on the Isle of Man it is even more essential that they are compared with features of datable axe-heads from elsewhere in order to attempt to establish a chronology. The data from Ireland has been published, but in order to appreciate the variety of axe-head styles found on the Island it was necessary to complete an inspection of axe-heads in the surrounding regions. As such,

arrangements were made to visit the museum and university axe-head collections in South West Scotland and the North West of England. Funding has not allowed this to be extended to North Wales and Ireland, but the main national collections housed at the British Museum stores and axe-heads on display at the Museum of London and National Museum of Scotland in Edinburgh were also scrutinised. Future trips to the collections at Cardiff and Dublin would also be helpful and highlight the need for a web-accessible database(s) for researchers to refer to and compare against local collections without the expense of visiting each collection.

Permission was granted to access the collections at the Carlisle Museum, University of Glasgow Hunterian Museum, Glasgow Museums Collections Archive, the Killmartin Museum and Trust, Arran National Trust Museum Cambeltown Museum and the Dumfries and Galloway Museum. Axe-heads on display were also studied at several smaller regional museums at Keswick, Kendal, Gretna, Wigtown, Stranraer, Styr, Ayr, the Lapworth collection in Birmingham and Museums Liverpool.

Any axe-heads classified as Group VI and Group IX in the British and Scottish collections were viewed because they are the most common rock types in the larger Irish Sea region and are as such the easiest to identify. A cursory review of the rest of each collection was undertaken looking for axe-heads that could be classified as Group XXV. The butt end of each axe-head in each collection was also examined to determine whether it could be classified as roughened and truncated at the butt end. Originally, Bruce noted that a limited number had been recorded in England and Scotland (1947, p. 148): 'the nearest parallels, geographically, seem to come from Wigtonshire in S.W. Scotland', specifically an axe-head 'from Stonykirk... has a similar profile and the butt is truncated by grinding'. Bruce also mentioned two examples from Yorkshire, originally recorded by Evans (Evans, 1897, Figures. 74 and 81; see also Bruce et al., 1947, p. 148), that 'appear to belong to our type'; as well as,

one example found at Whiston, in Lancashire, donated to the Liverpool Museum. In 1992 in Ireland, Etienne Rynne's reported two examples (1992, pp. 97–98), one from 'Currahchase near Adare, County Limerick' and one from Farravaun, in Athenry. More recently, another example from the Parish of Warnford, in Winchester, Hampshire (Axe-head HAMP-983A25) has been recorded on the Portable Antiquities System website; none are thought to be Group XXV.

A axe head was discovered on display at the Kelvingrove Museum and Art Gallery in Glasgow in Autumn 2013, that was reportedly found at the beach near Glen Luce, in Dumfries and Galloway (57.5 km north-north-west of the Point of Ayre) and appears on macroscopic inspection, to be made from the presumed Manx source. Similarly, a potentially Manx source axe-head from Peter Cherry's collection found at the coastal town of Seascale in Cumbria (56.55 km exactly east of the Point of Ayre) also appears to be roughened and truncated at the butt end, see Figure 5:10. Another axe, found at the Hunterian Museum in Glasgow, but that could not be removed from its display case, is not roughened but superficially resembles the Group XXVb, i.e. dark even grained, examples.

Figure 5:10 Manx Axeheads in Britain

Left: Peter Cherry's Manx Group XXV found at Seascale, Cumbria

Right: Kelvingrove Museum and Art Gallery Group XXV axe-head

5.5 Understanding Contextual Data

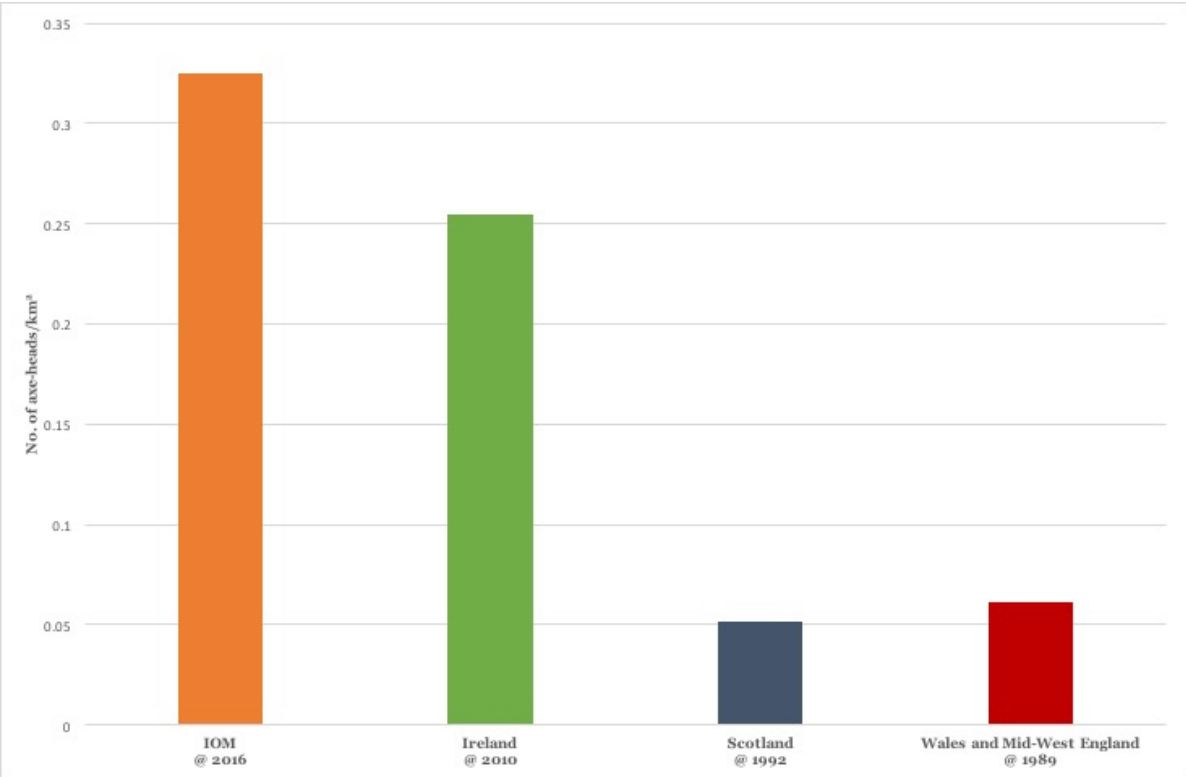
Regarding interpretation of the significance of 'find spots', concentrations of axe-heads have been found over time in several areas on the Island and appear to indicate, in line with evidence from pottery, flint scatters, burials, deliberate deposition and the use of quartz, that particular habitats were significant to local communities during this period in prehistory (Burrow, 1997; Fowler, 2001; Darvill, 2004). Information on 'find type' is more limited because the vast majority of axe-heads have been found in non-contextual situations, i.e. plough soil, hedges, gardens. Broken axe-heads represent a relatively small number of artefacts compared to the general axe-head population so it is likely that there was no large scale adoption of deliberate deposition of broken axe-heads specifically, but it is worth noting that several large, broken sharp blade ends with very rounded profiles have been found. It is complete axe-heads however have been found in hoards, see Section 5.3.6. Interestingly, the four areas with the highest concentrations of axe-head finds are all easily accessible from the coast, although as a small island nowhere is truly inaccessible. The calmest bay on the Island is at Langness near to the Ronaldsway sites that span from the earliest evidence of activity available onwards (Quartermaine, 2016). Just inland at Billown, Darvill noted the cyclic use of specific sites started around the 38th-37th century (Whittle et al., 2011, pp. 553–561). The area around the Meayll site at the very south of the Island has produced a number of axe-heads and the placement of axe-heads in even younger burial context at Spanish Head suggests there was continuous but changing meaning instilled in these artefacts throughout the period.

The peaceful and accessible (yet defendable) bay at Peel, on the west coast is surrounded on all sides by areas where axe-heads, flint scatters and pottery have been found, in addition to burials, cremations and megaliths like those at Ballaharra

inland and Knocksharry to the north. All lowland and coastal areas of the south and west of the island show a vibrant and variable material culture, similarly, the flat plains at the north of the Island have provided equally fruitful evidence of transient activities. In contrast, few axeheads have been found from the area between the higher cliffs of Maughold head on the north east coast to Douglas bay on the east. Very few axeheads have been found inland, and only two have been confirmed from the high hills (one in the south at South Barrule, and one in the north above Kirk Michael on Slieau Freoghane).

In terms of axehead density per km² the island appears to have a noticeably high number of axe-head compared to the surrounding regions, see Figure 5:11, however, neither Scotland nor Wales and Mid-West England have been reviewed as thoroughly as Ireland and the Isle of Man.

Figure 5:11 The density distribution of Manx Axeheads



	Isle of Man	**Ireland**	**Scotland**	**Wales/Mid-West England**
Reference		Cooney (2011, p. 428)	Sheridan (1992, p. 195)	Darvill (1989, pp. 29–30)
Date	2016	2010	1992	1989
Area (km²)	572	84,421	77,933	36,000
No. Recorded Axe-heads	186	21,471	4000	2200
Axe-heads/km²	0.325	0.254	0.051	0.061

CHAPTER 6

6.1 Discussion and Conclusions

This analysis reveals that there are definable differences between the Manx axe-head collection and comparable collections in Britain and Ireland. It has also shown that there is considerable diversity *within* the assemblage as well.

Axe-heads found on the island appear to have a more limited size distribution than axe-heads in the British and Irish collections. The Manx examples more often have a symmetrical shape and carefully finished butt ends than axe-heads in Ireland and in general, Manx axe-heads appear to be smaller and stouter than British counterparts, with a less diverse range of shape categories needed to define the group as a whole. The heaviest axe is made from porcellanite. The average length of a Manx axe-head is approximately 139 mm (median=134 mm) and the average width centres around 64 mm.

Overall average sized axe-heads have fatter profiles than smaller axe-heads, but the very large axeheads (over 240 mm) are often narrower than expected. More work is needed however to explain the disparity between cross section shape assignment (commonly indicating a CS09 'narrow oval' profile) with the fact that Irish axe-heads are most often classed as regular CS05 'oval'. Also when measured, the mean thickness of the Manx collection is 37.6mm whereas in Ireland thickness ranges from 18 mm to 34 mm. The pear-shaped profile of RTBA goes some way to explaining the discrepancy but reassessing the assignment of shape categories and measuring more of the Manx collection would help to establish whether it is the subjective assignment of categories by different researchers that causes the issue seen here.

In Ireland, the collection often exhibits asymmetry in various elements of the overall form, for example in the profile and cutting edge shapes (Cooney and Mandal, 1998,

pp. 45–46). In contrast on the Isle of Man symmetry is more common. As mentioned in Chapter 3, it is difficult to gauge an accurate measure of how deliberate the symmetry appears for cutting edge shape. Although when considered in parallel with the overall face shape, it would seem to indicate that triangular and parallel-sided axe-heads often have flatter or more asymmetrical blades, whereas convex and splayed axe-heads generally have rounded symmetrical blades. Splayed sided axe-heads are very common in the Manx collection. Regarding asymmetry in blade profile, there were few examples that were clearly asymmetrical in the Manx collection and only three that could be classified as an adze. Cooney and Mandal (1998, p. 21) consider blade profile symmetry more likely to be a deliberate feature, than for example cutting edge shape.

Only one rough-out of unconfirmed petrology has been recorded on the Island[1] with a confirmed context; an adze from Kermode and Herdman's excavation at the Meayll (Kermode & Herdman Illustrated Notes p.46), as such it would seem unlikely that raw material was transported in great quantities to the Island to be shaped locally, instead the finished products are more likely to have arrived and were either modified or reworked on the Island as required.

In general, the axe-heads are in relatively good condition, however, minor damage occurs even on sharp blades suggesting the majority of artefacts in the collection were used at least to a limited extent. This is not to infer that the damage to the blade end could only have been inflicted through a purely functional act. Similarly, the condition of the axe-heads overall suggests that there could have been differences in the way different petrologies were viewed on the island; of the unprovenanced igneous axe-heads many are rounded at the blade end and crudely shaped rather

[1] A note found in late April 2016 for the exotic artefact recorded as 'Neolithic Axehead Cleveland USA' was apparently .'exchanged for roughed out specimens/axeheads. per Mr J. Davies 91 Emm Lane, Bradford 9. 12/02/1954.

than well-formed. Whereas, the Group XXV and porcellanite axe-heads are remarkably well preserved, often with sharp blades, and relatively rounded in profile. The axe-heads from Irish sources stand out as morphological outliers in the database; all are very dark in colour, largely in good or even pristine condition with sharp blades, found through-out the Island. Group VI axe-heads are the most internally inconsistent sub-set of the collection with examples in a variety of different conditions, in an array of shapes. However, while representing the single largest rock type in the Manx collection they display a limited number of forms compared to those viewed in British collections. The Manx Group VI examples are smaller and less well-formed on average, while rounded butt ends are more common amongst Group VI examples in other collections. This suggests that perhaps the Group VI axe-heads were worked or re-worked locally, and since the treatment of Group VI and porcellanite axe-heads differs, there may have been significance differences in the way different sources were viewed on the Island. The most angular axe-heads in the Manx collection are Group VI, and in line with elsewhere Group VI axe-heads often have clear flat sides, whereas most igneous and porcellanite Manx axe-heads are rounded on the long edge.

On the island, axe-heads with flat butt ends are much more common than in Ireland, this is largely due to the truncation of the RTBAs. Taking the whole collection into consideration, most butt ends that are rounded in the plane are also rounded in profile, whereas those artefacts flattened in the plane are also flattened in profile. In Ireland unfinished, roughly shaped and damaged butt ends are much more common. Deliberate roughening of the butt end in the manner of the Manx RTBA classed as 'obvious' is less extensive in the Manx collection than has been previously noted. Researchers unfamiliar with the 'uniqueness' of the Manx collection would no doubt consider many of them as rough, poorly made examples rather than part of a

particular style. In addition, it has been noted that many of the RTBAs may have initially been polished all over. As such, any roughening could be considered a secondary process and this could perhaps indicate that the individuals who made the axe-heads were not necessarily the same individuals who roughened them. Similarly, it suggests that the process of making the polished axe-heads into RTBA could have been part of a bigger series of processes, one that no doubt could be interpreted as ritualised, perhaps symbolically transformative. The fact that the only un-roughened, Group XXV axe-heads reported to date were found by Darvill at Billown in a potential early setting is interesting, further study of the fragments for traces of polish is required.

When organised by petrology it becomes apparent that there is a wide range of rock types present in the Manx collection. In Ireland igneous, metamorphic and sedimentary artefacts account for less than fifty percent of the Irish axe-heads collection, the rest are made from porcellanite. On the Isle of Man, igneous sources dominate the collection, including unprovenanced dolerite examples and locally sourced Group XXV examples, see below. Also included but to a lesser extent are Welsh and Cornish sources, although further work on the assignment of these petrologies is required. Cumbrian tuff is the single most utilised source recognisable followed by flint and porcellanite.

Therefore, overall, most axe-heads are made from igneous sources of which thirty-six (36/186, c.20% total collection) were classified as made from a very distinctive coarse grained igneous rock given the appellation Group XXV. Regardless of the variations in colour all varieties generally appear similar in thin section. This is key when considering the superficial differences. After careful study in the hand, in thin section and geochemical analysis the following updated definition for these Group XXV axe-heads is offered:

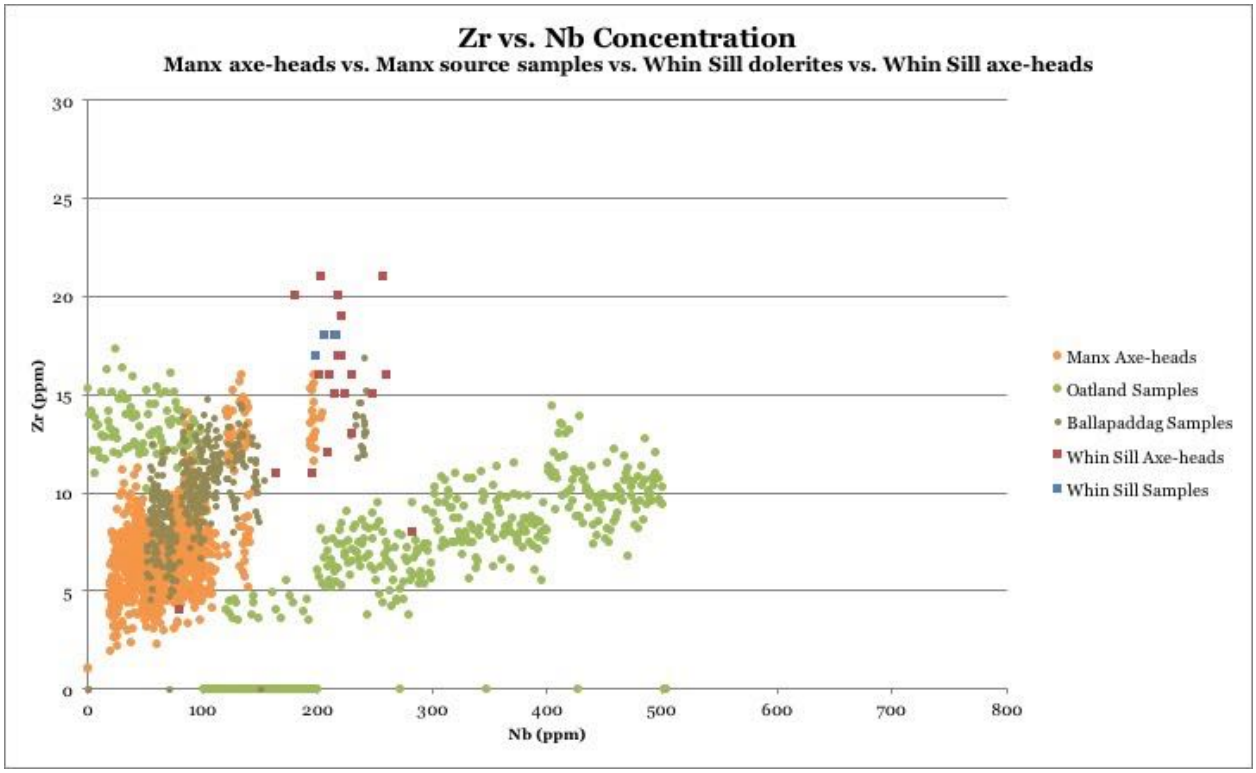
Group XXV, various Manx sources: holocrystalline porphyritic rocks with coarse, equant hexagonal phenocrysts in a quartz/plagioclase/hornblende rich matrix. The plagioclase is generally tabular subhedral to euhedral laths and sericitisation is common. Aggregates of euhedral to subhedral prismatic to tabular crystals of green-brown hornblende with intergranular quartz and alkali feldspar give the rock a spotted appearance. Overall colour varies considerably as does the relative grain size of phenocrysts to matrix. Three main subgroups can be discerned from inspection in the hand: Group XXVa has a pale, sometimes pinkish, matrix of largely plagioclase feldspar, with darker subhedral hexagonal phenocrysts of augite; Group XXVb is overall dark brown in appearance with hexagonal dark grey to dark brown phenocrysts and smaller ferro-magnesium minerals, with pink to orange feldspars; Group XXVc has a bluish green hue and finer overall grain size, pale grey to pale green-blue mottled matrix of ferro-magnesium minerals and white feldspars with brown phenocrysts.

In the course of this study Portable X-Ray Fluorescence Spectrometry (PXRF) was adopted in a non-destructive attempt to generate a distinctive geochemical signature for the Manx axe-heads that have been assigned to IPG Group XXV on the basis of macroscopic inspection or analysis of thin sections. The results indicate that both the Oatlands and Ballapaddag sources are likely to be part of the same larger suite of intrusive igneous rocks in the region. As is the case with most recorded source rock areas, it is likely that several small areas were quarried from various exposures, dykes and sills of similar composition. As such, if the IPG nomenclature is to be retained, both Oatlands and Ballapaddag areas should be considered as Group XXV source areas. It should be noted however that British and Irish researchers are increasingly considering the problems faced in America. As pointed out by Killick and Goldberg (2008) archaeometry has suffered from a lack of adequately trained archaeological scientists and appropriate funding. European archaeometry has not been immune to these issues either. Others have pointed out, primarily Shackley,

(2010, p. 18), that the overly enthusiastic utilisation of certain methods (for example, statistical manipulation and data analysis techniques in XRF on obsidian artefacts) without the corresponding background knowledge that should accompany it, has created a wealth of data and related interpretations that may not be as reliable as they seem at first glance. Therefore, it is essential that the geochemical data collected for Group XXV continues to be scrutinised and compared to other datasets.

As an example, the ratio of different elements in the Manx axe-heads samples have been plotted and compared to the ratios of the same elements in other known source areas. In Figure 6:1, using published data from work conducted by Olwen Williams-Thorpe (2003, p. 1253 Table 3b), the Manx axe-head data is compared to axe-heads thought to have been quarried from the Whin Sill, a well-known dolerite dyke which stretches across the northeast of England. It shows that both the Whin Sill samples and the Manx axe-head samples have a discrete area within which the composition lies and also demonstrates how valuable having a large Manx dataset is for clarifying the concentration ranges for heterogeneous samples.

Figure 6:1 Group XXV vs. Group XVIII



The value of the elemental ratio plots lies in the choice of elements compared and the scale at with the graph is plotted. It is also essential to carefully considered the geochemistry of the samples chosen for comparison to ensure that the most relevant indicators are studied in each case. The data now collected for the Group XXV suite of rock was robustly calibrated and provided a wealth of data for further comparisons with unprovenanced igneous rocks in the collection, as well as against potential Group XXV (±RTBA) found elsewhere (for example, the Kelvingrove Museum example found in Dumfries and Galloway and the axe-head in the Peter Cherry collection found in Cumbria).

That the only two potentially Group XXV axe-heads found in Britain have both been found on beaches facing the Island: one apparently found at the south-facing beach at Glen Luce in Dumfries and Galloway – directly north of the Point of Ayre and the other at Seascale in Cumbria directly to the east would seem to suggest a knowledge that the source lay beyond the horizon. It could be tempting to infer more, however

neither have firm dateable context or archaeological association. A review of the archival material that accompanies the finder details in the Kelvingrove Museum may reveal more information about the circumstances of discovery of the Glen Luce axe-head.

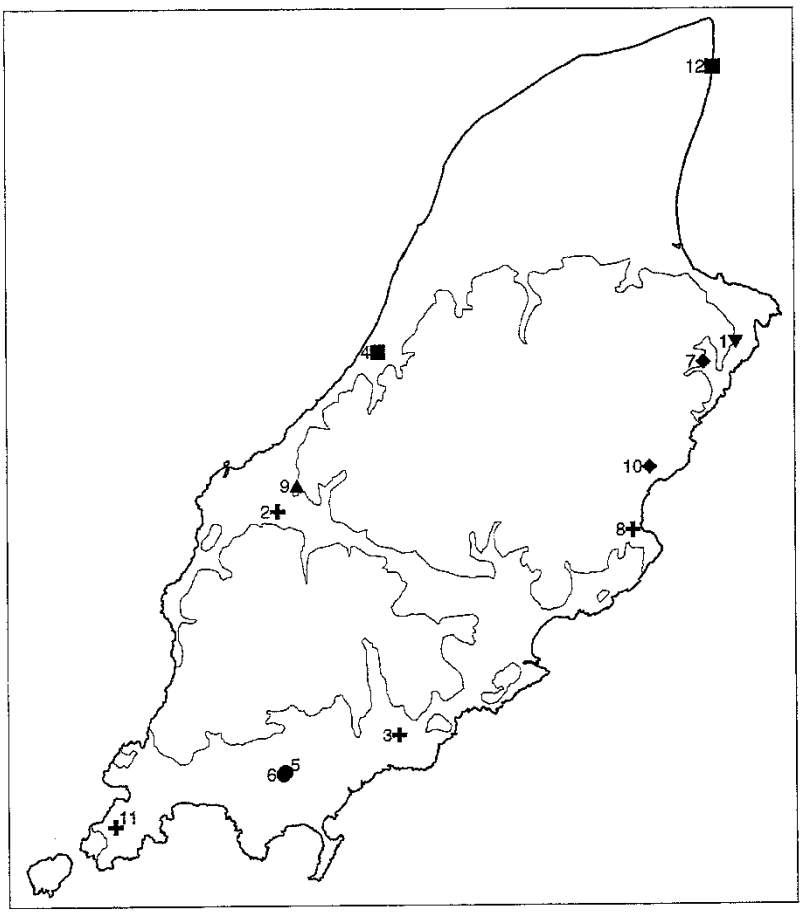
The seemingly deliberate deposition of axe-heads in good condition at Ronaldsway and the small hoard of pristine axe-heads found in German suggest their meaning was layered *on* the island as well. No broken axe-heads have been found in hoards. It is clear from this analysis of Manx axe-head distribution that four regions appear to be the most significant in terms of density of finds. These areas are: the northern plains, the west coast between Knockaloe and Ballagyr, inland to Ballaharra; Derbyhaven Bay (including the Ronaldsway House Site and surrounding area up to Billown) and the Meayll Peninsular at the very south of the Island, see Figure 6:2. This is likely to represent a real distribution when considered with the distribution of known sites, pottery and flint scatters, as well as cremation deposits (discussed recently in detail by Crellin, 2015). Burrow's maps of the distribution of Neolithic sites in on the island (1997, pp. 17, 28 and reproduced in Figure 6:3) parallels the findings here based solely on the distribution of axe-heads that have been found largely as surface finds in agricultural land. Similarly, Crellin noticed the high concentrations of finds in similar areas when she plotted the stone axe-heads for her PhD (see 2014, p. 200)

Burrow's conclusions, based on his pottery analysis and a comprehensive overview of Neolithic sites more generally, showed that the form of pottery changes between the Middle and Late Neolithic, becoming more crude. This line of evidence has been used in conjunction with RTBAs to support the uniqueness of the island in the Late Neolithic. In the south, Darvill's work at Billown shows that activity involving axe-head fragments could have begun as early as the early Middle Neolithic. Axe-heads in

the vicinity of the Meayll site, although not well dated, suggest axe-heads could have been in contemporary circulation with the megaliths, however the dearth of reported axe-heads in the north-east of axe-heads around Maughold where there is a Middle Neolithic court tomb at Cashtal ny Ard and cremation deposits at Ballafayle somewhat contradicts that assertion. Similarly, Crellin's recognition that RTBA were being mimicked in later copper styles suggests that stone axe-heads remained in the collective consciousness throughout the Neolithic and beyond.

Figure 6:2 Four key areas of prehistoric activity highlighted by axe-head density

Figure 6:3a Burrow's maps showing the distribution of Middle Neolithic sites on the Isle of Man (Burrow, 1997, p. 17)



1 Ballafayle
2 Ballaharra
3 Ballakelly
4 Berk
5 Billown Quarry 1
6 Billown Quarry 2
7 Cashtal yn Ard
8 Cloven Stones
9 King Orry's Grave
10 The Kew
11 Mull Hill Circle
12 Phurt

✚ Unclassified tomb
◆ Court tomb
■ Stray find
● Occupation
▲ Passage tomb
▼ Crematoria

Figure 5.1: Distribution of Middle Neolithic sites on the Isle of Man (with 400m contour shown)

17

Figure 3:3b Burrow's maps showing the distribution of Late Neolithic sites on the Isle of Man (Burrow, 1997, p. 28)

1 Ballacottier
2 Ballacross
3 Ballagawne
4 Ballahot
5 Ballaheaney
6 Ballaquayle
7 Ballateare Dutch Barn
8 Ballateare
9 Ballavarry
10 Ballig
11 Billown Circle
12 Billown Quarry 2
13 Cleigh Rouyr
14 Colby
15 Colby Mooar
16 Cronk Coar
17 Crossag
18 Earybedn
19 Glencrutchery
20 Gob y Volley
21 Greenlands
22 Guilcagh
23 Killeaba
24 Knockaloe Beg
25 Knocksharry
26 Leodest
27 Orrisdale Brooghs
28 Park Farm
29 Peel School
30 Ramsey Brooghs
31 Ronaldsway Airport
32 Ronaldsway 'House'
33 Ronaldsway Village
34 Round Ellan
35 Scholaby
36 Scard
37 Shellag
38 Skyhill
39 South Barrule
40 West Kimmeragh

Stray jar
Cremation burial
Occupation
Stray find

Figure 6.1: Distribution of Late Neolithic sites on the Isle of Man (with 400m contour shown)

28

In the north west of the Island a concentration of axe-heads has been found in the relatively small parishes of Jurby and Andreas. The Lhen, a post-glacial outwash channel winding through the area and the fertile land underlain by glacial tills of the northern plains would have provided conditions conducive to settlement in their pristine and natural state. Close to both fresh and salt water sources, with sheltered woodland and a healthy marshland environment, animal and plant life would have been plentiful. Repeated evidence for activity through the late Neolithic is seen from the numerous flint scatters and surfaces finds discovered right across this area from the Lhen on the west to Dog Mill Shores on the east coast, see Figure3.3b. Known occupation sites like Ballaheaney and Ballacottier have produced finds including axe-heads. The later keeill sites at Knock y Doonee and Cronk Mwyllin both revealed axe-heads in the immediate vicinity. This could be evidence of activity in prehistory, but because these areas are known to have been venerated later, it might be tempting to suggest that these finds extend the significance of the area backwards considerably, however it is just as possible that these items were brought to the keeill sites (or their precursor) as a symbolic gesture at any point in the intervening years from outside the region. It is clear however that during the Late Neolithic in the north of the island axe-heads of all petrologies were in abundance.

The second area of interest is in the west; the Sheading of Glenfaba. In the south of the Sheading, in the Parish of Patrick, the Knockaloe Hoard of four well preserved RTBAs including three Group XXV and one of erratic material, was found on the same hillside as a Late Neolithic 'occupation' site at Knockaloe Beg, a younger cist is also in the vicinity. Further inland there are several individual finds at Ballacosnahan as well.

The largest concentration of individual finds in any Parish is found in German.[2] The German collection display a variety of rock types in an array of shapes and sizes, broken, whole and fragmentary. Stray axe-heads have been found inland near Ballaharra, where Sheila Cregeen excavated a multi-phase site that included an early Middle Neolithic chambered tomb found during quarrying in the nineteen sixties (Cregeen, 1978) along with several rich cremation deposits that have been radiocarbon dated to the Late Neolithic (Crellin, 2014, p. 85; Fowler, 2004).

Seven axe-heads have been found north of Peel; several at Ballagyr, including five broken examples, and more at Bellellis and Knocksharry on the west coast. Crellin's reassessment of Knocksharry after new younger radiocarbon dates for the burials, (2014, p. 84) does not change the fact that there was activity in the area during the Neolithic.

Overall, the Sheading of Rushen in the south of the Island, has the most axe-heads. Here, two clusters are apparent, collectively representing 40% of the finds from Rushen. Ten axeheads were found on one farm at Balnahowe (with two more nearby at the Meayll—the famously unique Middle Neolithic Manx megalith). The axe-heads found at the Ronaldsway 'house' site have been a central part of defining the Manx Late Neolithic since its conceptualisation, but in reality they represent only a small part of the rich assemblage found at the site, interpreted recently by Crellin as possibly ritual deposits at a site of uncertain character rather than as terminal deposits from the abandonment of a 'house' as has been assumed until now (Crellin, 2014, pp. 289–290). Both these areas in the south and the fertile plains between are littered in Neolithic archaeology as attested by the work of Timothy Darvill and the BNLP (Darvill, 2004). It is unsurprising to find that axe-heads were not in short

[2] The Parish of Malew in Rushen has more axe-heads (n=33 cf. n=25 in German), but this includes 12 axe-heads found at the Ronaldsway House site excavation.

supply on the island. In general, the variable scatter across the landscape suggests they were circulating in the social and functional sphere of a changing, living community, rather than reserved for one particular function that limited contact with other elements of society.

6.2 Utilising resources in the Manx Neolithic

Trying to place the Manx 'Neolithic' within its framework has been a goal for many researchers over the years (Clarke, 1935; Moffatt, 1978; Burrow, 1997; Davey and Innes, 2002; Darvill, 2004), but perhaps it is time to rethink the need to do this. The terminology used is the issue. Post Gathering Time (Whittle et al., 2011) framing the archaeological evidence within ever firmer date ranges allows a clearer understanding of which elements of the evidence occurred contemporaneously; making it possible to view time periods at a choice of scales—hopefully, without the inherent bias associated with the hunter gather vs farmer debate that is currently wrapped up in loaded terms like the 'Mesolithic-Neolithic Transition' (Sheridan, 2007, pp. 451–458; cf. Thomas, 2007).

Unfortunately, this is not an easy task for the Manx Neolithic because of the limited number of artefacts associated with reliable radiocarbon dates. However, attempting to accurately date evidence is becoming standard practise and new projects, like Rachel Crellin's work at Killeaba (Crellin, 2015), help to clarify matters. Another project focusing on the island's mortuary practices and prehistoric round mounds, is in planning. Again led by Rachel Crellin at the University of Leicester in conjunction with Chris Fowler at Newcastle University, Manx National Heritage and Culture Vannin (Manx National Heritage, 2016). In addition, a new structure and associated findings from Ballagyr, German are being studied by Oxford Archaeology North (Quartermaine, pers. comm.) and more archival research and artefacts studies are also planned (Davey, P.J. pers. comm.)

The stone axe-heads, adzes and chisels that have been found on the Isle of Man naturally represent only a fragment of the material culture from the period of their use: a rich assemblage is seen that includes many other lithic forms including pounders and whorls, plus flint tools, pottery, hazelnut shells and bone which has survived at various sites like Ballaharra and Killeaba (Crellin, 2015; Fowler, 2001). Intriguing megalithic monuments, cremations deposits, pits, post holes and organic residue (including seeds, shells, charcoal) add to the overall picture of resource utilisation, suggesting a diverse array of activities were being carried out on the island throughout the 4th millennium BCE and axe-heads were an integral part of that network of things and agents that continuously evolved through time. Similarly, there can be little doubt that degraded materials, made of hide, grasses and wood, were much more abundant than the record could ever suggests.

Unfortunately, but also inevitably, there are gaps in the record and continuous occupation or sporadic utilisation of the environment are both real possibilities still debated. The extent of the data does not allow the area to be considered on multiple scales (i.e. generational, seasonal), but the data added from this project shows that towards the end of the Neolithic (c. 2500 Cal BCE), when polished stone axes were prolific in the region at large (Bayliss, et al., 2011, Bradley and Edmonds, 1993), axe-heads were conspicuous on Mann and from the variety of rock types used they no doubt played a considerable role in various social networks that connected with the Isle of Man.

6.3 Interconnection or Isolation?

The fact that some Manx axe-heads display a roughened butt end has been key to all previous interpretations of isolation in the Manx Late Neolithic. The focus of previous studies into Manx axe-heads has concentrated on the roughening of the butt end because it is not seen in other collections. In the author's master's project, it was suggested that RTBAs were over classified, and now it is suggested that limits are placed on the categorisation of RTBAs to only examples with very obvious neat and complete roughening of the butt end. Other roughened examples are still noteworthy, and may have held no different meaning to obvious RTBAs. However, several axe-heads with poorly defined roughened butt ends are not now considered deliberate RTBA.

There is a clear relationship between RTBA features and the Group XXV sources. All Group XXV axe-heads are obvious RTBA (with the exception of Darvill's fragments from Billown), but not all obvious RTBA are Group XXV. This could mean the non-Group XXV RTBA are imitating the style of the local resource, or equally that this neat roughening was never directly, exclusively or dominantly associated with Group XXV.

The fixation with RTBAs and Group XXV axe-heads has done a disservice to the rest of the collection, which have been largely ignored by interpretations so far (probably because they had not been catalogued). This analysis reveals that all Manx axe-heads contributed to a local style, that particular Manx style is full of a diverse array of characteristics *including but by no means limited to* careful consideration of the butt end. As a consequence, previous interpretations have been wrong to consider the unusual axe-heads a specific facet of the Ronaldsway Culture and then use them to infer isolation in the Late Neolithic. Axe-heads from the Manx Neolithic in general show both a distinct style *and* patterns of similarities with larger regional axe-head

themes, including the prevalence of Group VI axe-heads from Cumbria, and the presence of porcellanite from Ireland, greenstones from Cornwall, and granophyre from Wales. No doubt more of which will become apparent with further study. Indeed, as mentioned above Darvill 's discovery of 'fragments of a polished axe-head and sherds of plain Bowl pottery which could be taken as early in the (Meayll) tradition', in the earliest stages of what he considers to represent 'periodic pit digging and veneration and elaboration of natural hollows' in the 38th or 37th century BCE (Whittle et al., 2011, p. 561) highlights that axe-heads were in circulation on the Island throughout the Manx Neolithic. How significant this may be hinges on the petrology of this dated polished axe-head fragment. Darvill states in the eight BNLP Report (Darvill and Chartrand, 2004, p. 18) that of 'about 20 fragments of stone and flint axe registered, four were fairly substantial fragments of what seem to be Group XXV specimens'. It is unclear from the reports whether the dated sample is one of the four apparently un-roughened Group XXV axe-fragments. If so, however, it would challenge the established idea that the Group XXV sources were only part of the insular Late Neolithic Ronaldsway Culture assemblage.

Applying only one interpretation/explanation/justification to the reason we see the evidence for any singular 'culture' as it stands today, does an injustice to the inherent role of diversity that naturally permeates a single cultural unit. To imply the Neolithic communities of the Irish Sea region (and Britain, Ireland and Europe more broadly) acted as uniform and definable groups interacting en masse, is as dismissive as implying the same of today, or for that matter of the Viking or Roman periods. Instead, within each bracketed region are a series of smaller bracket regions until you get down to the individual. It is possible to interpret the evidence today as indicative of the diverse array of ways in which people with different backgrounds interact in prehistory, *regardless— and because of—their many personal cultural affinities*. It

is time to see innovation and change as coming from inside 'culture'; remembering that culture is not a fixed idea but an evolving entity that grows and changes with time depending on the experiences of the individuals within it, *as well as* on a larger scale in response to the inevitably fluctuating, contemporary environmental and social-economic constraints. This is fundamental to a new appreciation of prehistoric culture, one which is far removed from its culture history heritage, accepting innovation could, can and does occur without either isolation or colonisation, because 'culture' is *a response that develops temporally* before it is *a force that drives spatially*.

The evidence from stone axe-heads for the Manx Neolithic it is Irish Sea context suggest that the Isle of Man grew into part of a dynamic 'axe-knowledgeable' community of communities that evolved in situ in the Irish Sea region though the 4th Millennium BCE. There is little to suggest these communities were *all* sedentary from the onset, undoubtedly the resources of the region were exploited in a variety of ways that largely failed to penetrate the archaeological record. The cultural affinities and priorities of the human agents in the region were undoubtable influenced by constantly changing factors beyond their control and outside their immediate universe, but on a local scale and shorter time frame the inter personal relationships of the individual can be witnessed in the material culture that remains. It is in the detail that we see that a variety of lithic sources, of both local and regional significance were in circulation on the island, and while this parallels the treatment of axe-heads in the encircling isles, the Manx collection retain distinctive personality that is much more than the sum of its subset of RTBAs.

It has long been accepted that the unique elements of the Ronaldsway Culture, specifically the round-bottomed pottery and roughened and truncated butt axe-heads, support the notion that the Island was isolation in the late Neolithic. Indeed, coupled with earlier evidence from Megalithic structures across the Island (particular at the Meayll) the Island appears to have forged an identify of its own at this time. However, how far does an identity infer isolation? If exotic materials were difficult to obtain then we might, as in other areas (Larson, 2011), see more evidence for the veneration of axe-heads in the way they are deposited or notice a pattern that separates Late Neolithic activity from non-local sources but as it stands, from the petrological evidence it would seem that connections were upheld. However, it is also clear that an insular source was utilised but not part of wider distribution.

Even though the evidence from the axe-heads suggests that contact was upheld in all directions during the period, the morphologically the Manx axe-heads do not show an overwhelming likeness with any particular neighbouring collection (at least until further work is complete in Scotland, Wales and England).

As noted by Rachel Crellin in her recent PhD on the emergence of the Bronze Age on the Isle of Man (2014), the Island's unique expression of identity is not in dispute, it is only the interpretation that this identity was brought about by isolation that is refuted here. Limited contact is not the only plausible scenario to be extracted from the dataset, instead it can equally be argued that the Manx axe-heads exhibit a clear sense of identity, forged from continuous but ever changing contacts with neighbouring communities.

6.3.1 Further Work

The most recent work conducted on axe-heads in Britain and Ireland (Ballin, 2011; Davis and Edmonds, 2011, 2009) has utilised modern geochemical analysis to help identify the source rock used in the production of axe-heads with variable success.

However, methodology is constantly being adapted to consider the myriad types of potential data error, and an interest in non-destructive analysis, 3D imaging and geospatial analysis is increasing (although funding is an ever-present limiting factor). A targeted review of the geochemistry of non-local sources, specifically the greenstones, granophyre and tuffs, with the aid of the forthcoming IPG Atlas of Stone Axe Petrology should help to clarify the use of Welsh and Cornish sources on the Island. Similarly, comparisons with Irish and Welsh collections is incomplete and sources of igneous rock from the Scottish Islands have not been considered either. It remains likely that some of the ungrouped axe-heads could be sourced to igneous sources in Ireland, Scotland or Wales, for example Lambay Island off the coast of Ireland near Dublin is a known source for igneous axe-heads in Ireland (Cooney, 2005). However, the extent of distribution elsewhere is largely undocumented. Likewise, various ungrouped sedimentary and coarser volcaniclastic axe-heads may prove to come from Irish sources. The dolerite axe-heads and flint axe-heads deserve studies in their own right too; once work on potential source areas has been furthered.

Regarding the future of the database, by employing the latest computational processing speeds, modern statistical software has the ability to amalgamate disparate datasets for analysis, and as such establishing consistent meta-data standards is vital going forward in all areas of research. The Manx collection should not be allowed to become antiquated. Globally, the progress made in technology in the last decade is unprecedented. One of the underreported effects of this has been a rapid change to the nature of protocol and standards in Universities, Publishers and Science-focused Institutions so keeping current going forward is essential.

There is no individual treatment given to axe-heads elsewhere that could be wholeheartedly adopted and applied to the Island indiscriminately, however this is

not as unfortunate as it may at first appear. Whilst a universal approach to stone axe-head studies is in many respects desirable, any method that would blanket over the subtler regional difference in axe-head form or distribution needs to be avoided. As such, but acutely aware that there is also no demand to 'reinvent the wheel', the Manx Stone Axe-head Project attempts to bring into focus aspects of the collection that might be of wider interest without forcing a standardised methodology. By considering the key features of contextual, morphological and petrological significance it is hoped that this review of the Manx stone axe-head collection has contributed to the collective consciousness and may stand to represent a case study for similar archival collections that currently lack the clarity modern studies demand of them.

There is a lot more information still to be analysed from the Manx collection. It is clear that further work in all areas is needed before comparisons can be drawn more broadly. However, now that the database is active, real comparisons can begin to be made between the artefacts. Collectively, the Manx Museum's axe-head collection comes from several different petrological sources in a variety of shapes and styles, and they have been found across the whole Island.

This study enables Manx stones axe-heads to join the current debate about Neolithic Irish Sea regional interaction. As more work is completed in neighbouring regions, a clearer picture will no doubt continue to emerge of the significance of the petrology and morphology of axe-heads on the Isle of Man. As it stands however, this new dataset can already help to mitigate against the effect that the isolation interpretation has had on how the Manx Late Neolithic has been framed in the past. Collectively these axe-heads support the arguments also forwarded by Crellin (2014) that maintain the Manx Late Neolithic was far from isolated.

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