South Shian and Balure of Shian

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Highlights

Deposits exposed in coastal sections at these two sites include fossiliferous marine sediments which have been deformed by glacier ice. These provide important evidence for establishing the timing of the Loch Lomond Readvance and the marine environmental conditions during the Loch Lomond Stadial.

Introduction

The sites at South Shian [NM 910 420] and Balure of Shian [NM 896 420] comprise two stretches of coast in western Banderloch, 13 km north of Oban, each *c.* 0.65 km in length and including exposures on the respective foreshores and in the adjacent backing cliffs. The terminal position of the former Loch Lomond Readvance Creran glacier is associated with a wide and impressive range of landforms and deposits, some of which show evidence of glaciotectonic structures associated with overriding ice. The deposits are particularly well exposed at South Shian and Balure of Shian where glacially disturbed Lateglacial marine clay (Clyde beds) and bedded ice-contact sediments, as well as Holocene raised beach gravels can be seen. The marine clays at South Shian have yielded a diverse assemblage of molluscan and ostracod shells. With part of the similar Rhu Point site now being concealed by sea defences, South Shian and Balure of Shian are probably the most accessible localities currently available in Scotland for the examination of glacially disturbed marine clays and their relationship to other glacial and marine deposits. The landforms and sediments at South Shian and Balure have been investigated by Kynaston and Hill (1908), McCann (1966a), Peacock (1971b, 1971c), Gray (1972, 1975) and Peacock *et al.* (1989).

Description

The deposits and landforms in Benderloch comprise end moraines, glaciofluvial outwash and mounds of ice-contact gravel, sand and silt: all have been modified by Holocene marine erosion and redeposition up to a level of about 13–14 m OD (Figure 10.7). At the west end of Loch Creran there is an arcuate end moraine which reaches over 30 m OD. It is formed chiefly of transported marine clay with minor sand and gravel (Peacock, 1971a and unpublished data). West and south of this ridge there is a peat-covered composite outwash fan that laps around rock ridges and mounds of ice-contact silt, sand and gravel (Gray, 1972, 1975b). Moundy ice-contact gravels occupy a strip of country adjacent to the rock cliff of the Main Rock Platform east of Lochan Dubh and are terminated southwards by the back feature of the highest Holocene beach at about 12 m OD (Figure 10.7). Esker-like ridges formed of bedded gravel, which occur on both sides of the rock mound Creagan Dubh [NM 908 407], were originally thought to have been produced by glacial disturbance within the outwash gravels (McCann, 1966a), but have been reinterpreted as the deposits of a subglacial stream (Peacock, 1971b). It is now considered that they could be minor end moraines. Peacock (1971b) concluded that, following the maximum of the readvance, the terminal part of the glacier stagnated while ice up-valley supplied material for deposition of outwash. This ice was probably that which formed the end moraines south of the site.

Immediately west of South Shian pier about 1.5 m of marine clay are exposed in a low cliff and are overlain by a small thickness of sand (Peacock, 1971b). The marine deposit is stiff, dark grey, brownish-weathering and silty and is streaked in places with black disseminated sulphide and organic matter. It is weakly laminated and contains scattered angular pebbles of red granite, black schist and phyllite. Similar clay crops out between tide-marks in the bay south of the pier southwards to, and beyond the southern limit of the site. Where lamination can be seen in the clay it is commonly contorted. Shells of about 40 species of mollusc have been recovered from the disturbed marine beds (Kynaston and Hill, 1908, p.168; Peacock, 1971b, p. 356 and revision in (Table 10.1)). These are chiefly cool-water taxa, but include the arctic bivalve *Portlandia arctica* (Gray), which in western Scotland is otherwise known only in beds attributed to the Loch Lomond Stadial (Peacock, 1977b). Radiocarbon dates on shells collected a few metres west of South Shian pier

(calculated to $\delta^{14}C$) are as follows (Peacock, 1971c):

Chlamys islandica (Müller)	11,300 ± 300 BP (outer)
	11,530 ± 210 BP (inner)(IGS-C14/16)
Tridonta elliptica (Brown)	11,805 ± 190 BP (IGS-C14/17)
Mixed shell debris	6705 ± 130 BP (outer)
	11,430 ± 220 BP (inner)(IGS-C14/18) debris

At Balure of Shian glacially disturbed Lateglacial marine clay with *Tridonta elliptica* (Brown) is exposed on the foreshore and in a low cliff, where it crops out below ice-contact silt, sand and clay as well as below glaciofluvial outwash gravel and storm beach gravel associated with the highest Holocene raised beach. In the sea cliff west of Balure, some 10 m of interbedded silt, clay and fine-grained sand capped by about 3 m of poorly sorted gravel were formerly to be seen in a temporary section exposed by marine erosion in the mound [NM 896 418]. Marine clay at the base of this section (McCann, 1966a) is folded up into the overlying beds (Peacock, 1971b). The clays contain entire hinged valves of *Portlandia arctica* (Gray) and small quantities of *Nuculoma belloti* (Adams) and *Yoldiella lenticula* (Müller) (Table 10.1). No microfauna was found (Peacock *et al.,* 1989).

Shells (*Portlandia arctica* (Gray) from Balure of Shian have been radiocarbon dated using both conventional and accelerator methods. The results are as follows (Peacock *et al.,* 1989):

	Conventional age (^{14}C years BP ± 1σ)	Reservoir adjusted age (^{14}C years BP ± lσ)
SRR–3182	10,510 ± 90 (outer)	10,105 ± 100
	10,320 ± 70 (inner)	9915 ± 80
SRR–3204	10,550 ± 100	10,145 ± 110
OxA–1345	10,960 ± 120	10,555± 130

Interpretation

Most of the glacial deposits in Benderloch were regarded as '100 ft Beach' sediments by the original geological surveyors (Kynaston and Hill, 1908) and are shown as 'Higher Beach' and 'Highest Beach' on the accompanying 'One-inch' map (Geological Survey of Scotland, 1907, Sheet 45). Charlesworth (1956) noted morainic deposits east of Lochan Dubh [NM 908 400], but the possibility that the landforms and sediments were laid down near the terminus of a Loch Lomond Readvance glacier was first put forward by McCann (1966a) and independently by Synge (1966). McCann suggested that the 'high raised beach' deposits were in fact glaciofluvial outwash post-dating the marine clay, and Synge described the arcuate ridge south of South Shian as a terminal moraine. Both authors were of the opinion that the glacier terminated at the west end of Loch Creran (*c.* [NM 915 425]), but Peacock (1971b) put forward evidence that the ice had extended considerably farther west and south (by as much as 2 lan), a view supported by Gray (1972, 1975b) and Peacock *et al.,* (1989).

The radiocarbon dates from South Shian confirm that the dated molluscan fauna flourished in the latter half of the Lateglacial Interstadial and that the Loch Lomond Readvance glacier in Loch Creran reached its maximum later than about 11,400 BP. This is a similar picture to that obtained from radiocarbon dating of glacially disturbed marine clays at Rhu Point, Loch Spelve (Mull) and Menteith, west of Stirling (Sissons, 1967b; Gray and Brooks, 1972; Rose, 1980c; Sutherland, 1984a).

The Balure of Shian site provides clear evidence for the stratigraphic position of the Lateglacial marine clay, that is, it antedates deposits laid down by the Loch Lomond Readvance ice (when this was near its maximum extent). Further work (Peacock *et al.,* 1989) suggests that the marine clays at Balure are less deformed than those at South Shian and contain an arctic marine fauna typical of glaciomarine conditions. The low-diversity fauna dominated by *Portlandia arctica* (Gray), is typical of that found seaward of the mouths of glacial rivers and tidewater glaciers in east Greenland and Spitsbergen today (Odhner, 1915; Ockelmann, 1958). The marine clays would thus be expected to immediately antedate the arrival of the Creran glacier at its maximum position.

The radiocarbon dates obtained at Balure of Shian allow a revised estimate of the age of the maximum extent of the Loch Lomond Readvance glacier in the Loch Creran Valley, to within, and possibly towards the end of, the period 10,500–10,000 BP (Peacock *et al.,* 1989). This agrees well with recent estimates of the age of the maximum extent of the Loch Lomond Readvance glaciers at Loch Lomond and in the Upper Forth Valley (see Croftamie and Western Forth Valley; Browne and Graham, 1981; Sissons, 1983a; Rose *et al.,* 1988), but contrasts with dates from organic lake sediments which suggest earlier deglaciation (see discussion for Croftamie).

The deposits and landforms in western Benderloch, including those at South Shian and Balure of Shian, provide a well-documented record of environmental changes during parts of the Late Devensian and during the Holocene. As such they are integral members of a national network of key sites demonstrating changing marine and terrestrial conditions during the latter part of the Quaternary. The disturbed marine clays contain faunas which can be confidently referred to both the cool water (interstadial) and cold water (arctic) parts of the Clyde beds (see Chapter 1 and Geilston). Deformation of these deposits by overriding Loch Lomond Readvance ice can be clearly demonstrated, as can their burial by glaciofluvial deposits attributed to the subsequent retreat of the Creran glacier from its nearby maximum position. The presence of erosional and depositional landforms associated with the high Holocene sea levels and their relationship to the deposits of the Loch Lomond Readvance lend additional significance, particularly to the Balure site. Further, the sites offer considerable potential for research into Lateglacial marine microfaunas, sedimentology and the physical properties of glacially deformed marine and glaciomarine deposits (see Peacock *et al.,* 1989). Finally, the radiocarbon dates from the site provide important evidence for interpreting the age of the maximum extent of Loch Lomond Readvance glaciers.

Conclusion

The deposits at South Shian and Balure of Shian provide important evidence for interpreting critical aspects concerning the geomorphology and timing of the resurgence of glacier ice associated with the Loch Lomond Readvance, and the prevailing environmental conditions. The sea formerly covered this area, and fossiliferous marine deposits were laid down under cool-water and then cold-water conditions; these were subsequently deformed as Loch Lomond Readvance glacier ice in the Creran valley advanced across them to its maximum position. Radiocarbon dates provide important age estimates for the timing of this event (between about 10,500 and 10,000 years ago). South Shian and Balure of Shian is therefore a key locality for studies of the Loch Lomond Readvance in western Scotland.

(Table 10.1) Mollusca from South Shian and Balure of Shian

	1	2	3	4
Antalis entalis (L.)	* *	*		
Boreotrophon clathratus (Ström)		*	*	
Boreotrophon truncatus (Ström)	**			
Buccinum undatum (L.)	*	*		
Gibbula cineria (L.)		*		
Lacuna parva (da Costa)			**	
Lacuna vincta (Montagu)	*			
Littorina sp				
Littorina saxatilis (Olivi)				*
Lora turricula (Montagu)		*	*	
Manzonia zetlandica (Montagu)	*			
Margarites costalis (Gould)	*			

Margarites helicinus (Fabricius)			*	
Moelleria costulata (Möller)	*			
Onoba aculeus (Gould)			**	
Onoba semicostata (Montagu)	*		**	
Polinices pallidus (Broderip and Sowerby)	*	*		
Puncturella noachina (L.)	*	*		
Rissoa interrupta (Adams)			**	
Skeneopsis planorbis (Fabricius)			**	
Tectonatica affinis (Gmelin)	*			
Velutina velutina (Müller)				
Abra sp.	*			
Abra alba (Wood)			**	
Acanthocardia echinata (L.)	*			
Arctica islandica (L.)	*	**		
Astarte sulcata (da Costa)		*		
Chlamys islandica (Müller)	***	***		
Heteranomia squamula (L.)	*			
Hiatella arctica (L.)	*			
Jupiteria minuta (Müller)	*		**	
Lyonsia arenosa (Möller)			*	
Macoma calcarea (Chemnitz)		*	**	
Mya truncata (L.)			**	
Nucula nucleus (L.)	*	*		
Nuculana pernula (Müller)	**	***	**	
Nuculoma sp.		*	**	
Nuculoma belloti (Adams)	*			**
Parvicardium ovale (Sowerby)	**			
Portlandia arctica (Gray)		*	*	****
Spisula subtruncata (da Costa)			*	
Thracia cf. *myopsis* (Möller)			*	

T. cf. *villosiuscula* (Macgillivray)	*			
Thyasira gouldi (Philippi)	*		**	
Tridonta elliptica (Brown)	***	***		
Tridonta montagui (Dillwyn)	**	**	*	
Yoldiella solidula (Waren)	**		**	
Yoldiella lenticula (Müller)	**	**	***	**

1. Shore 10 m west of South Shian pier [NM 9083 4228].

2. Shore 10 m west of South Shian pier [NM 9083 4228], British Geological Survey collection.

3. Shore east of shellfish factory [NM 908 416].

4. Shore west of Balure of Shian (glaciomarine bed) [NM 8962 4216].

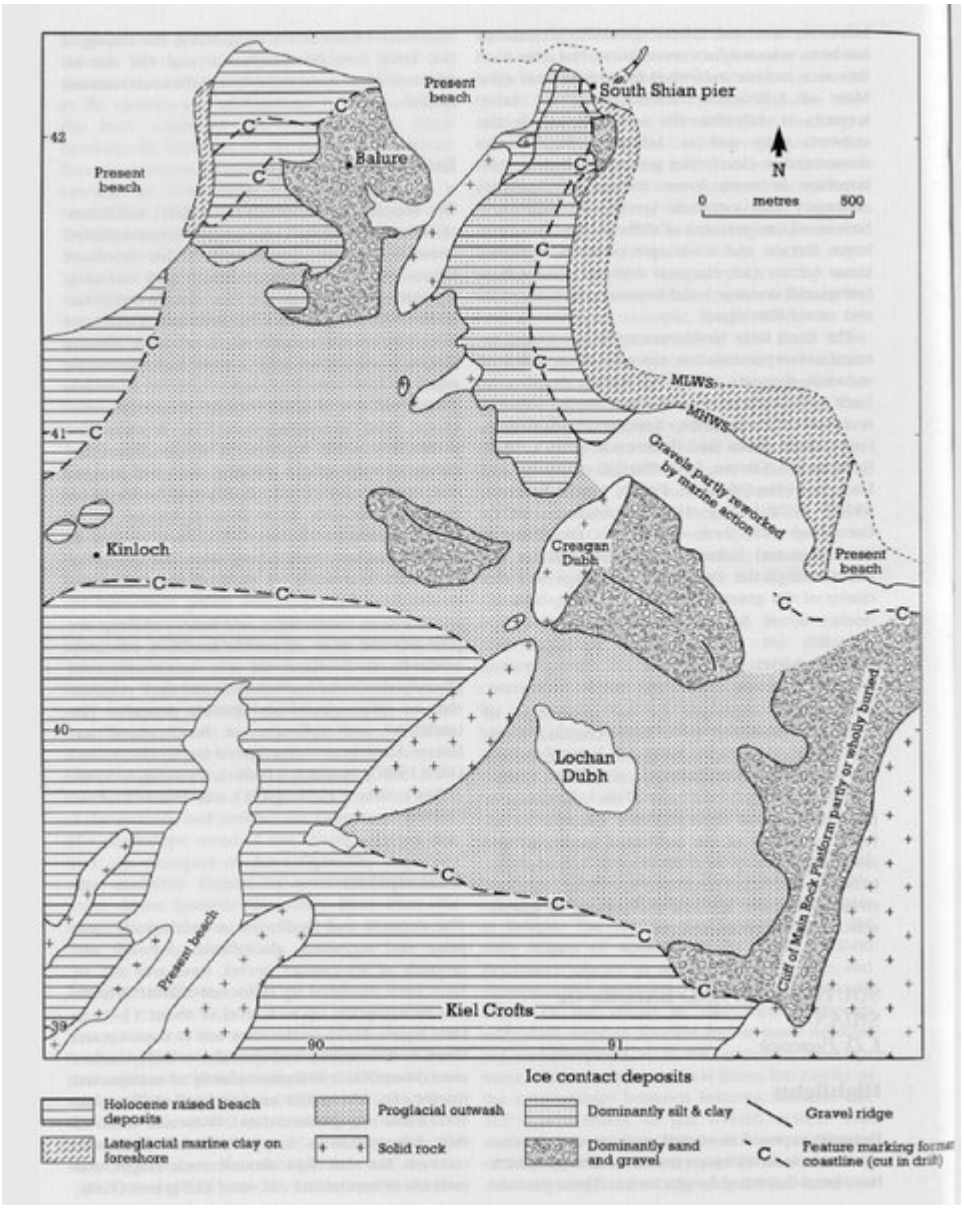
* *rare*

** *common*

*** *very common*

**** *dominant*

References



(Figure 10.7) Quaternary deposits of the South Shian and Balure of Shian area, Benderloch (from Peacock, 1971a, unpublished data).

	1	2	3	4
Antalis entalis (L.)	**	*		
Boreotrophon clathratus (Ström)		*	*	
Boreotrophon truncatus (Ström)	**			
Buccinum undatum (L.)	*	*		
Gibbula cineria (L.)		*		
Lacuna parva (da Costa)			**	
Lacuna vincta (Montagu)	*			
Littorina sp	*			
Littorina saxatilis (Olivi)				*
Lora turricula (Montagu)		*	*	
Manzonia zetlandica (Montagu)	*			
Margarites costalis (Gould)	*			
Margarites helicinus (Fabricius)			*	
Moelleria costulata (Möller)	*			
Onoba aculeus (Gould)			**	
Onoba semicostata (Montagu)	*		**	
Polinices pallidus (Broderip and Sowerby)	*	*		
Puncturella noachina (L.)	*	*		
Rissoa interrupta (Adams)		*	**	
Skeneopsis planorbis (Fabricius)			**	
Tectonatica affinis (Gmelin)	*			
Velutina velutina (Müller)		*		
Abra sp.	*			
Abra alba (Wood)			**	
Acanthocardia echinata (L.)	*			
Arctica islandica (L.)	*	**		
Astarte sulcata (da Costa)		*		
Chlamys islandica (Müller)	***	***		
Heteranomia squamula (L.)	*			
Hiatella arctica (L.)	*	*		
Jupiteria minuta (Müller)	*		**	
Lyonsia arenosa (Möller)			*	
Macoma calcarea (Chemnitz)		*	**	
Mya truncata (L.)		*	**	
Nucula nucleus (L.)	*	*		
Nuculana pernula (Müller)	**	***	**	
Nuculoma sp.		*	**	
Nuculoma belloti (Adams)	*			**
Parvicardium ovale (Sowerby)	**	*		
Portlandia arctica (Gray)		*	*	****
Spisula subtruncata (da Costa)			*	
Thracia cf. *myopsis* (Möller)			*	
T. cf. *villosiuscula* (Macgillivray)	*			
Thyasira gouldi (Philippi)	*		**	
Tridonta elliptica (Brown)	***	***		
Tridonta montagui (Dillwyn)	**	**	*	
Yoldiella solidula (Warén)	**		***	
Yoldiella lenticula (Müller)	**	**	***	**

1. *Shore 10 m west of South Shian pier (NM 90834228).*
2. *Shore 10 m west of South Shian pier (NM 90834228), British Geological Survey collection.*
3. *Shore east of shellfish factory (NM 908416).*
4. *Shore west of Balure of Shian (glaciomarine bed) (NM 8962 4216).*

* *rare*
** *common*
*** *very common*
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