A Desktop Resource Assessment of Building Stone and Slate on the Island of Bute

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Keywords

Geology, Bute, building stone, slate, quarry, resources, built environment.

Front cover
Main Image: Gate tower of Rothesay Castle, 16th c. Smaller images (top to bottom): Typical stone building from Rothesay with slate roof; Geology map of Rothesay showing Longhill Quarry.

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SUMMARY

Bute has a varied geology, resulting from the presence of the Highland Boundary Fault which crosses the island and brings metamorphic rocks of the Scottish Highlands into contact with Devonian and Carboniferous sedimentary rocks of the Central Belt. The island also has abundant igneous intrusions of various generations, mostly fine-grained, dark basaltic rocks. This diverse geology is reflected in buildings across the island which used local stone and slate, bringing a distinctive character to the built heritage of Bute.

Over sixty stone quarries are recorded on Bute. Most of these exploited igneous rock, likely to have been used for roadstone. Large-scale production of building stone was probably limited to Rothesay, where an igneous intrusion at Longhill Quarry provided block for buildings in the town. This 'greenstone' was used extensively in buildings up to the mid to late 19th century, when imported sandstone became increasingly used. In rural areas, buildings were typically constructed from the closest available stone type, obtained from any suitable outcrops or small quarries. Dressed stone, sourced from blonde and red sandstone, was also used for early buildings throughout Bute. These sandstones were probably obtained from unrecorded quarries in the Devonian and Carboniferous sediments of the S and E parts of the island.

The only significant mineral extraction recorded on Bute is for slate and limestone. Slate was exported from the 15th century, being the closest and most easily transported (by sea) source of slate to the emerging population centres around the Firth of Clyde. A number of quarries exploited the slate in a NE–SW trending seam running along the northern side of the valley between Kames Bay and Ettrick Bay. It is likely that the industry declined rapidly in the 18th century as superior slates became available from the West Highland quarries at Easdale and Ballachulish, although it may have continued for local use. Limestone was extracted from a bed in upper Devonian rocks S of Kilchattan, and it is recorded that the island was self-sufficient in limestone during the 18th and 19th centuries.

It is considered that there is little potential for large-scale extraction of stone in Bute today unless new markets can be identified. The reserves of Bute slate are probably of relatively limited extent and quality, and unlikely to be able to compete with today's international slate market. The limestone deposits of the island are relatively restricted and likely to have been largely worked out. The production of basic igneous rock for building has a very limited market, and although there are many sources of this rock on the island they are of such small size as to be unable to compete with the large scale aggregate quarries already operating throughout central Scotland.

The range of local stone types used throughout the island and the use of different stone types in Rothesay over time (reflecting improving transportation links) gives a particular character to the built heritage in Bute. The stone heritage of Rothesay in particular is probably unique to any town in Scotland. Identification and securing of appropriate stone types for future repair and maintenance is considered essential to retain these unique historic qualities and sense of place, and it is recommended that a detailed building stone audit and quarry resource assessment is carried out. The reopening of a limited number of key quarries on Bute would ensure that appropriate stone is used for the repair and maintenance of the built heritage, as well as providing a local and environmentally sustainable source of material. The availability of local building stone and slate could also be incorporated into planning design guidelines to ensure that new build development is 'in keeping' with the historic built environment.

CONTENTS

1. Introduction

This report forms one of a series of building stone resource assessments undertaken by the BGS for Scottish Stone Liaison Group (SSLG) under the contract 'Scottish Building Stone Resources'. These studies aim to document particular building stone resources in different parts of Scotland in order to increase awareness and provide information to allow those concerned with improving the supply of stone, slate etc. to improve decision-making.

This particular study has been requested following an approach by Bute Estate Trust to Scottish Stone Liaison Group to provide information on the stone and slate resources of the island. This report is a compilation of existing data held by the BGS together with published information. The objective is to provide an outline framework in order to allow more detailed investigations. This report is aimed at the non-geological specialist who requires further information regarding building materials on Bute.

It should be noted that this report is a desk study of existing information. No fieldwork has been undertaken as part of this work. Much of the geological interpretation is taken from published maps and other data held by BGS. Although much data exists on the locations of former quarries, the stone type worked is commonly not recorded. For many cases the stone produced from particular quarries has been inferred from the available information. It is possible therefore that some inaccuracies exist. A more detailed study could be obtained by undertaking site visits to provide an accurate audit of the stone resource on the island.

This report is divided into five chapters. Chapter 2 gives a general description of the geology of Bute, explaining the distribution of the main rock types throughout the island. Chapter 3 is a listing of the principal quarry sources of stone as obtained from the BGS Historic Scottish Quarries Database. The quarries are divided into three tables representing metamorphic, sedimentary and igneous rock. Each table gives basic information; quarry name/locality, grid reference, rock type worked (inferred from published geological maps) and other relevant information.

Chapter 4 describes existing published historical information specifically relating to the use of building stone in Bute, and identifies a number of different stone types which have been used. This information is obtained from published historical sources and interpretation of photographs of buildings held by BGS. Chapter 5 specifically details the known major slate quarries on Bute, drawing much information from the published Historic Scotland Research Report (Walsh 2000). Chapter 6 documents information on other mineral resources such as limestone and clay deposits. Discussion and recommendations are given in Chapter 7. A glossary of terms (mostly geological) is provided at the end of the report.

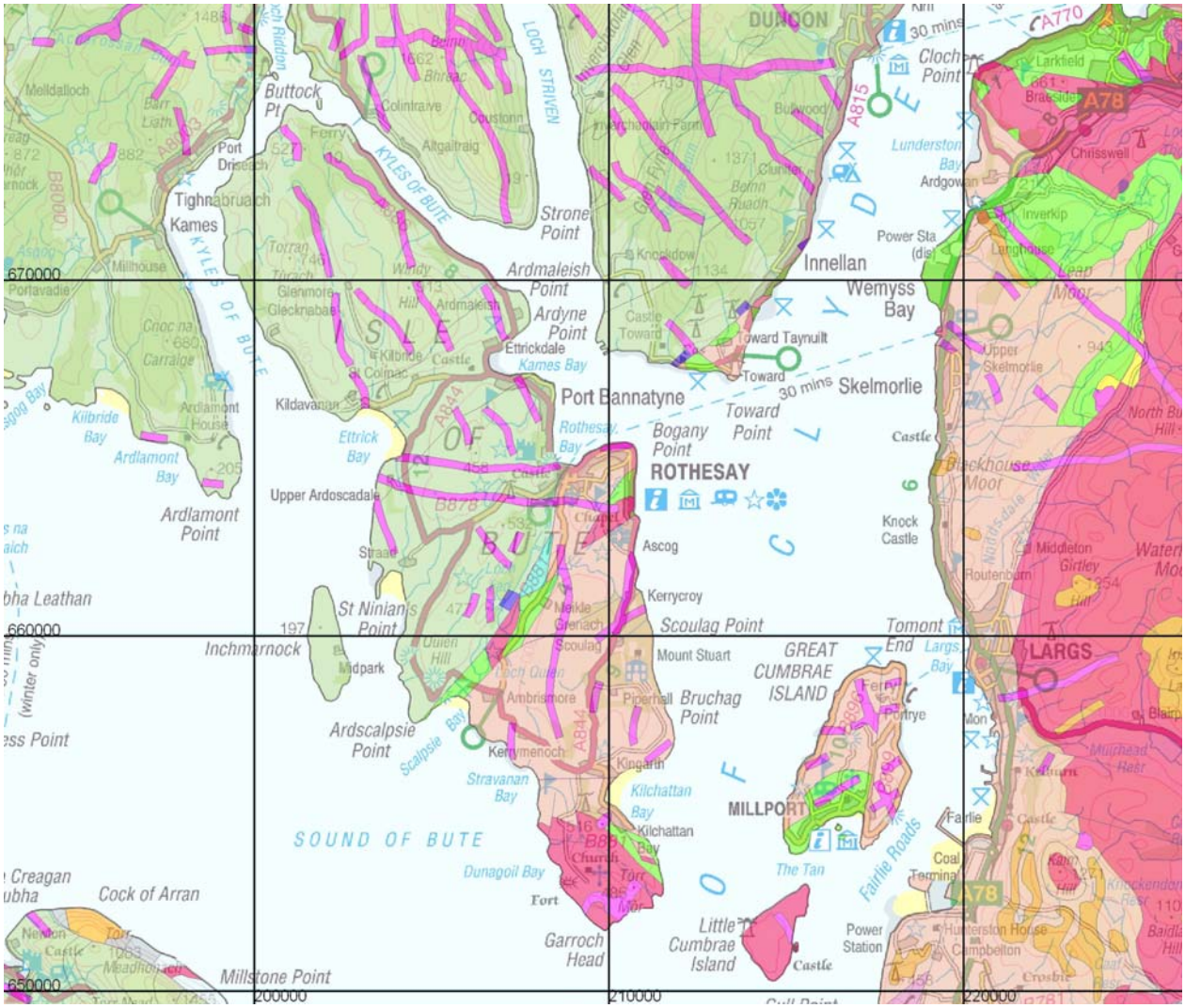

Fig. 1. General geological map of the island of Bute and surrounding areas. The geology of Bute is divided by the presence of the Highland Boundary Fault which separates Dalradian 'Highland' rocks (shown in green) from sedimentary rocks typical of the Scottish Central Belt (pink colour). Igneous intrusions and volcanic rocks are shown in red. Grid squares are 10km.

2. General geological description

2.1 Introduction

The geology of Bute is unusually complex and variable, largely due to the presence of the Highland Boundary Fault (a major geological boundary) which runs across the centre of the island in a north-east to south-west direction. The northern part of the island is dominated by typical 'Highland' metamorphic rocks of Precambrian (Neoproterozoic) age belonging to the Dalradian Supergroup. The area to the south of the fault is dominated by younger sedimentary rocks typical of the Central Belt of Scotland, mostly sandstones and conglomerates of Late Devonian Upper Old Red Sandstone age, with some Carboniferous sandstones and basaltic lavas. Basic igneous intrusions (dykes and sills) of various ages are present extensively throughout the island, with a particularly large outcrop near the southern tip. A summary map of Bute showing the geology and its relationship to the adjacent mainland is shown in Fig. 1.

2.2 Dalradian rocks (northern and central parts of the island)

The Dalradian rocks belong to the Southern Highland Group, forming part of an extensive belt of rocks which extends from north Ireland to near Stonehaven on the north-east Scottish coast. On Bute they can be divided into 3 main groups (Fig. 2);

(i) The northern part comprising the Beinn Bheula Schist Formation, which on the west side comprises gritty psammite and pelite (with localised thin bands of metaconglomerate –which also crop out on the northern tip of island), whilst to the east it is dominated by pelite, semipelite and psammite. An arbitrary boundary between these lithological variations is shown as a north-south line on Fig. 2, with the western lithology shown in green, and purple representing the eastern lithology.

(ii) The central part consists of phyllitic pelites of the Dunoon Phyllite Formation.

(iii) The southern part of the Dalradian is psammite of the Innellan Formation, containing localised beds of pelite and subordinate metalimestone.

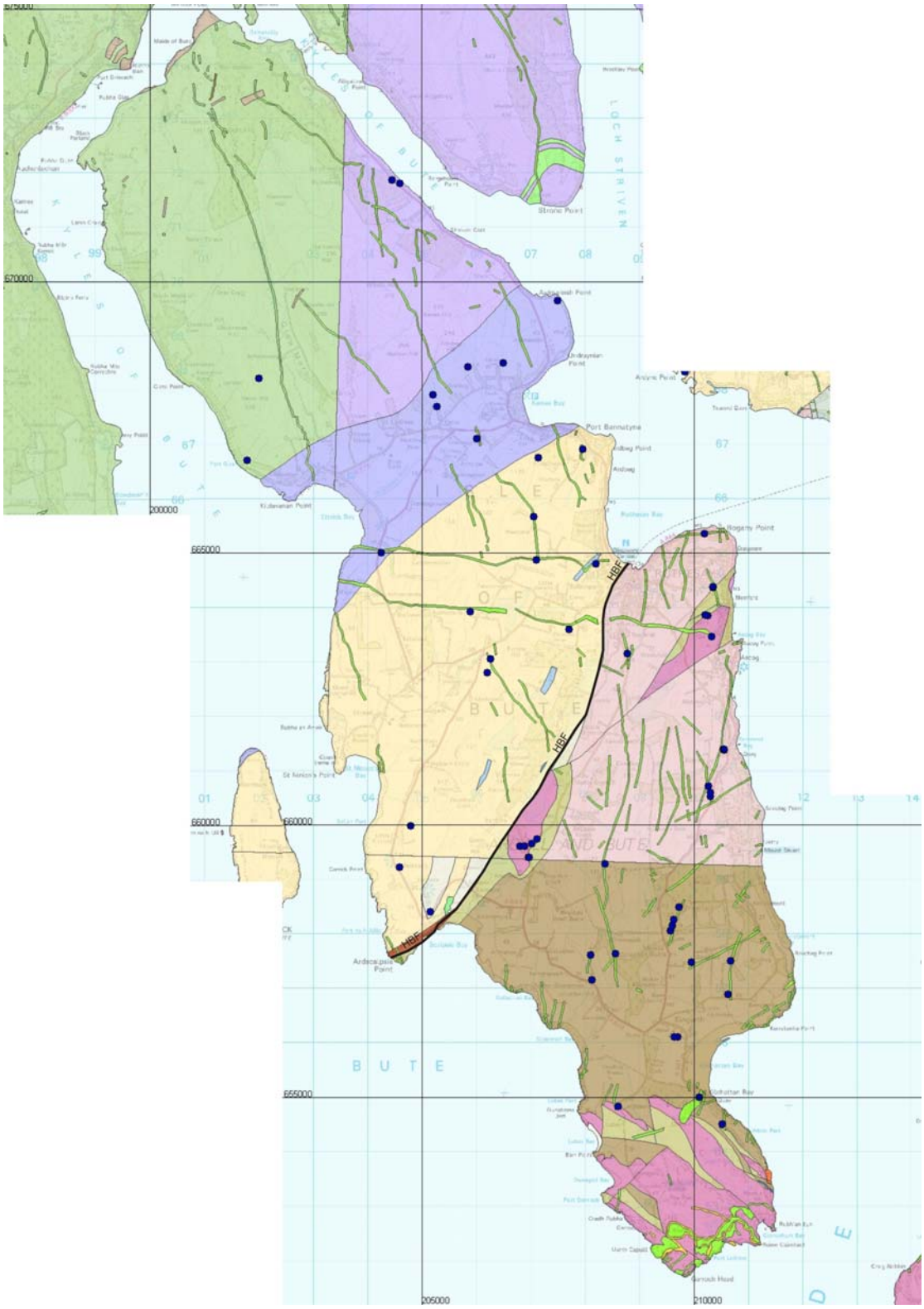

Fig. 2. Geological map of Bute showing locations of former quarries from the BGS Historic Quarries database, listed in Tables 1 to 4 (shown as blue dots). Key to the geology, from north to south: Green/purple = Beinn Bheula Schist Formation; Blue = Dunoon Phyllite Formation; Yellow = Innellan Formation psammite; Pale pink/brown = Devonian sedimentary rocks; Light green = Carboniferous sedimentary rocks; Bright pink and bright green = igneous rocks. A detailed explanation of the different formations is given in the text. Most of the quarries are associated with basic igneous dykes (bright green). HBF = Highland Boundary Fault. Grid squares are 5km.

The Dalradian rocks are a mixture of different sedimentary rocks (sandstones, mudstones etc.) that have undergone low-grade regional metamorphism resulting in recrystallisation and the formation of metamorphic minerals such as chlorite (producing the green colour). Deformation of the rocks has produced a schistosity which in places is expressed as a slaty cleavage. In the northern part of the island the metamorphism is more intense.

2.3 Southern part of the island

Most of the area to the south of the Highland Boundary Fault is underlain by sedimentary rocks of Late Devonian age (Upper Old Red Sandstone). These rocks can be divided into a northern belt of conglomerates (Bute Conglomerate Formation) and a southern area of interbedded sandstone and conglomerate (Stratheden Group). A thin band of Lower Old Red sandstone interbedded sandstone and conglomerate is present at Ardscalpsie Point. The transition between these lithological variations is represented in Fig. 2 by an arbitrary line running east-west with the conglomerates represented by pale pink and the southern sandstones by a brown colour.

The Devonian rocks are overlain in places by pale coloured sandstones of Carboniferous age (undifferentiated Inverclyde/Strathclyde Group), with argillaceous (mudstone) interbeds. These outcrop in a large area to the southwest of the Highland Boundary Fault; inland from Ascog Bay; and also on the southern part of island. The Carboniferous sedimentary rocks are overlain by basaltic lavas of the Clyde Plateau Volcanic Formation (also of Carboniferous age) most prominently visible at the southern end of the island. Thin beds of Upper Devonian limestone ‘cornstone’ are locally present in the southeast, south of Kilchattan. A thin band of Ordovician age conglomerates (Loch Fad Conglomerate Formation) occur locally along the Highland Boundary Fault, forming part of the Highland Border Complex.

2.4 Igneous rocks

Igneous rocks are present throughout the island, belonging to several different episodes of magmatism, though mostly all basaltic in composition (Fig. 2). On the southern end of the island (Garoch Head) there are extensive outcrops of basalt, microgabbro and trachyte of undetermined age. Related dykes and sills are present further north, although in the central and northern parts of the island these are ascribed to the roughly north-south trending 'Mull Dyke Swarm' of Palaeogene age. A small area of volcanic vent agglomerate (of Carboniferous-Permian age) is present on the south-east coast. A series of roughly east–west-trending quartz microgabbro dykes in the central part of the island belong to the late Carboniferous 'Central Scotland Tholeiitic Dyke Swarm'.

3. Inventory of stone quarries

3.1 Introduction

The BGS quarries database contains information on approximately sixty stone quarries on Bute. In this report these are separated into a series of tables; Table 1: Quarry sites in Dalradian metamorphic rocks (northern part of island); Table 2: Quarries in Devonian and Carboniferous sedimentary rocks and later volcanic rocks (southern part of island); and Table 3: Quarries in igneous intrusions from throughout the island. Slate quarries are considered separately is Chapter 5 (Table 4). The database does not generally contain specific information regarding the rock type worked or the use of the material. The stone type listed in the tables is therefore inferred from the published geological maps. For most quarries it is therefore not possible to determine if the stone was used as a building stone, walling stone, road metal etc. In addition no information regarding the significance of a particular quarry is given, such that some quarries could have been large operations supplying stone for the whole island whilst others were for very local use. Further information on the use and significance of quarries would require site visits.

The following tables list the quarries on the island contained within the BGS historic quarries database, showing quarry name (where known), grid reference and the main rock type assumed to have been worked. In cases where the quarry lies on more than one rock type (i.e. across geological boundary) both rock types are given. The database is unlikely to contain all sites of quarrying on the island, and there may be many other small sites of extraction. The locations of the quarries held in the database are shown as blue dots in Fig. 2.

It is worth noting that many of the quarries on Bute are associated with small basic igneous dykes (bright green lines on Fig. 2), and these probably represent relatively small (local-scale) workings for roadstone. These are listed in Table 3, and comprise over half of the documented quarries on Bute.

The BGS quarry information is linked to a Geographic Information System (GIS) database showing spatial relationship of quarries to the geology and other geographical features. Examples of two areas on Bute are shown in Figs. 3 and 4.

Table 1. Quarries in Dalradian metamorphic rocks (northern part of island)

Name	Easting	Northing	Lithology	Lithostratigraphy	Location
Skelmorlie	202000	668200	Psammite and pelite	Beinn Bheula Schist Formation	Achavoulaig
'Quarry'	201780	666700	Psammite and pelite	Beinn Bheula Schist Formation	Kildavan
Shalunt	204450	671860	Pelite, semipelite and psammite	Beinn Bheula Schist Formation	Shalunt Wood, Shalunt
'Quarry (disused)'	207140	666750	Psammite	Innellan Formation	Port Bannatyne
'Ardbeg'	207829	666908	Psammite	Innellan Formation	Ardbeg
Milton	206200	662800	Psammite	Innellan Formation	Milton
'Quarry (disused)'	204590	659220	Psammite	Innellan Formation	Little Kilmory
'Quarry (disused)'	204790	659980	Psammite	Innellan Formation	Little Kilmory
'Quarry (disused)'	205150	658400	Gritty, foliated psammite	Innellan Formation	Ardscalpsie

Table 2. Quarries in Devonian and Carboniferous sedimentary rocks and Carboniferous and Palaeogene volcanic rocks (southern part of island).

Name	Easting	Northing	Lithology	Lithostratigraphy	Location
'Old Quarry' working	210350	664370	Sandstone and interbedded argillaceous rocks.	Inverclyde Group and Strathclyde Group (Undifferentiated)	Montlord
Old Quarries	210200	663860	Sandstone and interbedded argillaceous rocks. Basalt also in quarry.	Inverclyde Group and Strathclyde Group (Undifferentiated)	High Bogany
Old Quarry	210320	663460	Sandstone and/or basalt (whinstone)	Clyde Plateau Volcanic Formation	Ascogbank
Carpenter's Shop (disused)	210550	661380	Conglomerate and/or basalt (whinstone)	Bute Conglomerate Formation and/or Mull Dyke Swarm	Kerrycroy
'Quarries (disused)'	210300	660600	On the boundary of conglomerate and basalt (whinstone)	Bute Conglomerate Formation and/or Mull Dyke Swarm	Kerrycroy

Table 3. Quarries in igneous rocks (whinstone).

Name	Easting	Northing	Lithology	Lithostratigraphy	Location
'Old Quarry'	204250	665000	Quartz microgabbro	Central Scotland Late Carboniferous Tholeiitic Dyke Swarm	Larigievrechan
'Cranslagomry'	206000	667100	Basalt and microgabbro	Mull Dyke Swarm	Cranslagomry
Point House	207950	666900	Basalt and microgabbro	Mull Dyke Swarm	Ardbeg
'Quarry (disused)'	207100	664870	Quartz microgabbro	Central Scotland Late Carboniferous Tholeiitic Dyke Swarm	Gartnakeilly
'Quarry (disused)'	207050	665670	Basalt and microgabbro	Mull Dyke Swarm	Westland
Longhill	208200	664800	Quartz microgabbro	Central Scotland Late Carboniferous Tholeiitic Dyke Swarm	Ballochgoy. Probable 'Greenstone' quarry for Rothesay.
Quarries (disused)	207700	663600	Quartz microgabbro	Central Scotland Late Carboniferous Tholeiitic Dyke Swarm	Craigberoch
'Quarry (disused)'	205890	663920	Quartz and microgabbro	Central Scotland Late Carboniferous Tholeiitic Dyke Swarm	Greenan
'Quarry (disused)'	206260	663050	Basalt and microgabbro	Mull Dyke Swarm	Milton
'Quarry (disused)'	206400	663226	Basalt and microgabbro	Mull Dyke Swarm	Greenan Mill
'Quarry (disused)'	206800	659600	Basalt	Clyde Plateau Volcanic Formation	Ambrisbeg
'Quarry (disused)'	206880	659600	Basalt	Clyde Plateau Volcanic Formation	Ambrisbeg
'Quarry (disused)'	207020	659650	Basalt	Clyde Plateau Volcanic Formation	Ambrisbeg
'Quarry (disused)'	207110	659740	Basalt	Clyde Plateau Volcanic Formation	Ambrisbeg
Ambrisbeg	206960	659400	Basalt	Clyde Plateau Volcanic Formation	Ambrisbeg

'Old Quarry'	210190	665350	Quartz-microgabbro	Central Scotland Late Carboniferous Tholeiitic Dyke Swarm	Craigmore
'Old Quarry'	210350	664370	Basalt and microgabbro	Mull Dyke-Swarm	Monford
'Old Quarry'	210190	665350	Quartz microgabbro	Central Scotland Late Carboniferous Tholeiitic Dyke Swarm -	Craigmore
Crossbeg	208770	663150	Basalt and microgabbro	Mull Dyke-Swarm -	Townhead
'Old Quarry'	209875	663296	Basalt	Clyde Plateau Volcanic Formation	Ascog
'Old Quarry'	209853	663007	Basalt	Clyde Plateau Volcanic Formation	Ascog
'Quarries (disused)'	208360	659280	Basalt and microgabbro	Unnamed igneous intrusion of unknown age	Brigidale Knock
Quarry (disused)	209570	658050	Basalt and microgabbro	Unnamed igneous intrusion of unknown age	Piperhall
Quarry (disused)	209600	658150	Basalt and microgabbro	Unnamed igneous intrusion of unknown age	Piperhall
Quarry (disused)	209630	658250	Basalt and microgabbro	Unnamed igneous intrusion of unknown age	Piperhall
Quarry (disused)	209720	658480	Basalt and microgabbro	Unnamed igneous intrusion of unknown age	Piperhall
Quarry (disused)	210630	656880	Basalt and microgabbro	Unnamed igneous intrusion of unknown age	Barefield
Quarry (disused)	209950	657470	Basalt and microgabbro	Unnamed igneous intrusion of unknown age	Barefield
Quarry (disused)	210670	657500	Basalt and microgabbro	Unnamed igneous intrusion of unknown age	Barefield
Quarry (disused)	208100	657600	Basalt and microgabbro	Unnamed igneous intrusion of unknown age	Drumreoch
Quarry (disused)	208560	657630	Basalt and microgabbro	Unnamed igneous intrusion of unknown age	Drumreoch

Quarry (disused)	208120	657150	Basalt/microgabbro and/or interbedded sandstone and conglomerate	Unnamed igneous intrusion of unknown age or Stratheden Group	
Quarry (disused)	210100	655000	Basalt and microgabbro	Unnamed igneous intrusion of unknown age	Kilchattan Bay
Quarry (disused)	208600	654830	Basalt	Clyde Plateau Volcanic Formation	Largizean
'Old Quarries'	208333	659163	Basalt and microgabbro	Unnamed igneous intrusion of unknown age	Brigidale Knock
'Old Quarries'	208673	659129	Basalt and microgabbro	Unnamed igneous intrusion of unknown age	Brigidale Knock
	208759	661548	Basalt and microgabbro	Mull Dyke-Swarm	Kerrycusach
	208634	662328	Basalt and microgabbro	Mull Dyke-Swarm	Kerrycusach

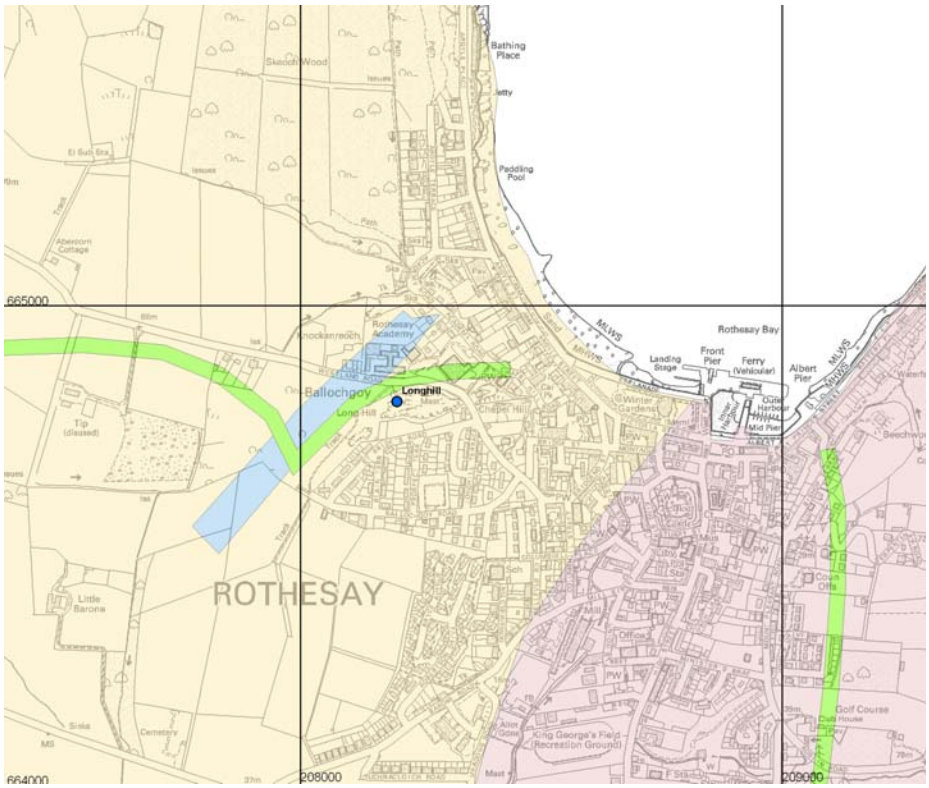

Fig. 3. Map showing the location of Longhill Quarry (blue dot), exploiting a basic igneous dyke (green colour) to provide much of the early building stone ('greenstone') used in Rothesay. Other geological units (pale yellow = Dalradian metamorphic rocks; light pink = Devonian conglomerate and red sandstone; blue = metalimestone). Grid squares are 1km.

Fig. 4. Map of Kerrycroy Bay showing Devonian (Old Red Sandstone) Bute Conglomerate Formation (pale pink) with a series of basic igneous dykes (green). Former quarry sites from the BGS quarries database are shown as blue dots. Grid squares are 1km.

4. Building stone quarries

There are very few quarries on Bute which are specifically documented as having provided building stone. The BGS quarries database contains a large number of quarries across the island, the majority of which are likely to have been exploited for roadstone or dyking (walling) stone. It is not recorded which were used for building stone, and very few historical references have been identified which specifically mention building stone quarries.

Martin (1703) in his "Description of the Western Islands of Scotland" states that "there is a quarry of red stone near the town of Rosa [Rothesay], by which the fort there, and the chapel on its north side, have been built". The exact location of this quarry is not known, although it is likely to have been situated in the extensive area of Devonian red sandstones that outcrop on the south and east side of Rothesay Bay and to the south-west of the town. Rothesay Castle (much altered and reconstructed through time) appears to consist of a mixture of local stone types (Fig. 5).

The Statistical Account of 1834-45 (Buchanan 1845) states there are "no mines of importance" on the island, with the exception of the limestone quarries at Kilchattan (see below) and a "greenstone quarry in the immediate vicinity of Rothesay". The latter is said to have provided stone for most of the houses in Rothesay, including "numerous mansion-houses and villas [which] have recently been built along the sides of the Bay of Rothesay, and give great beauty to it". Cited examples of the use of 'greenstone' are the County Buildings and Prison (1832), and Harbour (1822). Unfortunately this quarry is not specifically identified by name nor location. Geologically the term 'greenstone' is defined as an altered basic igneous rock and therefore could have been obtained from the basaltic igneous intrusions that occur on either side of Rothesay Bay. Examination of photographs of buildings of this time in Rothesay suggest that the main building stone is a dark green basic igneous rock, often used in combination with pale sandstone dressings (Figs 6 and 7). The BGS quarries database records a large quarry (Longhill Quarry) on the west side of the town which exploited a quartz microgabbro (a dark green basic igneous rock) from an approximately east–west trending igneous dyke. Former editions of Ordnance Survey maps

indicate that this was a quarry of some considerable size (Fig 3). It is therefore considered likely that the 'greenstone' referred to in the Statistical Account is very local basaltic rock, which over time has weathered to a dark (sometimes brownish) appearance as seen in these buildings today (Figs. 6 to 8).

The 1834-45 Statistical Account (Buchanan 1845) records that in Rothesay the freestone dressings (used at corners and around doors, windows etc.) are sandstone which is imported from Inverkip on the Renfrewshire coast. This is likely to be a 'blonde' Carboniferous sandstone, typical of that used extensively in west-central Scotland, and probably sourced from quarries in the Glasgow area or Ayrshire coast. It is commonly seen in early to mid 19th century buildings in the town (Fig. 8).

Later buildings in Rothesay (late 19th and early 20th century) appear to be constructed largely from imported 'Glasgow-type' blonde sandstone (Fig. 9) or red sandstone (probably imported from the large quarries at Corrie in Arran or the Ballochmyle quarries in Ayrshire). At this time it is unlikely that the relatively small-scale local building stone quarries on Bute could compete with the larger quarries on the mainland, in terms of cost and quality of stone and quantity required.

Throughout the island, including the early buildings in Rothesay, the stone used for building usually directly reflects the local geology. For example early dwellings near St Ninian's Bay on the west coast are constructed predominantly from local rubble of metamorphic rocks (pale green psammitic schists of the Innellan Formation). It is likely that this rubble masonry would have been lime-harled. The dressed stone used for window surrounds etc. are red sandstones, likely to have been obtained from Devonian sandstone outcrops in the south and eastern parts of the island, or possibly imported from Arran (Fig. 10).

Fig. 5. The 16th century gate tower of Rothesay Castle, constructed from a mixture of stone types including large basaltic boulders, grey Dalradian metamorphic rocks, Devonian red sandstones and pale Carboniferous sandstone, directly reflecting the geology of the local area. The sandstones have been used for dressings, and are likely to have been obtained from Carboniferous and Devonian sandstones from outcrops to the east and south of Rothesay. Basaltic rocks crop out within the town as a series of igneous intrusions (dykes).

Fig. 6. House in Rothesay (typical of late 18th/early 19th centuries), constructed using roughly squared dark basaltic rubble known as 'greenstone' and probably obtained from the nearby basic igneous dyke quarry at Longhill Quarry (Fig. 3). This quarry is recorded as having supplied much of the early building stone for the town. The dressed stone is a blonde sandstone, probably obtained from the limited outcrops of Carboniferous sandstones to the south and east of the town.

Fig. 7. Detail from above showing the Rothesay greenstone (weathering to dark brown) comprising roughly squared large block and smaller 'sneck' stones giving a highly distinctive masonry style. The pale sandstone dressings are undergoing severe stone decay with surface loss.

Fig. 8. Typical early to mid 19th century buildings in Rothesay, constructed using local dark igneous rubble (greenstone) with pale sandstone dressings. The greenstone is likely to have been obtained from Longhill Quarry on the west side of the town, whilst the pale sandstone (weathering orange) was probably imported by sea from Renfrewshire of the Glasgow area.

Fig. 9. Typical late 19th/early 20th century buildings in Rothesay, constructed entirely from imported stone; Carboniferous 'blonde' sandstone (right-hand building and large central building –weathering orange) probably from the Glasgow area; and Permian 'red' sandstone (buildings to left-hand side) likely to have been obtained from Corrie on Arran or the Mauchline area in Ayrshire.

Fig. 10. Detail of house near St Ninian's Bay, constructed from random rubble walling and red sandstone dressings. The rubble is a mixture of very local stone types directly reflecting the underlying geology, mostly dark pelitic metamorphic rocks and grey psammites from the Dalradian Innellan Formation. The red sandstone is likely to have been transported from quarries in the east and south of the island, or possibly by sea from Arran (Corrie). The rubble walling is likely to have been originally lime harled (subsequently replaced by a cement-based mortar). The use of very local stone is typical of rural buildings throughout Bute.

5. Slate Quarries

Slate is likely to have been one of the only mineral commodities that was exported from Bute. The slate occurs as a band of metamorphosed mudstone within the Dalradian Dunoon Phyllite Formation. These outcrops belong to the Highland Border Slates, forming part of a series of slate rocks that occur across Scotland in the Dalradian rocks immediately north of the Highland Boundary Fault. These have been exploited in quarries along the entire length of the fault (e.g. at Arran, Dunoon, Luss, Aberfoyle, Comrie, Dunkeld and other localities). The Bute slate quarries have been described in detail (along with other Highland Border slates) by Ritchie and Anderson (1944) and Walsh (2000), and much of the information given below is based on this work. Highland Border slates are typically more variable than other Scottish slates, showing a considerable range of colour and surface texture (Emerton 2000). The Bute slate are typified by a dark grey-blue appearance and have a characteristic rough surface texture and variable thickness that gives a distinctive appearance to a roof (Fig. 11).

The recorded Bute slate quarries are located near Kames Bay; at Ardmaleish Point and on the southern slopes of the hills to the northeast of the bay (Fig. 12). The BGS quarries database contains four sites that operated as quarries, listed in Table 4. The quarry at Ardmaleish is located close to the coast at just above sea level and is likely to represent the oldest workings. The other quarries form a series located at intervals along an escarpment at a height of approximately 120 m where they follow the north-east–south-west trending slate outcrop.

Table 4. Worked former slate quarries on Bute from the BGS quarries database.

Name	Easting	Northing	Lithology	Lithostratigraphy	Location/notes
Edinmore (Edinbeg, Eadinbeg)	205200	667900	Phyllitic Pelite (slate)	Dunoon Phyllite Formation	Eadimore
Hillton (Hilton)	205850	668430	Phyllitic Pelite (slate)	Dunoon Phyllite Formation	Hillton
‘Quarry (disused)’	206500	668500	Phyllitic Pelite (slate)	Dunoon Phyllite Formation	Hillton
Ardmaleish	207500	669650	Phyllitic Pelite (slate)	Dunoon Phyllite Formation	Ardmaleish Point

Fig. 11. Typical roof of Bute slate (Rothesay). Note the variable size, thickness and colour which gives a characteristic 'rough' appearance, typical of a Highland Border slate. Bute slate in particular shows variable orange ochre staining. This roof appears to have been relatively recently re-laid (note new flashings and cement mortar fillet to right-hand side)

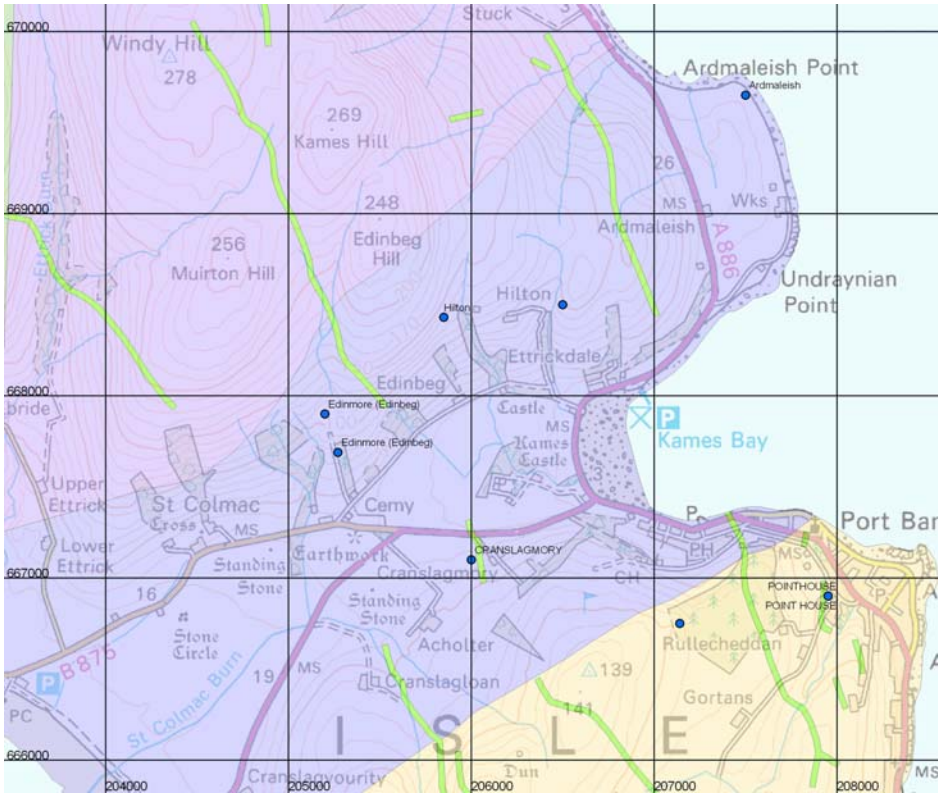

Fig. 12. Map showing the Dunoon Phyllite Formation (blue) which contains the Bute slate. The slate quarries (blue dots) follow a seam of slate rock running northeast-southwest from Ardmaleish Point to St Colmac. Grid squares are 1km.

It is the coastal situation and proximity to population centres around the Firth of Clyde which are likely to have made the slate industry commercially viable on Bute, particularly prior to the availability of superior slates from the North-west Highlands in the 19th century and Welsh slate in the 20th century. The Bute slate quarries are mentioned as early as 1445 when 130,000 slates (at a cost of 11s 10d) from Ardmaleish quarry were sent to Dumbarton "to repair the King's Castle" (Hewison 1845). The oldest house in Glasgow, Provands Lordship, is reputed to be roofed with Bute slates (Marshall 1955). It is likely that the quarries were worked periodically; for example the Statistical Account of 1834-45 (Buchanan 1845) states that slate from the quarries "is little wrought at present". By the 1880s it is likely that slate production had almost ceased, although Hilton Quarry was reopened for a time just prior to the 1920s for the re-roofing of Wester Kames Castle (NS 062 681).

The main slate outcrop occurs as a band aligned northeast-southwest, approximately 1 km wide and 4 km long, tapering to the south-west. It occurs within a broader band of phyllitic pelite (highly schistose metamorphosed mudstone) which forms much of the low valley between Kames Bay and Ettrick Bay. The quarry at Ardmaleish exploits a much smaller isolated outcrop. Any future extraction of slate would require a detailed survey of the area in order to map the outcrop of the band of slate (see Walsh 2000 for further discussion).

Slate is also recorded as having been worked in small quarries on Inchmarnock island (immediately south-west of Bute), both on the eastern and south-west sides of the island, exploiting a band of slate that crosses the island in a NNE direction (Gunn et al. 1903). The slate is reported as being "rough", grey in colour and similar to that worked in the late 18th century on the Cock of Arran.

The following data from Walsh (2000) describes the three main slate quarries on Bute:

(i) Ardmaleish Quarry (Fig. 13)

The slate is a light grey occasionally green colour with considerable 'rusty' weathering. The exposure shows irregular jointing and the slate contains

imperfections of thick veins of quartz and grit bands. There are two small workings approximately 20 m x 10 m in size, now overgrown with gorse.

(ii) Hilton Quarry (Fig. 14)

The slate is blue-grey in colour with irregular joints, and common silty bands and quartz veins. A band of slate <1 m thick has weathered to a soft yellow colour. There are two workings: the easterly quarry is approximately c.30 m x c.5 m and c.20 m high, aligned diagonally across the strike of the slates. It is now overgrown. The second quarry to the west has been worked more recently (possibly used in the early 20th century for Wester Kames Castle). The quarry is c.10 m wide and was worked along strike for c.30 m distance. The overhanging face to the southwest is unworked due to the presence of thick quartz veins.

(iii) Edinmore Quarry (Fig. 14)

The slate is grey-blue/grey in colour. The largest workings are estimated as c.200 m x c.50 m in area with tips 30m high. Flooded areas suggest some workings were below the present quarry floor. The quarry face is obstructed by large spoil heaps. According to Richey and Anderson (1944) the slate at the western edge of the quarry is overlain by flaggy green gritstone. The slate tips have been used relatively recently, probably as a source of infill material.

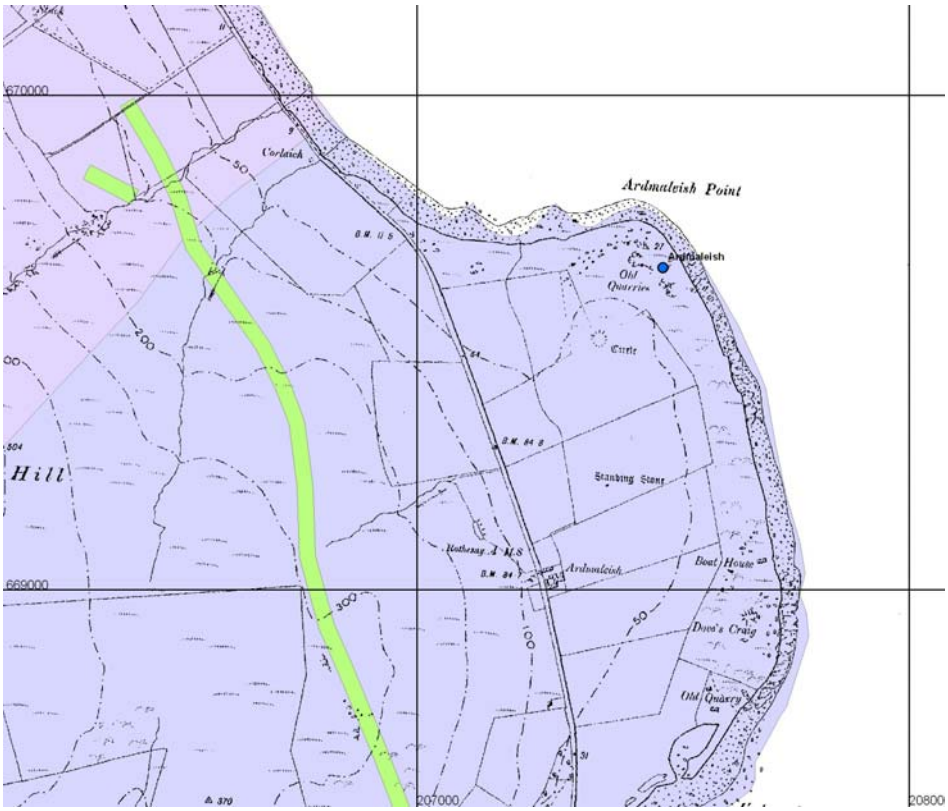

Fig. 13. Ordnance Survey map (1897) with geological overlay showing the Dunoon Phyllite Formation (blue) and the site of the Ardmaleish slate quarry (blue dot), likely to represent the earliest slate workings on Bute. Basaltic dyke intrusion shown in green. Grid squares are 1km.

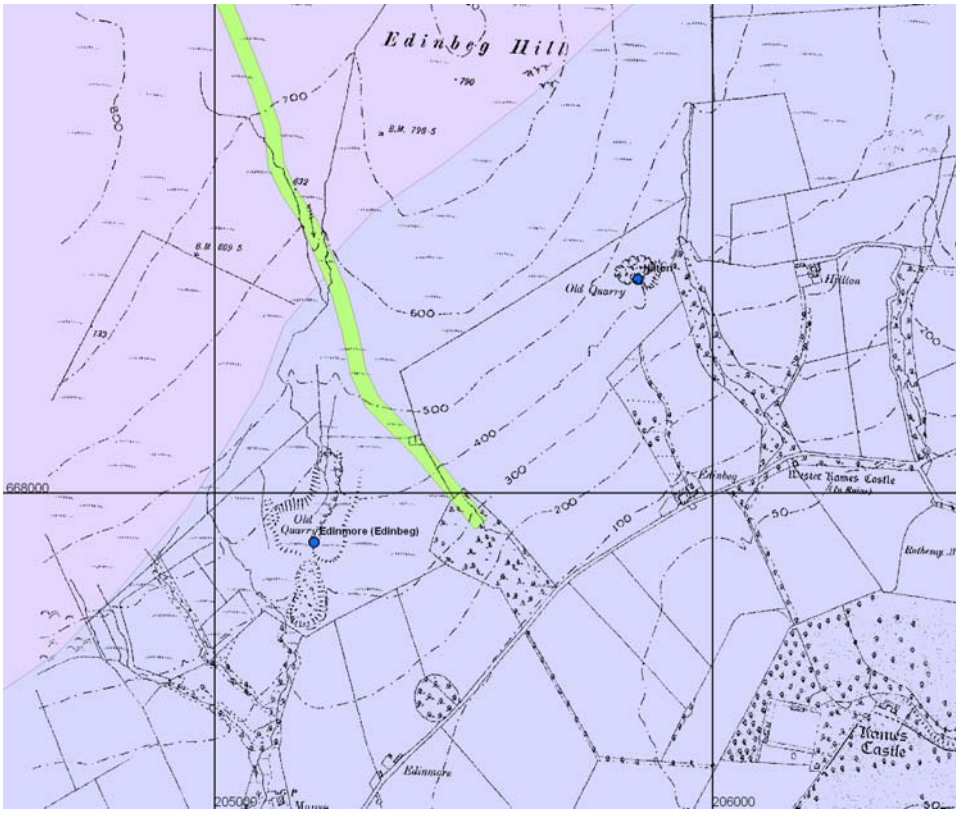

Fig. 14. Ordnance Survey map (1897) with geological overlay showing the Dunoon Phyllite Formation (in blue) and the locations of the slate quarries at Hillton and Edinmore. These were the largest slate quarries on Bute. Basaltic dyke intrusion shown in green. Grid squares are 1km.

6. Limestone, superficial deposits and other mineral resources

6.1 Limestone quarries

The only recorded large limestone quarries on Bute are old workings to the south of Kilchattan (Gunn et al. 1903). It is understood that these are now largely infilled with water and have been used as a reservoir. There appears to have been a long history of working limestone on Bute. The Statistical Account of 1791-1799 (Stuart and Sinclair 1799) states that Kingarth Parish 'abounds with limestone', whilst the Statistical Account of 1834-45 (Buchanan 1845) states that the limestone at Kilchattan is sufficient for the entire island, and was also shipped for export from Kilchattan Bay. The limestone is likely to be the 'cornstone', a dolomitic limestone which overlies the Devonian sandstones and conglomerates in a north-west–south-east trending strip at the southernmost end of Bute. Although it is shown as a thin outcrop of limited extent on the published geological map at the southeast end of the island (Fig 15), it is likely that the limestone band extended north-westwards towards Kilchattan.

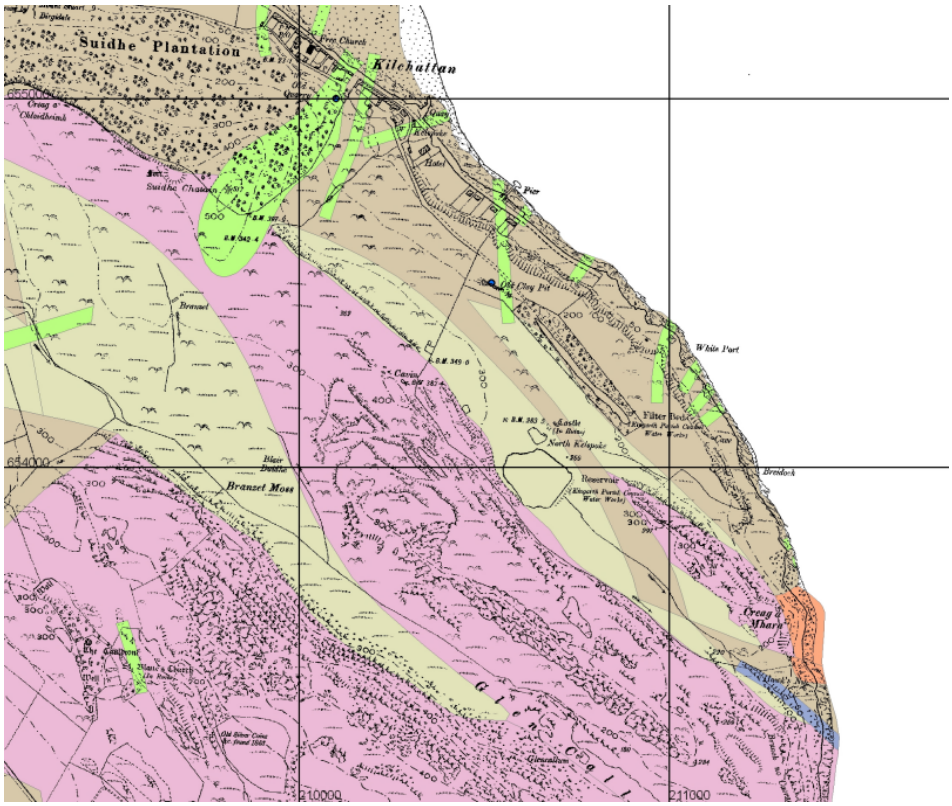

Fig. 15. Ordinance Survey Map (1897) south of Kilchattan with geological overlay. The exposed bed of limestone is shown in blue, occurring along the boundary between the Carboniferous (pale green) and Devonian (pale brown) sedimentary rocks. Limestone was quarried from the elongate area now used as 'Filter Beds' and transported to a lime kiln at Kilchattan. Pink, orange and green = volcanic rocks. Grid squares are 1km.

6.2 Documented quarries in superficial deposits

A small number of quarries in the database are recorded as working superficial deposits (sand and clay). These are listed in Table 5. There are likely to have been many more smaller quarries working these materials, and those in the table are likely to represent only the larger operations

A laminated fine clay is recorded as having been worked for tile making at Kilchattan (Sheet Explanation 1903). The clay is reported to be approximately 4.25 m thick resting on red till, dying out towards the eastward where it is replaced by gravel. It is recorded as containing occasional pebbles and at the western end it contains shells which makes it unsuitable for tile-making purposes. The clay is overlain by 3 to 3.5 m of massive red sand.

Table 5. Quarries on Bute exploiting superficial deposits.

Name	Easting	Northing	Lithology	Lithostratigraphy	Location/notes
Kingarth (Kilchattan)	209700	656100	Possible Clay Pit, overlying Sandstone and Conglomerate	Stratheden Group	Kingarth
'Old Clay Pit'	210520	654500	Clay, overlying Sandstone and Conglomerate	Stratheden Group	Kilchattan Bay
'Sand Pit'	209277	660264	Sand overlying conglomerate	Bute conglomerate Formation	Dixon's Dam (only mention from historical map at 1897)

6.3 Other recorded mineral exploitation

No records of metalliferous minerals have been identified in the course of this study. Several references to the absence of coal are made. The Statistical Account of 1791-1799 (Stuart and Sinclair 1799) reports that Lord Mount Stuart employed skilled men from Newcastle to find coal, but with no success. Despite many subsequent trials in the Carboniferous rocks of the island no coal has ever been found on Bute, and it is recorded that it had to be imported "at great expense" from Glasgow, Ardrossan, Saltcoats, and Ayr.

A curious phenomenon has been recorded by Martin (1703) relating to the presence of ‘hectic-stone’ on Bute, stating “the hectic-stone is to be had in many parts of this isle”. Along with several other parts of the Western Isles, this stone, apparently a white or red pebble, was believed to be a cure for consumption and other ailments when heated and placed into water, milk or whisky. Martin describes the phenomena on the Isle of Skye as follows: “the natives use stone as a remedy against dysentery and diarrhœa; they make them redhot in the fire, and then quench them in milk, and some in water, which they drink with good success. They use this stone after the same manner for consumptions, and they likewise quench these stones in water with which they bathe their feet and hands”. No further references to this phenomenon have been found, nor confirmation of the claims made.

7. Discussion and conclusions

The geology of Bute is complex and varied, largely due the presence of the Highland Boundary Fault which has resulted in juxtaposition of Dalradian metamorphic rocks typical of the Scottish Southern Highlands alongside younger sedimentary rocks of Devonian and Carboniferous age (dominated by 'red' sandstones and conglomerates, and 'blonde' sandstones, respectively). Basaltic igneous rocks are present throughout the entire island, mostly as relatively thin intrusive vertical sheets (dykes), although extensive areas of intrusive volcanic deposits are present in the southern part of the island.

Despite this varied geology, the mineral resources of Bute are limited, with slate and limestone being the only material extracted in significant quantities. Basic igneous rocks were once quarried in significant quantities in Rothesay as a building stone, and red and blonde sandstone are likely to have been quarried on a smaller scale to provide dressed stone for the towns buildings. In other parts of the island, local stone of varying types was exploited as rubble for building. Numerous small quarries in basic igneous intrusions throughout the island were worked, probably largely for roadstone.

Slate is probably the only stone material likely to have been exported from the island in significant quantity. Prior to the availability of West Highland slate (from Easdale and Ballachulish) from the late 18th century, Bute would have been the closest and most easily transportable source of slate for the developing urban areas of West Central Scotland (in particular Glasgow). The use of Bute slate gives a distinctive appearance to many building across the island.

Significant quantities of limestone were worked in the 18th and 19th centuries near Kilchattan, and it is recorded at this time that the island was self-sufficient in limestone, presumably used for both soil improvement and mortar for building purposes. The worked limestone deposits appear to be restricted to a relatively thin bed in the uppermost Devonian sedimentary rocks in the Kilchattan area, and are likely to have been largely worked out. It is considered unlikely that significant limestone remains for future exploitation.

The early buildings in Bute appear to have been built from local stone, directly reflecting the underlying geology. This is true both in rural areas and in Rothesay, the latter being constructed largely (until the late 19th century) using local basaltic rock. Most of the early development of the town (18th and early 19th century) used basaltic 'greenstone', probably from nearby Greenhill quarry, in combination with dressings of blonde and red sandstone, originally likely to have been obtained from Devonian and Carboniferous outcrops to the south and east of the town. Subsequently, dressed stone was imported from the mainland, probably obtained from quarries in the Glasgow area. Towards the end of the 19th century and in the early 20th century buildings in Rothesay were constructed entirely using imported sandstone, both blonde 'Glasgow-type' sandstone and red sandstone, the latter probably from Corrie (Arran) or the Mauchline quarries (Ayrshire). These stone types typify the later stone buildings in Rothesay.

In rural areas various local stone types have been exploited for building purposes. For example, in the St Ninian's Bay area the older buildings are constructed using rubble stone largely from local outcrops of Dalradian metamorphic rocks. The dressings (window surrounds etc.) are typically of red sandstone, probably transported from nearby outcrops of Devonian sandstone or possibly imported by sea from Corrie (Arran).

It is clear that a number of different building stone types were used for early buildings in Bute prior to the development of efficient transport systems in the mid-19th century. By this time the local quarries would have become superseded by larger quarries on the mainland which developed to supply the rapid urban expansion in West Central Scotland. These quarries were likely to have been larger in scale and produced higher quality stone, and it is unlikely that the local quarries could have competed. Additionally, by the late 19th/early 20th century architectural styles demanded superior quality stone and larger block sizes that were unlikely to have been obtained from the Bute quarries.

In conclusion, it is considered unlikely that significant high quality stone resources are present on Bute that could be economically worked on a large scale (i.e. for export) today. Bute slate, despite once being exported, is unlikely to be present in sufficient quantity or

quality to be competitive in today's global slate market. The 'greenstone' (basaltic rock) used extensively for early buildings in Rothesay is undoubtedly a high quality material (and has survived well), and there is likely to be significant resources of this material on the island. However the market for such stone (as dimension stone) outside Bute is likely to be relatively small and its potential value relatively low.

One highly significant issue for Bute is the need for appropriate stone to repair and maintain the existing building stock. The large range of stone types used in Rothesay reflects the historical development and gives a distinctive character to the town. Today many buildings require repair and there is a need to characterise the original stone types and identify appropriate matching stone for repairs. Given that a number of different local sources of stone were used for the construction of buildings in Rothesay (and throughout Bute) it is likely to be difficult to source similar stone from active quarries in the UK, and it may be that small-scale quarrying of various rock types on Bute would be the best way to safeguard the future for the island's historic stone buildings. In order to do this it is recommended that an audit of stone and slate used for building is carried out, in parallel with a resource assessment to identify suitable quarries which could be secured for such use. Such a study could be carried out as part of the existing Townscape Heritage Initiative and Conservation Area schemes in Rothesay. Renewed availability of local building stone and slate might also be used in new construction (including boundary walls etc.), to ensure that modern developments are 'in keeping' with the historic built environment.

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APPENDIX 1

Glossary of Geological Terms

Argillaceous	Fine-grained sedimentary rocks, commonly clays, shales, mudstones, siltstones, and marls.
Basalt (basaltic)	Fine-grained, dark coloured, volcanic (igneous) rock type. (See Greenstone)
Cleavage	The alignment of crystal planes along which a mineral can be easily split yielding smooth surfaces.
Conglomerate	A sedimentary rock consisting of rounded or sub-rounded fragments or pebbles.
Dyke	A sheet-like body of igneous rock which is discordant and cuts across the host rock, commonly at a steep angle.
Flagstone (flaggy)	A stone which is easy to split, typically along bedding planes containing mica.
Foliation/foliated	The preferred orientation of minerals within a rock.
Gritstone	A sedimentary rock composed of coarse sand grains with inclusions of small pebbles. It is a coarser version of sandstone.
Greenstone	A geological field term for a slightly altered basic igneous rock. (See Basalt).
Igneous rock	A rock formed from magma (molten rock).
Intrusion (intrusive)	A body of igneous rock (e.g. dyke) which has forced itself into pre-existing rocks.
Joints	A fracture in a rock between the sides of which there is no observable relative movement.
Lithology	Rock type.
Lithostratigraphy	The classification of different rock types or units based on chronological sequence.
Metamorphic rock (metamorphosed)	A rock which has been altered by heat and/or pressure. The prefix ‘meta-’ may be used to describe a pre-existing rock type that has been metamorphosed (e.g. metalimestone).
Microgabbro	A medium grained dark coloured basaltic igneous rock.

Outcrop	Area of rock or superficial deposit exposed at the Earth's surface.
Pelite	Metamorphosed fine-grained sedimentary (argillaceous) rocks such as mudstone.
Phyllite	A foliated metamorphic rock with similarities to slates and schists. Generally coarser grained and less perfectly cleaved than slates, but finer grained and better cleaved than schists.
Psammite (psammitic)	Metamorphosed detrital sedimentary rocks, typically sandstones.
Schist (schistose)	Metamorphic rock type characterised by its strong foliation.
Sedimentary rock	A rock formed by the deposition of sediment.
Semipelite	Partially metamorphosed fine-grained sedimentary (argillaceous) rocks.
Slate	Metamorphic rock type formed from the compression of fine-grained sedimentary (argillaceous) rocks. Often has a well developed cleavage.
Trachyte	A fine grained feldspar-rich volcanic rock.
Whinstone	A colloquial term covering any dark coloured fine-grained igneous rock.