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FURTHER OBSERVATIONS ON THE STONE RUNS OF THE FALKLAND ISLANDS

Abstract

The last discussion on the stone runs of the Falkland Islands criticised the theory that solifluction was a significan process in their evolution, and it advocated that they evolved *in situ*. This paper describes morphological and interna characteristics of the stone runs which were ignored in previous accounts, and considers the spatial relationships of the runs with glacial landforms, with other slope phenomena, and with remnants of a regolith of chemically rotted bedrock. It is concluded that processes similar to those which form sorted stone stripes in periglacial environments probably created the stone runs, but that the latter evolved on an exceptional scale on the Falkland Islands during the Pleistocene because of climatic, lithological and regolith factors.

INTRODUCTION

Observations made by Charles DARWIN and Sir Wyville THOMSON led James GEIKIE (1894) to compare the stone runs of the Falkland Islands to the „rubble drift" of southern England, formed under conditions of alternate freezing and thawing. Quite independently ANDERSSON (1906) concluded that the stones had been derived by frost action, moved by solifluction and left bare when rill wash removed interstitial fines. BAKER (1922) subsequently argued that frost action on nunataks projecting above ice caps had generated the stone runs which „slithered down the icy slopes". More recently JOYCE (1950) has made a critical appraisal of ANDERSSON's solifluction hypothesis. Although agreeing with ANDERSSON that evidence of glaciation is entirely lacking JOYCE pointed out that some stone runs lie across the tops of low dome-like hills, that they are not well developed on the Wickham Heights, the highest hill range on East Falkland, and that the underlying matrix of fine debris required by the solifluction process is entirely lacking. In conclusion JOYCE argued that the stone runs are restricted to quartzite rocks of the Devono-Carboniferous series and that they have not travelled any distance but developed *in situ* during the Pleistocene as frost disintegration caused the valley sides to retreat.

The following observations made by the writer on the Falkland Islands may help to put the various theories in perspective.

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MORPHOLOGY OF THE STONE RUNS

An important fact ignored by JOYCE is that on many hill sides the stone runs are arranged as large parallel stripes (Fig. 1. Pl, 1). Aligned directly downslope, they vary in width from 3 m to over 15 m. In cols, embayments and valley heads, the stripes converge to form blockfields, but elsewhere they continue directly downslope without converging (Fig. 1). Where trunk valleys are relatively narrow the stripes merge into valley-floor blockfields at the foot of the slope (Pl. 1). Stone runs are well developed beneath bedrock cliffs but occur also where there are no cliffs.

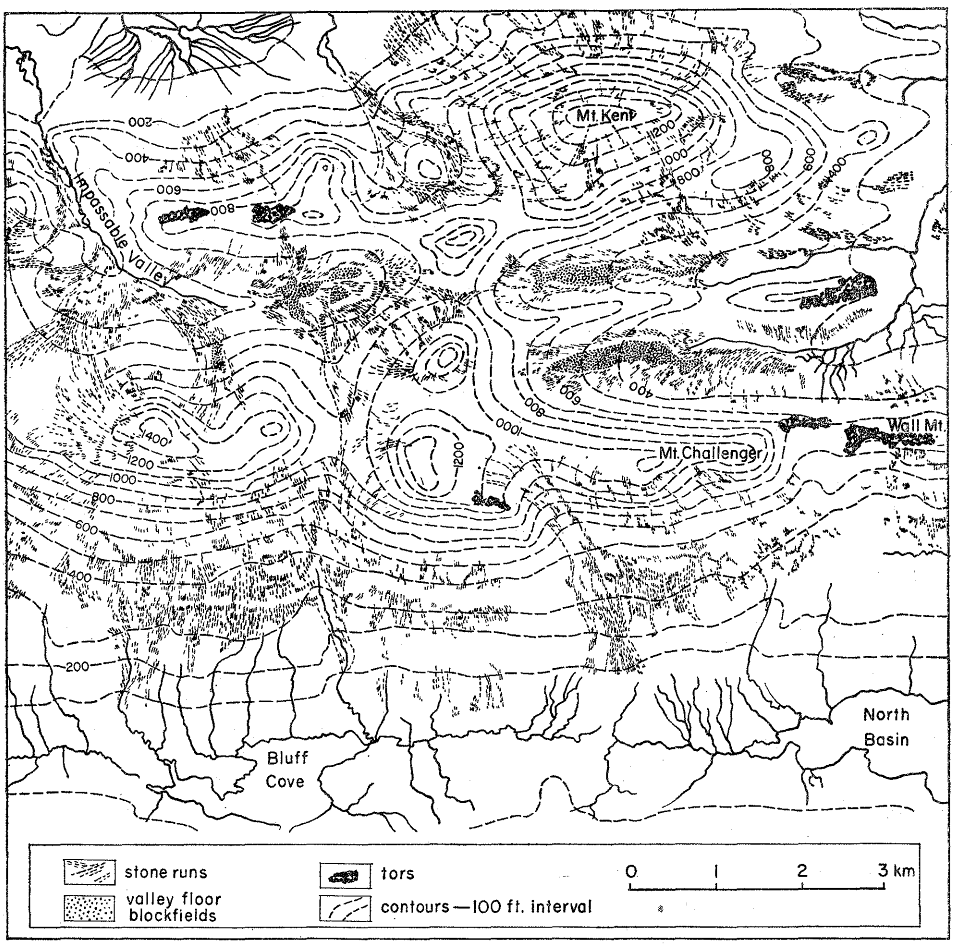

Fig. 1. The location and distribution of stone runs, valley floor blockfields and tors on an upland area 25 km. West of Stanley

The map is based on Sheet 14 of the 1:50 000 series published by the Directorate of Overseas Surveys

COMPOSITION OF THE STONE RUNS

The surfaces of the stone runs consist mainly of slabs that are commonly 1—2 m wide and seldom less than 50 cm wide. In areas of quartzite bedrock the slabs are frequently 8—15 cm thick, but this tends to vary locally according to the thickness of the bedding planes. A large number of the surface slabs are arranged on edge and at the margins of the runs they are tilted outwards at various angles (Pl. 2). Scme slabs beneath the surface are also erected on edge (Pl. 3). Since all of the surface slabs are crusted with lichens it seems that they are now stable and no longer in motion, and the edges of many have been rounded off by weathering. The surface slabs on the stripes are generally loosely packed and lack any matrix of fines. Cross sections exposed at the coast show a vertical and lateral gradation in particle size, however, with comparatively fine gravel and sand 3—4 m below the surface (Pl.3). 2 km west of Stanley cliff exposures show 2—3 m of solifluction debris overlying 2—3 m of chemically decomposed quartzite bedrock. The latter has the consistency of soft cheese with small veins of relatively undecomposed (but shattered) quartz remaining as hard rock.

RELATIONSHIPS WITH OTHER LANDFORMS

It has recently been shown (CLAPPERTON, 1971) that hill ranges which rise above 660 m nourished cirque glaciers probably on more than one occasion during the Pleistocene. The presence of trough-like valleys on West Falkland suggests also that small plateau ice caps may have generated short valley glaciers in places. Stone runs are either very small or totally absent from the cirques, troughs and their catchment slopes above, but are widespread beyond them (Pl. 4). This relationship is particularly clear on the Mt. Adam, Mt. Robinson and Mt. Maria massifs on West Falkland and on the Mt. Usborne massif on East Falkland. All of these massifs rise to above 540 m. The parts of the Wickham Heights below 540 m, lying to the east of Mt. Usborne are extensively covered with stone runs (Fig. 1).

Stone runs are not the only debris forms on the hill slopes and valley sides. Screes, stone lobes, terracettes and large boulder terraces are almost equally common but because they are much less spectacular, they have not received as much attention. In the valleys west of Stanley, for example, stone runs cascade over 3—5 m high boulder terraces which trend obliquely downslope. The two phenomena either developed simultaneously or else the terraces pre-date the stone runs in some places. Summit tors are also common on the high massifs of East and West Falkland.

DISCUSSION

The morphological characteristics of the stone runs and their internal composition suggest that they resulted from the mechanical disintegration of chemically fresh bedrock. The larger slabs were selectively arranged into stripes by a process which may also have erected them on edge, leaving stripes of smaller stones in between. The fluvial-like pattern of the runs in valley heads and the extension of the runs over boulder terraces and to the foot of most slopes strongly indicate that downslope movement has occurred. The presence of a regolith of fine particles derived from deeply rotted bedrock was probably of vital importance to such movement, particularly when saturated.

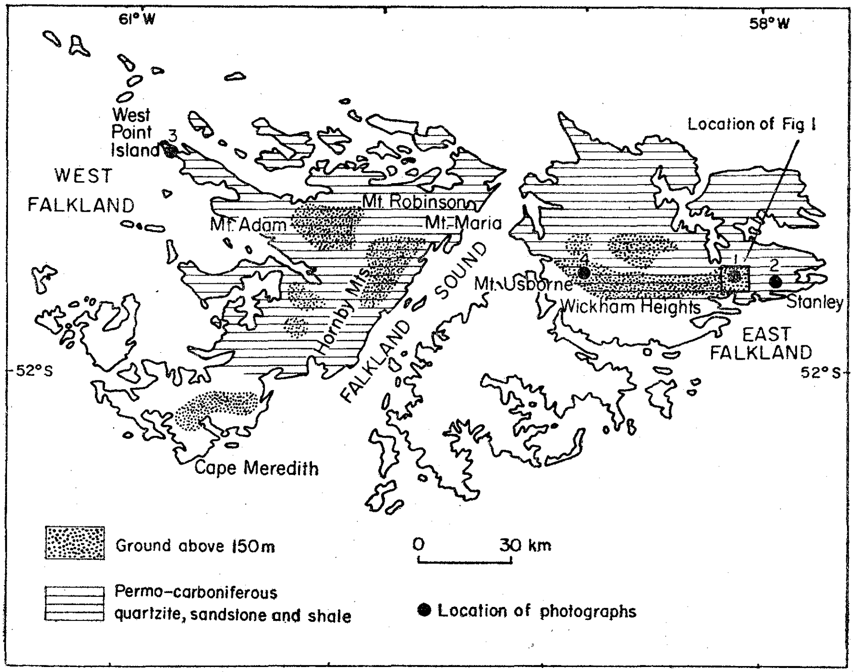

Fig. 2. The distribution of Permo-Carboniferous quartzite on the Falkland Islands

The stone runs thus appear to be little different in their external and internal characteristics from stone stripes formed by the periodic growth and melting of ice in the ground (e. g. as discussed by WASHBURN, 1956; LUNDQUIST, 1962; CHAMBERS, 1967). The most significant difference is that of scale and three factors probably account for their extraordinary development. First, of all, the widespread occurrence of Devono-Carboniferous quartzite (Fig. 2), sharply folded into anticlines and synclines with well-developed bedding planes and vertical joints has facilitated both chemical and mechanical weathering processes. Secondly, during the Pleistocene glacial maxima, air masses affecting the Falkland Islands must have been significantly cooler than at present because of the influence of the adjacent Patagonian ice sheet, an expanded Antarctic peninsula — South Shetland Islands ice sheet (JOHN and SUGDEN, 1971) and a cooler surrounding ocean. Precipitation from westerly air masses may have been considerably higher because of very cold dry air from the Patagonian ice sheet becoming unstable on passing over the open ocean west of the Falkland Islands. With glacier ice confined mainly to the higher hill ranges the Falkland Islands probably experienced a severe but maritime periglacial climate from time

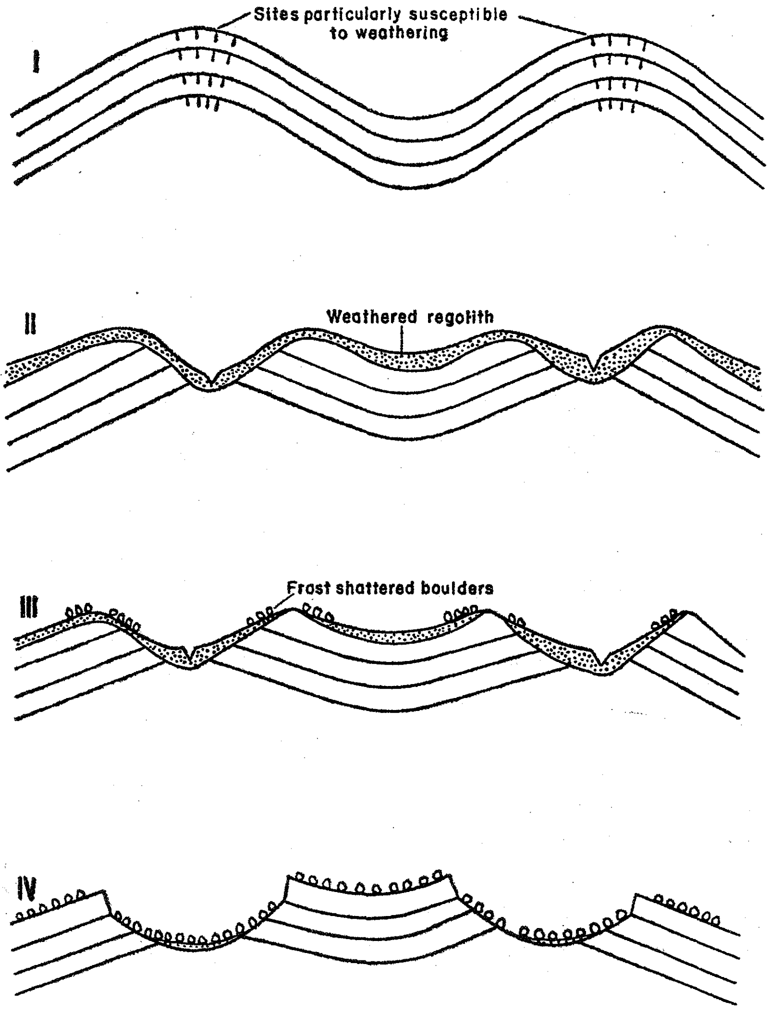

Fig. 3. A model suggesting stages in the evolution of the topography and stone runs on parts of the Falkland Islands

I — Stage 1: Anticlines and synclines of quartzite, sandstone and shale

II — Stage 2: Prolonged denudation during the Tertiary era produced inverted relief and a regolith of chemically rotted bedrock

III — Stage 3: Onset of periglacial conditions leading to the exposure of fresh bedrock. Development of stone runs and other slope phenomena aided by regolith of rotted bedrock

IV — Stage 4: Present situation with well developed stone runs and other periglacial slope phenomena. Much of the Tertiary regolith has been removed to time during the Pleistocene. Parts of Iceland and Spitsbergen currently have this type of climate which, with a high number of freeze—thaw cycles, is considered to be very favourable for mechanical frost weathering (EMBLETON and KING, 1968, p. 451). The third factor concerns the possible widespread occurrence of a chemically decomposed regolith, inherited from prolonged Tertiary weathering. This would have greatly facilitated frost-heaving processes and downslope mass movements during conditions of seasonal saturation.

From this discussion it can seen that JOYCE'S main criticisms of ANDERSSON are invalid. The stone runs on low dome-like hills are actually summit blockfields from which stripes may or may not extend downslope. Because the Mt. Usborne part of the Wickham Heights and similar hill ranges on West Falkland were glacier covered, stone runs and other debris forms are poorly developed there (CLAPPERTON, 1971). If JOYCE had observed the exposures of chemically rotted regolith, he would not have been concerned by the unlikelihood of a deep soil developing in „tundraic conditions".

If JOYCE's concept of *in situ* development of the stone runs is tenable there has been a most remarkable phase of relief evolution during which valleys 2 km wide and 200 m deep were created in a comparatively short time. MALING (1960) considered that the basically mature landscape evolved long before the stone runs. Furthermore, the spatial pattern and morphological characteristics of the stone runs clearly show that the boulders have moved and are not *in situ*.

The evidence presented in this paper generally supports ANDERSSON'S basic thesis that the stone runs were derived by frost-shattering and moved by a process of solifluction. To have been erected on edge the surface boulders must originally have been mixed with a matrix of finer debris. This matrix was later washed out leaving a boulder surface which plants could not colonise. Figure 3 is a model presented in conclusion to illustrate the probable sequence of landform evolution leading to the development of stone runs on parts of the Falkland Islands.

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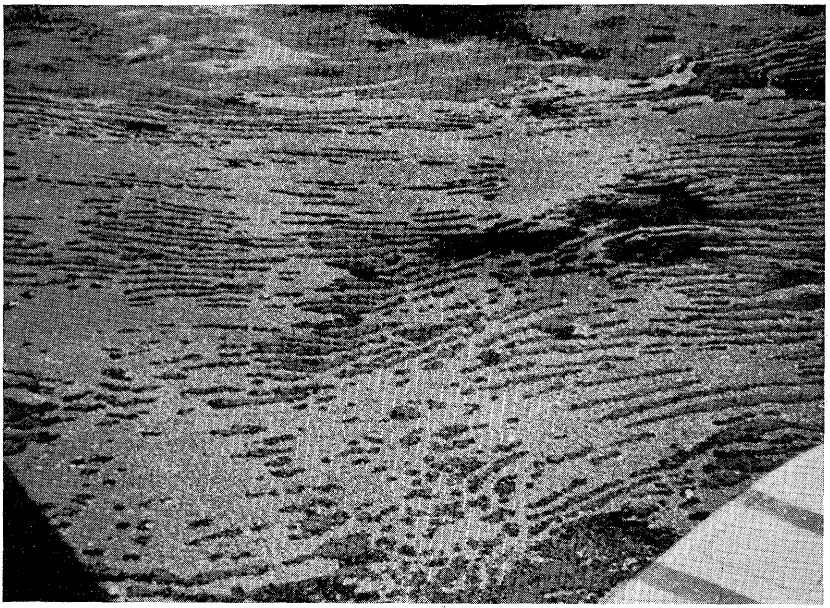
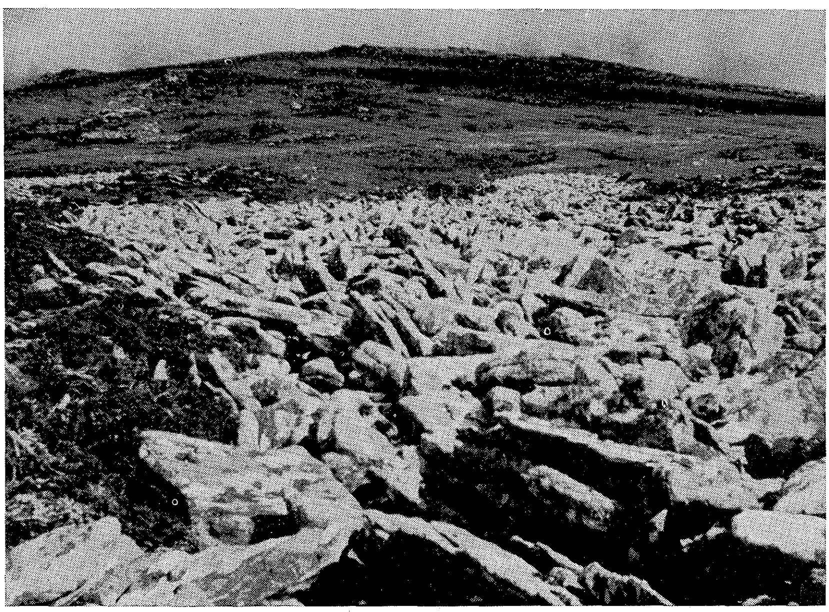
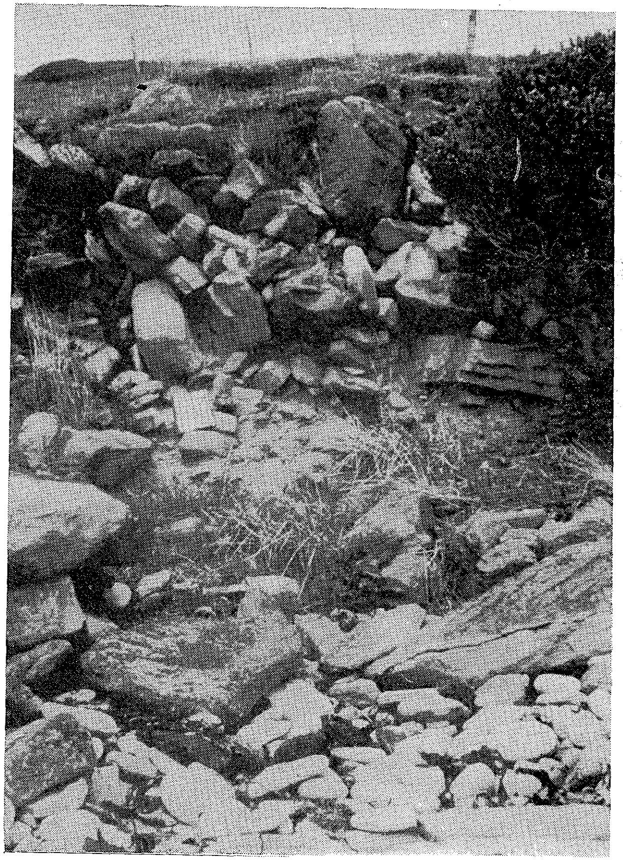


Pl. 1. Stone runs merging into a valley floor blockfield about 25 km. west of Stanley

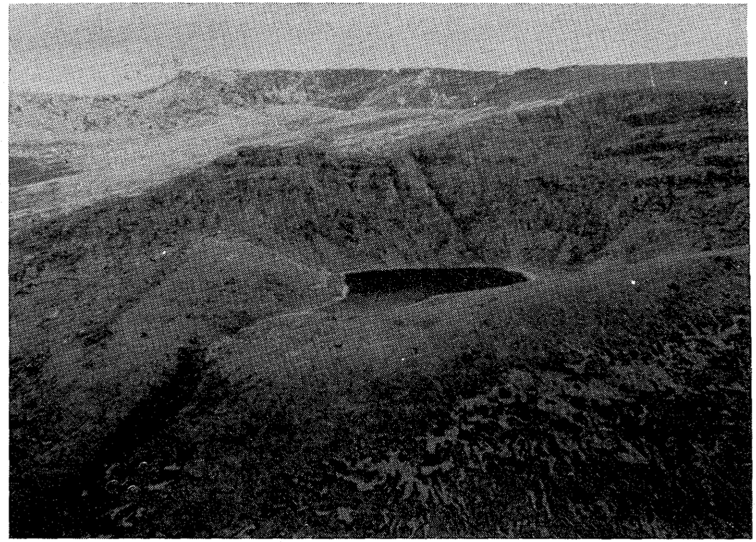


Pl. 2. Typical morphology of a stone run, showing vertical and tilted slabs



Pl. 3. Cross section of a stone run exposed in a cliff on West Point Island

Many slabs are arranged vertically and near-vertically and are underlain by finer debris



Pl. 4. Cirques on Mt. Usborne, East Falkland

The stone lobes and other periglacial forms (lower right) begin abruptly beyond the former glacier limit