R. S. Waters
Sheffield

DARTMOOR EXCURSION

Sunday, 12th July 1964

Leader: Professor R. S. Waters, assisted by Professor D. L. Linton and Mr B. Clayden

Itinerary: Exeter — Great Haldon (SX/897840) — Little Haldon (SX/919765) — Bovey Basin (SX/855755) — Haytor (SX/758772) — Merripit Hill (SX/660800) — Long Plantation (SX/596751) — Cox Tor (SX/530761) — Exeter

Sunday, 12th July 1964, was devoted to a field examination of Pleistocene sections and landforms on and adjacent to the massif of Dartmoor in south Devon. This distinctive portion of Britain's never-glaciated plateau uplands is developed on the outcrop of the easternmost and largest of the five major post-tectonic Armorican granite masses of southwest England and its aureole of altered Palaeozoic sediments and basic intrusives (fig. 1). On its eastern margin, east of the middle Teign Valley, the Palaeozoic basement passes beneath an unconformable cover of Permian breccias, sandstones and marls. A little farther east, on the Haldon Hills, the Permian rocks are themselves unconformably overlain with Upper Greensand, an outlier of the prominent scarp former of east Devon. On Great and Little Haldon the Cretaceous formation carries a residual deposit of angular flint and chert, amongst which are preserved rolled Tertiary gravels. Comparable cobbles and shingle occur at the base of c. 500 feet of Middle Oligocene lacustrine sediments (sands, clays and lignites) in the adjacent Bovey Basin.

Throughout this area, as over the whole of southwest England, the cold phases of the Pleistocene are represented by disturbed regoliths, head (solifluxion) and loess-like deposits and, on the granite particularly, by spreads of boulders and blocks. Although some of the Pleistocene deposits are clearly derived from the cryergic weathering of bedrock, as witness a few of the tors on the granite and all of the altiplanation benches on the metasediments and metadolerites, the bulk of the head consists

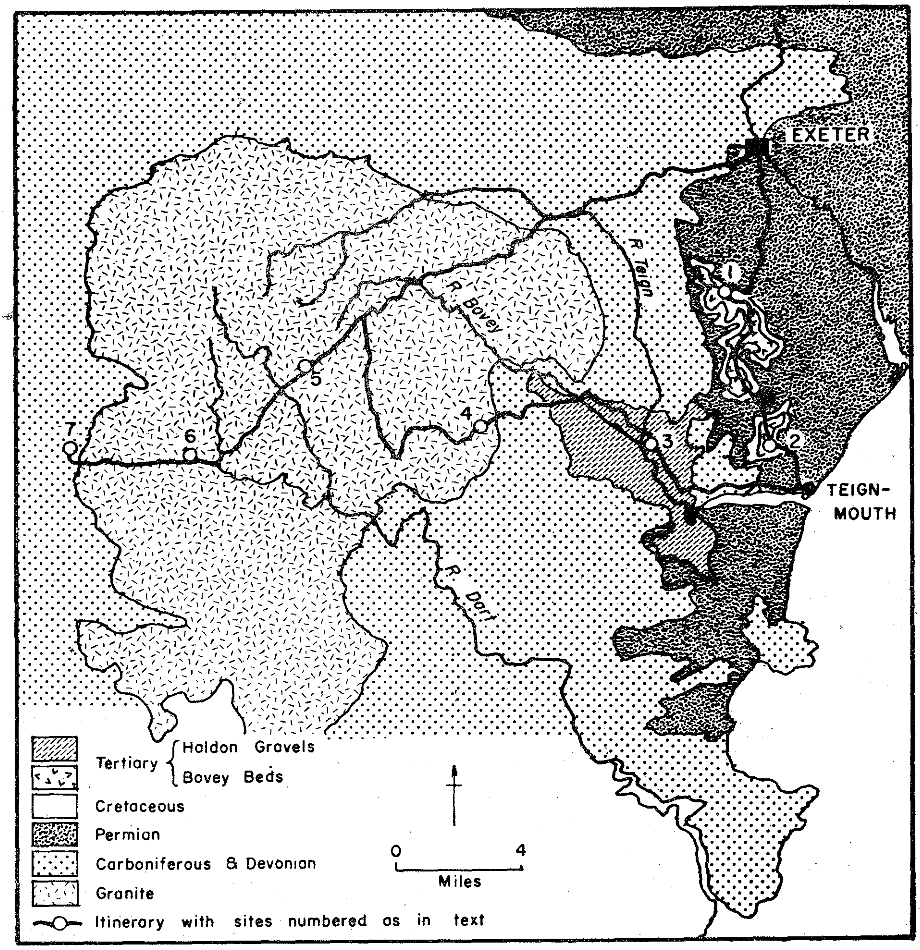

Fig. 1. Dartmoor Excursion. Route map and geology

of pre-existing waste re-distributed in a periglacial milieu. Nevertheless, at higher elevations on granite and clastic sediments alike, the overall result of the periglacial metamorphosis was a diversification of pre-existing surface form. Tors, already differentiated by selective, sub-surface weathering, were exposed by the soliflual removal of the surrounding products of decomposition, and initially irregular hillslopes on metamorphic rocks which carried relatively thin regoliths were converted into flights of steps with broad treads and steep risers.

Indications of the downslope transfer of pre-existing chemically weathered regoliths and of the production and movement of frost-weathered material are given in many "gravel" pits on Dartmoor. The most complete sections reveal evidence of only two cold phases which, in the absence of dateable horizons, have been referred tentatively to the late Pleistocene. It would appear that the earlier (? Vistulian) was the more severe of the two periglacial episodes. Many pits on Dartmoor show frost-weathered bedrock beneath a variable thickness of up to 8 feet of decomposed granite and head. Frost action during the second cold phase was limited to a maximum depth of 3 feet and its effects on bedrock were negligible save on certain of the tors and near the bases of steeper slopes on particularly susceptible rocks like the metasediments of the aureole.

GREAT HALDON

The effects of solifluxion on the lightly dissected, E-facing, Upper Greensand scarp were examined in fresh road cuttings, north of the A 38 (Exeter—Plymouth) road. Small gullies were seen to be filled with Tertiary cobbles and frost-shattered chips and flakes of flint and chert from the top of the hill; and evidence of the lateral displacement of larger valleys was noted in the alternation of soliflual debris and bedrock along road

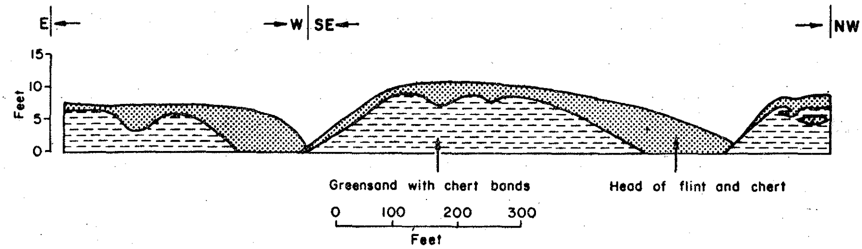

Fig. 2. Head-filled gullies on Great Haldon

cuttings across spurs (fig. 2). The filled valleys, the first of their kind to be recorded in Britain, were likened by Professor Linton to the fossil gullies near Wellington, New Zealand, described by Cotton and Te Punga.

LITTLE HALDON

Sections in a disused pit in the Tertiary gravels on the 750 ft. plateau surface were seen to display evidence of frost disturbance and indications of sorting. Mr B. Clayden of the Soil Survey of England and Wales pointed out superficial pockets of loess-like, silty material separated by flakes and cobbles of flint and chert; and Professor Waters recalled that the most convincing evidence of deposition of periglacial loess came from soils on the serpentine of the Lizard peninsula in western Cornwall. This and the high proportion of silt in the fine fraction of soils in many parts of southwest England was suggestive of mechanical rather than chemical weathering, and the silty lenses in the top of the Haldon gravels and elsewhere seemed to indicate local re-arrangement of loess-like material by wind, frost or water during the last cold phase.

BOVEY BASIN

In the Preston Manor ball-clay pit small anticlinal structures were examined in the uppermost 20—25 feet of the Bovey Beds, a thick sequence of granite gravels and sands and kaolinitic clays derived from the weathering of the Dartmoor granite during the Oligocene. The disturbances of the exposed lignitic clays were seen to comprise anticlinal or domelike features ranging from gentle undulations to sharp diapiric or piercement structures with cores of pale clays c. 10 feet thick. They have been interpreted [1] as periglacial disturbances of Pleistocene age that were produced during the downward growth of the permafrost, probably at the onset of a cold phase. Professor Péwé observed that their vertical extent (10 to 20 feet) certainly precluded the possibility of their association with an annual active layer. Professor Dylik cited comparable structures in Hungary which had been produced by re-freezing, and Professor Cailleux referred to similar diapirs which penetrated gravel in the Paris Basin. The possible effects of the superincumbent load of the overlying 15 feet of river gravels were also discussed, though it was observed that some of the domes were truncated by erosion before the overlying gravel and alluvium were deposited.

HAYTOR

In the light of field evidence in the vicinity of this typical example, Professor Linton considered the problem of tor formation on Dartmoor (*vide infra*, under "Discussion: Tuesday, 14th July, 1964", p. 133 *et seq.*). There was general agreement that the interfluve tors, at least, appear to

[1] Dineley, D. L. 1963 — Contortions in the Bovey Beds (Oligocene), S. W. England. *Biuletyn Peryglacjalny*, no 11; p. 151—160.

be "the result of a two-stage process, the earlier stage being a period of extensive subsurface rotting whose pattern is controlled by structural considerations, and the later being a period of exhumation by removal of the fine-grained products of decay" [2]. Current weathering is modifying the smoothly rounded outlines of Haytor Rocks, and Professor Waters demonstrated the effects of frost weathering during the last periglacial episode. Their exhumation, primarily by the soliflual removal of decomposed material, and initial modification would seem to date from an earlier cold phase.

MERRIPIT HILL

The following section, typical of comparable middle-of-slope locations, was examined in a roadside "gravel" pit: 4 ft of Main Head of angular and sub-angular granite fragments in a fine gritty or sandy loam matrix, over 12—18 in. of Bedded Growan with weakly developed contortions, resting on c. 18 in. of frost-weathered, platy or flaggy bedrock. Attention was directed to the very large proportion of fine material in the solifluxion deposit which, with the bedded growan, is indicative of downslope transfer of a pre-existing chemically weathered mantle.

LONG PLANTATION

Involutions in growan and granite head were seen in a pit in hydrothermally altered (tourmalinised), coarse-grained granite at 1,380 ft. O.D. on a gently sloping ($<2°$) interfluve. Pit sections showed up to 8 ft. of decomposed granite, head and peat on an uneven floor of relatively sound bedrock from which more massive stacks project upwards to within a foot or two of the surface. In the deepest section, downward hanging lobes or pods of head separated by upward swirls of growan, were seen above an 8 in. layer of undisturbed growan. It would appear that the lowest layer of equally incoherent, decomposed granite remained frozen while the overlying growan and head formed the active layer (*mollisol*). It was also noted that the stacks of relatively fresh bedrock were frost-shattered where they penetrated the seasonally-thawed layer.

---

[2] Linton, D. L. 1955 — The problem of Tors. *Geogr. Jour.*, vol. 121; p. 472.

COX TOR

A walk to the summit of Cox Tor afforded opportunities for members to observe striking contrasts in the effects of frost weathering and solifluxion on the granite and the metadolerite and hornfels of the aureole. Well developed altiplanation terraces were examined on the altered rocks [3] and interest was expressed in the turf-covered mounds of silty-loam soil (*mottureaux*) which were seen to be confined to the outcrop of metadolerite. The relatively debris-free, benched hillslopes of the Cox Tor mass (metadolerite and metasediments) were contrasted with the smooth, boulder- and block-strewn granite slopes below the Staple Tors. It was pointed out that the clitters of blocks and boulders (the Upper Head), which were detached from the previously exposed tors during the last periglacial phase, commonly extend downslope to rest unconformably on the Main Head of large to small sub-angular stones in a loamy matrix. Main Head was seen to occupy the floor of the valley developed along the granite/killas contact between the Staple Tors and Cox Tor. The presence of the clitters is indicative of the "resistance" of their constituent blocks and boulders to further comminution. Most of the large, joint-bounded blocks retain one or more smooth, chemically weathered faces, and the boulders are true core-stones. Survivors of a phase of rotting and still virtually impermeable, they were quite unaffected by frost weathering.

[3] Waters, R. S. 1962 — Altiplanation terraces and slope development in Vest-Spitsbergen and South West England. *Biuletyn Peryglacjalny,* no 11; p. 89—101.

R. S. Waters
Sheffield

NORTH DEVON EXCURSION

Monday, 13th July 1964 *

Leader: Mr N. Stephens

Intinerary: Exeter — Barnstaple — Fremington (SS/529318) — Saunton (SS/440379) — Croyde Bay (SS/430398) — Exeter

Mr Stephens had introduced members of the symposium to some of the complexities of the Pleistocene sections in North Devon when he delivered his paper on the preceding Saturday.

Two distinct layers of head (congelifluxion deposits) were described from Barnstaple Bay. They occur in an apron or solifluxion terrace often of wide extent; they are up to fifty feet thick and represent material which moved down the coastal slope. The upper layer of Vistula (Würm) age, disturbed in places by frost wedges and convolutions, is less weathered than the lower or main head regarded as Saale (Riss) in age. The calcareous shelly boulder clay at Fremington is considered to be Saale (Riss) also, and equivalent to the Irish Sea till of southern Ireland. Erratic boulders, in places up to 50 tons in weight, occur sealed below the raised beach or below the main head, and no boulder clay has been found in association with them. The large boulders are regarded as ice-rafted blocks which were floated on to existing wave-cut platforms in the early Pleistocene. The presence of an ice sheet in Ireland, Wales and North Devon would seem to imply that ice pressed high against the cliffs between Hartland Point and Lynton. Accordingly Mr Stephens suggested that temporary drainage diversions resulted in the production of marginal, glacial drainage channels, including the Valley of the Rocks west of Lynton. Previous explanations of the dry valleys along the coast, by rapid marine erosion causing disruption of former drainage lines, can now be reconsidered in

* This report is based on the abstract of the paper by Mr Stephens: "Some Pleistocene deposits in North Devon", and on additional notes provided by Mr Stephens.

the light of the inferred presence of Irish Sea ice against this coast. The "lake clay" below the shelly boulder clay in the Fremington section could indicate the existence of a former lake, which may have overflowed via an inland route or alternatively over the ice.

FREMINGTON CLAY-PIT

It was generally agreed that a boulder clay was present, overlain by a layer of washed sand (representing a phase of erosion of the surface of the till), a layer of weathered till (3—4 feet thick at the point of observation) and a solifluxion "earth" (8—10 feet). Erratics recorded from the boulder clay include chalk, flint, various granites, dolerite, quartz porphyry, and carboniferous limestone. Shell fragments were seen to be abundant.

There was a lively discusion on the possible origin of the thick (up to 22 feet have been recorded in this pit) stoneless clay which lay immediately below the uppermost layer of boulder clay. It was seen to contain only occasional stones and a few large "rafted" erratic boulders. The clay was variously interpreted as lake clay, estuarine clay, and stoneless till.

By chance, during the visit the foreman at the claypit was able to show that another identical layer of calcareous, shelly till lay beneath the stoneless clay, which was thus sealed between two till bodies. This lower till had never previously been recorded in this or in any other pit in the neighbourhood. It therefore seems likely that the clay body as a whole must be considered as a till.

SAUNTON

Cliff sections were examined near the Bloody Basin, where fossil raised beach gravels were overlain by sandrock (lower part marine, upper part wind-blown = calcareous aeolianite) and by head deposits. The main or lower head was represented in the cliff sections as some 20 feet of shattered rock with much sandy matrix and considerably weathered. The upper or younger head was seen in roadside cuttings where it consisted wholly of angular, shattered rock which passed downwards into bedrock. This layer did not reach the cliff top or front edge of the main solifluxion (head) terrace.

CROYDE BAY (NORTH SIDE)

A solifluxion terrace of head was noted on the south side of the bay below Saunton Down. At Middleborough raised beach shingle and sand-rock, overlain by head, were seen to rest upon a platform at 45 feet O.D.

Particular interest was aroused at a nearby section which showed multiple layers of head. Professor Dylik and Professor Cailleux demonstrated that the several layers could represent one cold period, of increasing cold and varying humidity. However, on a subsequent visit with Professor Fairbridge on 14 July it was found that there was a separate, lower head at the base of the cliff section, and that this was clearly and sharply separated from the rest of the multiple layers of head by a layer of red sand. This lowermost head rested upon sandrock and a rock platform. Thus the complete section appears to represent more than one glacial period.

Further sections at Freshwater Gut showed a large gneiss-granulite erratic resting upon a 25 feet rock platform (height at notch), with a 35—45 feet platform cut into by the lower platform. Professor Fairbridge claimed that a third platform was present because fossil notches partly filled with sandrock could be seen at 18 feet O.D. Main head covered all three platforms and the large erratic.

During further discussions on the puzzling sections with multiple layers of head it was suggested that the upper blocky layer (3—4 feet thick) with fossil wedge-like structures represented the total depth of the active layer during the maximum cold phase of the last glacial period. Thus where head of considerable thickness (say 8—16 feet minimum) could be shown to be disturbed by convolutions to a depth of up to 12 feet and to be overlain by an upper head it must represent an earlier glacial period.

PENCIL ROCK

Here the 45—50 feet platform was seen to be very clear, with a sharp notch, and a trace of the 25-feet rock platform could be seen below it. Members were shown a shelly, shingle beach containing many angular blocks of head, and there was discussion as to the implications of this and the thick sandrock which overlay it.

Mr Stephens interpreted the shingle as part of a regressive beach that was formed as sea level began to fall and cold conditions began to produce head on the coastal slope. This head was incorporated in the beach gravels. Subsequently the fall of sea level exposed a sandy strand from which shell sand was blown against the cliff to seal the old beach and platform. The sand (now sandrock) contains lenses and fragments of head throughout its entire thickness, and it is sealed off by head. This section can be matched elsewhere in Devon and Cornwall and in Southern Ireland; it is not purely a local phenomenon.

Professor Cailleux argued that the sea must have stood at approximately its present level when the shell sand was deposited:

"Le dépôt éolien, ou calcarénite, diffère beaucoup des dunes que nous voyons au fond de la baie, en particulier par sa disposition en une sorte de placage le long du versant abrupt et à son pied, alors qu'au contraire les dunes sont édifiées sur des parties plates. Il s'agit de deux dynamiques très différentes.

D'autre part, puisque la calcarénite est interstratifiée avec quelques lits de head, d'origine périglaciaire, elle s'est formée lors d'une phase froide. Mais étant faite surtout de débris de coquilles marines, elle nous indique qu'alors le niveau de la mer était élevé, voisin du niveau actuel. La calcarénite a donc dû se former, en majeure partie, tout au début d'une période glaciaire, ou tout à la fin, quand le niveau de la mer était haut."