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# THE PERIGLACIAL LEGACY IN THE LANDFORMS OF THE WEYMOUTH LOWLAND (South-Central England)

It is now generally agreed that the landscape of southern England, south of the limits of Pleistocene glaciation, bears the imprint of more than one episode of periglacial activity, marked by the presence of relict solifluction deposits and associated topographic forms (Dines *et al.*, 1940; Te Punga, 1957; Williams, 1968). The extent to which periglacial processes have been responsible for shaping the present land surface is, however, a more difficult question: Te Punga's (1957) description of southern England as 'a typical relict periglacial landscape' has not been accepted literally by subsequent workers. In the Central Weald, the present author decided that episodes of periglaciation had only a modifying effect on landforms shaped essentially by runoff processes similar to (but at times possibly more vigorous than) those now active: most of the denudation was attributed to runoff during inter-periglacial and post-periglacial phases (Bird, 1963). The coastal lowland of the Weymouth district in south-central England offers an opportunity to consider this question further.

The Weymouth lowland is an area of ridge-and-valley topography developed on Jurassic formations in the denuded Weymouth anticline, lying south of the Upper Cretaceous escarpment which runs from Wears Hill, above Abbotsbury in the west to the cliff at White Nothe, to the east (Fig. 1). Studies of the geomorphology of this area have been concerned primarily with the evolution of the drainage pattern, which shows marked discordance with the strike of the Jurassic outcrops, generally explained as the result of superimposition of drainage following one or more episodes of marine submergence (Linton, 1932; Arkell, 1947; Sparks, 1952). Sparks (1952) mapped platform remnants at ten distinct levels between 24 and 146 metres above present sea level, and argued that they represented successive episodes

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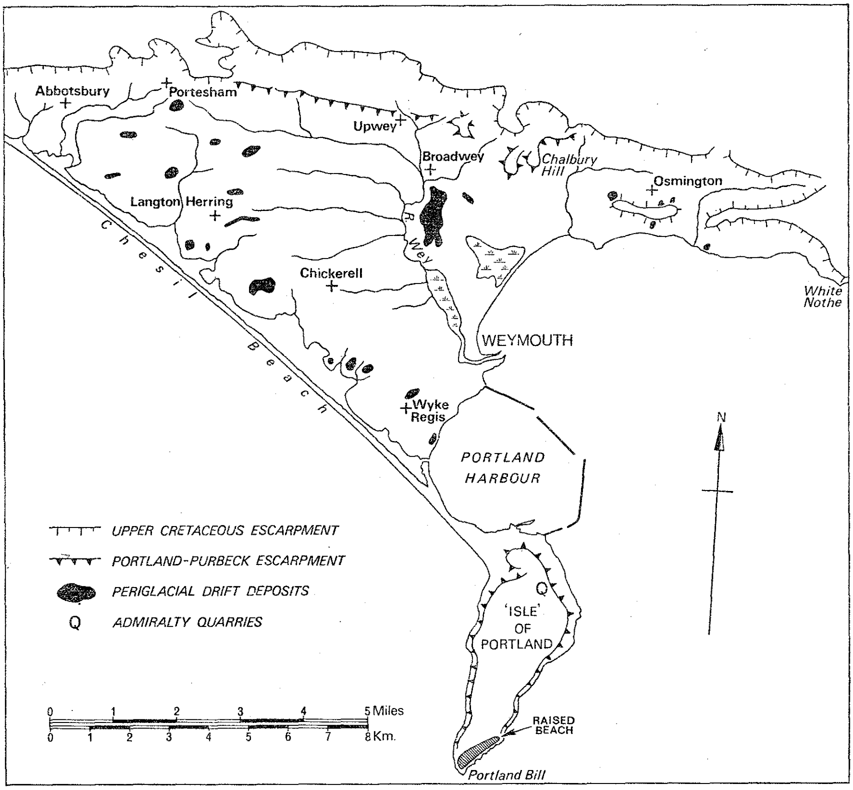


Fig. 1. Periglacial solifluction deposits in the Weymouth lowland

of sea level stillstand and marine planation in this coastal region. During intervening episodes, when the sea withdrew to lower levels, the streams extended superimposed courses across these marine platforms and began to incise the valleys which now dissect them. Supporting evidence in the form of marine deposits, of the kind that constitute the 'raised beach' 12 to 15 metres above present sea level at Portland Bill, is lacking for these platforms.

The scattered drift deposits which are found in the Weymouth lowland include spreads of angular and subangular flint and chert gravel on hill crests, and various kinds of locally-derived superficial material on hillsides. The gravels were first described by Buckland and De La Beche in 1836 as *Head* deposits; Prestwich (1875, 1892) termed them *rubble drift*; Damon (1884) commented that they were 'of limited and local origin'; Strahan (1898) correlated them with cold climatic conditions in the past; and Arkell (1947) noted that they had spread out over slopes too gentle to admit of such movement and accumulation under present conditions. Their significance in terms of the denudation of the Weymouth lowland has still to be elucidated.

## THE HILL CREST DRIFTS

The hill crest drifts include flints derived from the Chalk escarpment to the north and from the Tertiary gravels which cap this escarpment at Black Down, brown cherts from the Upper and Lower Greensand formations, and black splintering cherts (as distinct from the conchoidally-fractured flints found in the Chalk) from the Purbeck and Portland formations. As Figure 1 shows, the Purbeck and Portland beds outcrop at the base of the Chalk escarpment on some sectors, and as a secondary escarpment out in front of the Chalk on others. The angular flints and cherts have been produced by frost-shattering on those escarpments, then transported southwards across the Weymouth lowland by periglacial solifluction for distances of up to six kilometres. Periglacial solifluction is the slow sludging of disintegrated rock debris, which can take place over slopes of gradient as small as 0.5°, as the result of repeated freeze–thaw alternations. It yields extensive thin sheets of rubble drift in front of escarpments which recede, and probably steepen, as the result of frost-shattering and slope wastage. The patches of solifluction material which persist on hill crests in the Weymouth lowland have been isolated by later valley incision, and in order to explain them it is necessary to reconstruct theoretically the land surface across which the solifluction took place.

The highest level at which periglacial drift deposits are found south of the escarpments is at about 120 metres in a sub-surface hollow in Portland Limestone exposed in the Admiralty Quarries on the Isle of Portland (Fig. 1). First described by Neale (1852), these deposits have yielded Pleistocene mammalian fossils indicative of cold climatic conditions (Prestwich, 1875). They consist of angular flint and chert rubble which must have been carried by periglacial solifluction over a land surface that rose gradually northward from the Isle of Portland across the now-denuded Weymouth anticline to a source area of Upper Cretaceous rocks. Attempts to reconstruct such a surface suggest that the source area was a westward extension of the Chalk--capped ridge that now runs west from White Nothe behind Ringstead to terminate at Osmington Hill, rather than the more distant escarpment of Upper Cretaceous rocks at Bincombe.

The present surface of the Isle of Portland, a dip-slope declining southward, is virtually free of superficial drift deposits, but there must have been a sheet of flint and chert gravel extending over at least part of this surface in order to supply the material preserved in the Admiralty Quarries. It is difficult to explain the removal of this drift cover from the surface of the Isle of Portland. The most likely explanation is that it was swept away during a phase of marine transgression, possibly one of the transgressions to above 120 metres widely invoked in the British geomorphological literature (e.g. Green, 1936; Sparks, 1949), but there are no marine deposits about this level on the Isle of Portland to support this hypothesis. All that can be deduced from the available evidence is that an episode of periglacial solifluction took place here relatively early in Pleistocene times, across a land surface that had not yet been dissected below 120 metres.

An ensuing episode of periglacial activity is indicated by the patches of angular flint and chert rubble which are widespread on hill crests between 60 and 85 metres above present sea level. The largest patch of this material is on Fleet Common at 60–65 metres. This rubble has been spread southwards from the bordering escarpments across a landscape of faint relief: it was emplaced before the present valleys became incised below the 60 metre level. Residual patches of solifluction debris are most extensive on the relatively undissected watershed area south-east of Portesham, between the Rodden valley and the western headstreams of the Wey (Fig. 1).

This second phase of periglacial solifluction evidently took place after partial planation of the Weymouth lowland between 60 and 85 metres: the drift deposits extend on to remnants of the 73 metre platform mapped by Sparks (1952). This implies a Pleistocene sea level stillstand at about this level, but the extent to which the planation was achieved by marine processes, rather than by runoff, is indeterminable. A correlation of falling sea level with cooling climates during the Pleistocene admits the possibility of some rejuvenation of streams, and partial dissection of previously planated land surfaces, prior to the onset of periglacial conditions. There is little evidence that passage of solifluction debris led to any significant lowering of the land surface: the flint and chert rubble is only slightly diluted by the admixture of weathered materials incorporated from the land surface over which solifluction occurred.

Below the 60–85 metre level there are rubble drift deposits extending down on to platform or terrace remnants between 15 and 20 metres above present sea level on the slopes overlooking the Fleet lagoon at Langton Herring and Furzedown and on the shores of Portland Harbour near Small Mouth. Baden-Powell (1930) classified these as 'degraded river terraces', but the superficial deposits are mainly angular and subangular stones in an earthy matrix, and appear to be of periglacial rather than fluvial origin. They correspond with the periglacial drift deposits (Head) resting on the Portland Bill raised beach, which in turn occupies a platform rising to an old shoreline

12–15 metres above present sea level. Solifluction deposits are found on another coastal platform at a similar level at Ringstead, and it is inferred that this third periglacial phase in the Weymouth lowland took place after the cutting of coastal platforms during a 12 to 15 metre sea level stillstand.

There are also rubble drifts immediately fronting the Upper Cretaceous and Upper Jurassic escarpments which probably belong to this phase. The spread of solifluction was less extensive than in the preceding phase, largely because the material from the escarpments passed down the incised valleys instead of spreading out over a broad plain. Relics of an extensive valley--floor accumulation persist south of Broadwey on a terrace that descends from 33.5 metres to just over 20 metres southward, maintaining an elevation of 15 to 18 metres above the present Wey flood-plain. The gravels here are up to 2 metres thick, and rest upon a surface which can be interpreted as the valley floor of the Wey developed during the late Pleistocene 12 to 15 metre sea level stillstand.

This third phase of periglacial solifluction was the last extensive manifestation of this process in the Weymouth lowland, and probably occurred during the Last Glacial (Main Vistulian) stage. The first and second phases of periglaciation are thus referred to preceding Glacial stages (*cf.* Waters, 1960).

## HILLSIDE DRIFTS

In addition to the hill-crest drifts there are superficial deposits mantling hillsides in the Weymouth lowland, some of which represent more recent phases of local periglacial solifluction, while others appear to be hillwash produced by runoff.

The first category includes deposits exposed in roadside sections on the Upper Jurassic escarpment facing south at Chalbury Hill (Fig. 1). These escarpment drifts show an upper layer 10–30 cm thick, consisting of relatively fine material (stones with diameter 1–3 cm), resting upon a layer 20 to 40 cm thick consisting of coarser material (stones with diameter 5–10 cm). The contact between the two is locally irregular as the result of ice-wedge development resulting from freeze—thaw action and indicating that periglacial conditions existed during or after the emplacement of this material. At least two phases of down-slope movement are represented, followed by a phase of relative stability which has permitted the development of a rendzina soil profile. The material is entirely of local derivation, consisting of brown fragments of limestone and black splintered cherts from the frost-shattered upper layers of the Portland and Purbeck rocks which outcrop on Chalbury Hill and are exposed in a hill-top quarry. Similar features are seen on the Chalk escarpment, especially in the vicinity of the two large escarpment coombes at and west of Portesham. The deposits resemble those described from the escarpment of the northern Weald (Kerney *et al.*, 1964) and are probably, like these, of Late-Glacial and Post-Glacial age.

The second category of hillside deposit is widespread in the Weymouth lowland, and takes the form of a slope mantle, generally less than a metre thick, consisting of material derived from weathered rock outcrops and superficial deposits on the crest of the hill. The broad gentle slope south of Friar Waddon Hill has an almost undissected mantle of such deposits. Pieces of angular flint and chert from hill-crest deposits may become incorporated in these hillside accumulations, but their presence is not necessarily an indication of periglacial solifluction. Most of the hillside deposits have been emplaced by runoff, derived either from melting snow or from rainfall, which may at times have been greater or more intense than at present. Runoff would certainly have been more effective in late Pleistocene or early Holocene times, before tundra conditions of climate and vegetation gave place in the Weymouth lowland to a forest cover. The fact that hillside deposits are generally thicker and more extensive on south-facing slopes favours snow melt, rather than rainfall, as the emplacing process. South-facing slopes receive stronger insolation, and during phases of colder regional climate would have had a greater frequency of snow-melt than north-facing slopes.

The hillside mantles appear to be relict features in the present environment, although it is possible that some sites are still receiving slope wash and soil creep, especially on slopes that have been ploughed. Here, as elsewhere in southern England, more research is needed to determine the sequence of Late-Glacial and Post-Glacial deposits, and to separate the effects of climatic conditions from the effects of man's activities, notably of deforestation and cultivation of the land surface during the past few thousand years.

## CONCLUSION

Superficial deposits indicative of periglacial activity are thin and scattered in the Weymouth lowland, and are associated mainly with former land surfaces at about 120 metres, between 60 and 85 metres, and between 15 and 33.5 metres above present sea level. These former land surfaces are attributed to a combination of subaerial and marine planation, their subsequent dissection being largely the work of fluvial denudation. The effects of periglaciation on the landforms of the Weymouth lowland have been limited to the recession of the bordering escarpments and the deposition of thin but widely-spread derived rubble drifts which are preserved on hill crests and platforms. The essential outlines of the Weymouth lowland are independent of the limited effects of brief intrusions of periglacial activity in this area.

## References


Arkell, W. J., 1947 – Geology of the country around Weymouth, Swanage, Corfe and Lulworth. *Mem. Geol. Survey.*

Baden-Powell, D., 1930 – On the geological evolution of Chesil Bank. *Geol. Mag.*, vol. 67; p. 499–513.

Bird, E. C. F., 1963 – Denudation of the Weald Clay Vale in West Kent. *Proc. Geol. Assoc.*, vol. 74; p. 445–456.

Buckland, W. and H. T. De La Beche, 1836 – On the geology of the neighbourhood of Weymouth. *Geol. Trans.*, no. 4; p. 1–15.

Damon, R., 1884 – Geology of Weymouth, Portland and the coast of Dorsetshire. Weymouth.

Dines, H. G., S. E. Hollingworth, W. Edwards, S. Buchan, and F. B. A. Welch, 1940 – The mapping of Head deposits. *Geol. Mag.*, vol. 77; p. 198–226.

Green, J. F. N., 1936 – The terraces of southernmost England. *Quart. Jour. Geol. Soc.*, vol. 92; p. 58–87.

Kerney, M. P., E. H. Brown, and T. J. Chandler, 1964 – The Late-Glacial and Post--Glacial history of the Chalk escarpment near Brook, Kent. *Proc. Roy. Soc.*, B. 248; p. 135–204.

Linton, D. L., 1932 – The origin of the Wessex rivers. *Scot. Geogr. Mag.*, vol. 48; p. 149––166.

Neale, A., 1952 – Notice of fossil bones at Portland. *Quart. Jour. Geol. Soc.*, vol. 8; p. 109.

Prestwich, J., 1875 – Notes on the phenomena of the Quaternary period in the Isle of Portland and around Weymouth. *Quart. Jour. Geol. Soc.*, vol. 31; p. 29-54.

Prestwich, J., 1892 – The raised beaches and 'Head' or rubble-drift of the south of England. *Quart. Jour. Geol. Soc.*, vol. 48; p. 263–343.

Sparks, B. W., 1949 – The denudation chronology of the dip-slope of the South Downs. *Proc. Geol. Assoc.*, vol. 60; p. 165–215.

Sparks, B. W., 1952 – Stages in the physical evolution of the Weymouth lowland. *Trans. Inst. Brit. Geogr.*, vol, 18; p. 17–29.

Strahan, A., 1898 – The geology of the Isle of Purbeck and Weymouth. *Mem. Geol. Surv.*

Te Punga, M. T., 1957 – Periglaciation in southern England. *Tijdschr. Ned. aardrijksk. Genoot.*, vol. 74; p. 399–412.

Waters, R. S., 1960 – Pre-Würm periglacial phenomena in Britain. *Biuletyn Peryglacjalny*, No. 9; p. 163–176.

Williams, R. B. G., 1968 – Periglacial erosion in southern and eastern England. *Biuletyn Peryglacjalny*, No. 17; p. 311–335.