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Geology of the Matley and Denny Nature Reserve, New Forest

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INTRODUCTION

A DETAILED geological survey has been made of an area south-east of Lyndhurst in order to provide an accurate map of rock types as a basis for ecological and other natural science research in Nature Reserve No. 30. The results of the survey are presented in this paper, to provide the information required for such work in the biological and other sciences, and also as an addition to the detailed knowledge and understanding of the geology of the central part of the New Forest.[1]

The geological survey of this area was commenced by the author, with the assistance of R. R. Vine, K. R. Greenleaves and P. Clifford, while in the Geology Department of the University of Southampton. This early work has, however, since been enlarged and modified by the author, who is responsible for the views advocated in this paper. The area has little surface exposure, and throughout it has been necessary to use an auger to fix the geological boundaries with accuracy.

An account of the geology of the area can conveniently be considered in two sections—the first dealing with the 'solid' strata of Eocene and Oligocene age, the second with the superficial, drift deposits, of Pleistocene and Holocene age, which cover large parts of the surface.

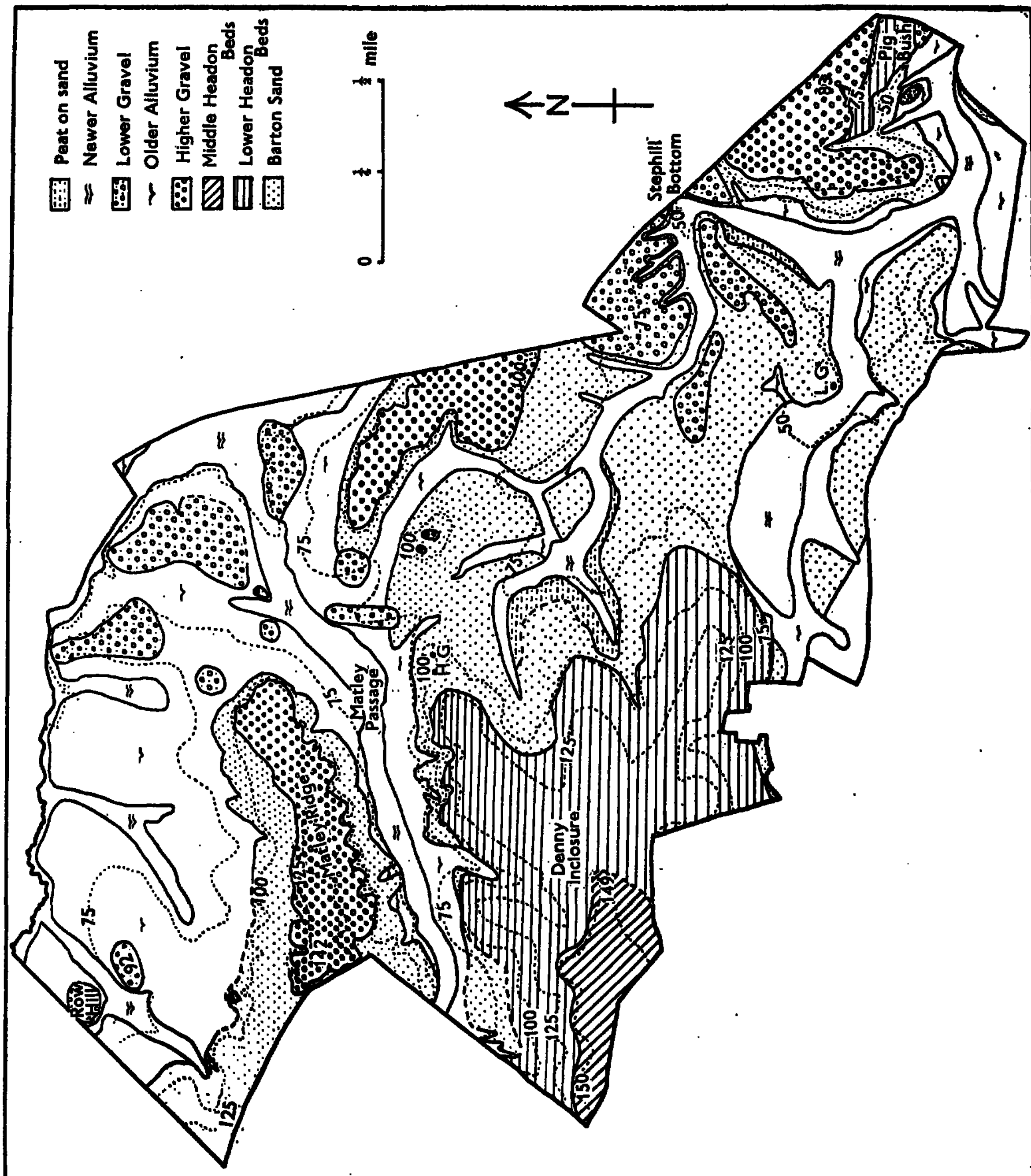
SOLID GEOLOGY

The exposed solid strata of the area fall into the highest Eocene and lowest Oligocene deposits of the Hampshire Basin, viz.—

1. The Barton Sand.
2. The Headon Beds.

The Barton Sand is present at the surface or immediately beneath the superficial deposits over much of the area. The underlying Barton Clay is also thought to be present beneath the alluvium along the northern edge of the area, but has nowhere been found exposed at the surface. The thickness of the Barton Sand as a lithological unit is in this district about

1. The boundaries of the accompanying geological map differ slightly, in places, from those of the Nature Reserve, since this paper was written before the reserve was established and its limits had been finally decided.



Geology of the Denny area, New Forest.

130–140 feet. This is somewhat larger than the 80–100 feet assigned to the formation by Reid (1902, p. 37), but the difference appears to be due to Reid's tentative correlation of the lower part of the sand with the *Chama*-beds, and its consequent inclusion with the Barton Clay.[2] In the absence of any palaeontological evidence in support of such a correlation, the Barton sand has been mapped as a lithological unit for this work. The lower part of the sand (e.g. at Row Hill) has no apparent differences from the beds above. It may well be, however, that the lithological boundary between Barton Sand and Barton Clay is a diachronous one.

These sands generally form wide, flat areas of heathland. They are well exposed only in a few pits, and to a lesser extent in bomb craters in the vicinity of the Southampton–Brockenhurst railway. The best exposure is in the pit just south of the Lyndhurst–Beaulieu road, ¼-mile south of Matley Passage. The rock is a pale, cream-coloured, fine sand, in which the quartz grains have an average diameter of 0·2 mm. Large flakes of muscovite with a diameter of about 0·5 mm. are by no means uncommon. The sand is generally soft and uncemented, but reasonably good exposures show some layers and veins of harder limonitic rock, though no really hard iron-pan. Some scattered subangular flints, generally less than ½-in. in diameter, are present at certain horizons. Where these sands have suffered leaching in the upper layers of the subsoil, they have generally been altered to a silvery white colour.

The Headon Beds are confined to the south-western and south-eastern parts of the area, where they form higher, forested land, generally forming a marked topographic feature above the heathland of the Barton Sand. The larger area in the south-west forms part of a long tongue, stretching north-west to beyond Lyndhurst, that marks the position of a syncline with a slight south-easterly pitch. The outcrop in the south-east of the area, at Pig Bush, is an outlier on the southern slopes of a hill not far to the north of the main outcrop; the northern part of this outlier is concealed by gravel.

Lower Headon Beds appear to form the whole of the Pig Bush outlier and the major part of the south-western area. They consist of stiff, light grey clays and marls, which are poorly exposed and have not yielded the freshwater fossil bands recorded from sections in neighbouring areas. They have a sharp junction with the underlying Barton Sand, even where, as at Pig Bush, the basal part of the clay is somewhat sandy and pebbly.

Reid (1902, p. 39) suggested that the Lower Headon Beds might thin out or become partly marine northward towards Lyndhurst, but gave no evidence in support of this view, and at Lyndhurst Hill recorded the richly fossiliferous marine Middle Headon Beds as being 50 or 60 feet above the base of the Headon. Nor is there any evidence in support of his suggestion in the Denny area or the adjoining districts to the south and south-west, for everywhere richly fossiliferous marine beds (the Brockenhurst Beds) appear to mark the base of the Middle Headon, overlying about 55 feet of unfossiliferous Lower Headon Beds.

Within the limits of the area Middle Headon Beds are confined to the higher parts of Park Hill. Shell fragments lying on the surface or brought up by the auger are generally of *Circe edwardsi*, von Koenen or *Sinodia* (*Cordiopsis*) *suborbicularis* (Goldfuss) (=*incrassata* Sowerby, see Tremlett 1953, p. 65), but a few other forms of the fauna of the Brockenhurst Beds (Reid 1902, p. 40; Davies 1952) can also be recognised. The Middle Headon strata of Park Hill are of the same lithological type as the Lower Headon of this district.

2. The views expressed by Reid in the memoir for the district (1902) were not, however, applied in the 1 in.–1 mile geological map (sheet 315) of 1899, except in the key to the map. The Barton Sand was mapped lithologically, and in order to explain the distribution shown by the map it requires more than the 80–100 feet thickness given by the key.

The geological structure of the area is simple, for it lies completely to the north-east of the axis of the Lyndhurst syncline. The strike of the strata is about 5° S. of E. in the southern and south-eastern parts of the area, but due W. or slightly S. of W. in the western and north-western parts. The dip decreases from about 80 feet per mile (0° 50′) in the north to about 55 feet per mile (0° 35′) in the south.

DRIFT DEPOSITS

It will be seen from the geological map of this area that drift deposits cover a large part of the surface, and are far more extensive than has been indicated on previous maps. They are essentially of two types—(i) accumulations of coarse gravel, and (ii) a mixture of fluviatile clays and sands, with beds of peat and occasional thin local beds of fine gravel, which are grouped together under the term alluvium. These are each represented by two groups of different age, the particular characters of which can best be considered in chronological order. In order to avoid repetition, however, some general remarks can first be made on the characters of the gravel and alluvium.

The gravels are composed almost entirely of rounded pebbles of brownish- or white-coated flint, of very variable size but rarely exceeding 2 in. in diameter. The occasional other types include small pebbles of light grey chert and white quartz. It is generally not possible to determine the thickness of gravel deposits by augering, but in the sections exposed in gravel pits they do not seem to exceed 4 or 5 feet.

The present-day remnant patches of gravel tend to give rise to flat-topped plateaux with a fairly well-defined edge—especially noticeable in the case of the Higher Gravels. There is, however, sometimes some slumping and downwash of gravel below the edges of these plateaux, and this can create difficulty in deciding precisely where to place the edge of the gravel patch on the geological map. The practice adopted has been the inclusion of slumped patches of gravel but not the surface downwash of scattered pebbles. A slight camber at the edges of the gravel patches can often be observed due to the washing away of underlying sand or clay by the copious supply of water which comes from the gravel after periods of heavy rain.

The alluvium is of heterogeneous character but consists mostly of a mixture of clay and sand, generally of either orange or bright blue-green hue. This sandy clay is always less compacted than the clay of the Headon Beds, and is more or less waterlogged; it often contains small plant fragments. Beds of peat are also found within the alluvium, and occasional thin beds of gravel, generally much finer than the thick gravel accumulations outside the alluvium.

1. *The Higher Gravel.* From a consideration of the height and distribution of the Higher Gravel of the area it is clear that though it might now be termed 'plateau gravel', it was deposited in a system of valleys graded to a higher sea level than that of the present day. (It is seen below that this appears to have been a 70 ft. sea level.) Outside this valley system still higher gravels of earlier origin existed, and some remnant patches of fluviatile and marine 150 ft. and 100 ft. gravels (Everard 1954B) are still to be found just beyond the western and south-western limits of the area. Undoubtedly erosion of these once more extensive sheets supplied the pebbles for the Higher Gravel deposits of this area.

The variation of the height of the base of the Higher Gravel within this area indicates that during its deposition the floors of the valleys dropped from 100′ O.D. in the north-western parts of the area to 80′ O.D. in the south-eastern corner, and possessed a slight lateral gradient.[3]

3. A future publication is planned on the evolution of the river system responsible for the deposition of these gravels and the other drift deposits of this and neighbouring districts.

The south-eastern patches of gravel, with their base at a height of about 80′ O.D., lie approximately 4 miles from the 70 ft. shoreline determined by Everard (1954B, Fig. 4). This distance and the variation of height shown within this area in general indicate deposition of gravel in a system of valleys graded to the 70 ft. sea level. The only exception is the Matley Ridge gravel, which in its eastern part has its base at 100′ O.D., in accordance with the general picture, but rises westward with an increasing gradient to about 140′ O.D. The absence of any break of slope in this gravel precludes the possibility of a higher terrace in the western part, and so this sheet of gravel appears to have been deposited in 70 ft. times on an eastward sloping ridge separating the valley of the Matley river from another valley to the north. This does not accord with the general picture of fluviatile transport and deposition of the gravels within the valleys of that period, and in the opinion of the author this accumulation must owe its origin to solifluxion from a formerly extensive 150 ft. gravel outcrop a little to the west, removed by erosion in 70 ft. times and subsequently.

2. *The Older Alluvium.* There are very extensive areas of Older Alluvium in the district, lying always considerably below the level of the Higher Gravel. In places the width of the deposits and their very slight lateral gradient indicate their accumulation in a system of wide mature valleys. The erosion of these valleys through the Higher Gravel must indicate a drop of sea level from the 70 ft. level, while their maturity and the extensive deposits of alluvium suggest a long period of stability at a new lower level. In the south-east of the area the alluvium lies 35 feet below the base of the gravel, and there seems little doubt that this deposit can be correlated with the 35 ft. sea level recognised by Everard (1954B). In the northern and north-western parts of the area also, the lowest areas of Older Alluvium lie some 35 feet below the base of the lowest parts of the Higher Gravel, but these do not correspond exactly due to alterations of the drainage pattern in the intervening period. Similarly a comparison of the distribution of the Older Alluvium with the present-day drainage pattern reveals numerous differences, strips of the alluvium often marking the positions of old valleys which are now dry.

3. *The Lower Gravel.* The Lower Gravel is generally found resting upon the Older Alluvium, but in places it exists outside the latter and was deposited directly on the solid strata. It is clear from its present distribution that this deposit generally had a more restricted occurrence than the Higher Gravel, often being confined to valleys between remnant patches of the latter, but locally in the north-west and south-east it appears to have achieved a wider distribution. In its formation downhill solifluxion from patches of Higher Gravel may have been important in places, for example on the eastern side of Stephill Bottom where the Lower Gravel accumulated at the foot of the feature caused by the Higher Gravel.

4. *The Newer Alluvium.* The Newer Alluvium occurs in long, narrow strips along the present streams of the area and some former river courses. The deposit differs from the Older Alluvium in its generally less compacted nature and consequent higher content of water. It was deposited in trenches which had generally been cut through the Lower Gravel and down into the Older Alluvium, and this marked down-cutting of valleys clearly indicates a further drop of sea level. In many areas the process of infilling of the trenches is not yet completed and they are represented by belts of swamp vegetation growing in more or less stagnant water.[4] It is therefore clear that the trenches were cut during a period of lower sea level than that of the present.

4. Only in the Beaulieu, Matley and lower Shepton rivers is there any appreciable flow of water, and in the former, at any rate, artificial cutting of the channel cannot be ruled out.

As in the case of the Older Alluvium, some of the strips of Newer Alluvium suggest changes of drainage pattern, and these appear to have come about mainly through river captures during the period of over-deepening of the valleys.

In certain parts of the area one finds that strips of Barton Sand adjacent to the marshy trenches of Newer Alluvium are also saturated, and have some accumulation of peat on their surface (see accompanying map). In other places bands of distinctive types of vegetation are found on the marginal part of the sand, running parallel to the edge of the alluvium.

Some past cutting of peat from the Newer Alluvium and adjacent Barton Sands can be seen in some places and inferred in others. The large area mapped as Newer Alluvium in the northern part of the Bishop of Winchester's Purlieu may have originated partly by peat-cutting, but proof of this would require dating of the subsequent infilling of soft peaty ooze. Near the eastern margin of the Purlieu there is a smaller rectangular strip of obvious cutting, partly infilled by soft peat and sand.

THE ORIGIN OF THE DRIFT DEPOSITS

Everard (1954B) has given a summary (with full bibliography) of previous views on the origin of the gravels of South Hampshire. He has shown that they are partly of fluviatile and partly of shallow marine origin, associated with sea levels above that of the present day. The gravels of the Denny area are not shown on Evarard's figure 1, but a study of their distribution and height in general supports the idea of their fluviatile origin and their accumulation in valleys graded to the 70 ft. and 35 ft. shorelines.

As has been pointed out by Everard (1954A, p. 282) the fluviatile transport of these large volumes of coarse gravel could only have occurred during Pleistocene climatic conditions very different from the quieter conditions of Post-Glacial times. In the opinion of the author the transport of these gravels occurred during glacial periods when southern England was suffering periglacial conditions, with phases of strong solifluxion and abundant melt water: while the alluvium represents deposition under more temperate, interglacial conditions.

The correlation of terraces, gravels and periods of illuviation with particular phases of the Pleistocene is uncertain, since details of the periglacial and interglacial history of southern Britain are not yet fully known. However, the aggradation to the 70 ft. sea level, which is the first recognisable event in the Denny area, has in the Bournemouth area been correlated by Green (1946, p. 93) with the Taplow terrace of the Thames valley. The succeeding 35 ft. level, indicated by the Older Alluvium of the Denny area, would similarly appear to correspond with the Upper Floodplain terrace.

The Taplow terrace is generally agreed to date from the early part of the Last Interglacial and the Upper Floodplain terrace to represent the later part of that period. The Higher Gravel of the Denny area, succeeding the 70 ft. aggradation but preceding the 35 ft. terrace, then clearly appears to correlate with the periglacial conditions indicated by the subarctic Danish Middle Bed (Jessen and Milthers 1928). This period of glaciation in Scandinavia would presumably cause a temporary slight fall of sea level, but the consequent deepening of valleys in southern England might be expected to be confined to their estuarine parts, on account of the brief duration of this episode, and certainly in the Denny area there is no sign of channelling of the 70 ft. landscape prior to or during the deposition of the gravels.

Following the stabilisation of sea level at 35 ft. and the deposition of the Older Alluvium in the later part of the Last Interglacial, the Lower Gravel of the Denny area would appear to represent the periglacial conditions of the Last Glaciation. The glacial stades of that period were accompanied by sea levels below that of the present day, leading to the buried channels and drowned estuaries of southern England. Drowned estuaries are clearly recognisable in the Beaulieu river and in the Southampton Water, where Everard (1954A) found three submerged terraces, which presumably correspond with the three maxima of the Last Glaciation. Such low sea levels have clearly led to the development of the over-deepened channels in the Denny area, which eventually became infilled by Newer Alluvium, but due to the alternation of glacial stades and interstadials and consequent variation of sea level this must have been a complex process.

Even the sea levels of the interstadials appear to have been below the 35 ft. level,[5] and so would help in the cutting back of the valleys through the 35 ft. terrace. Everard's discovery of gravels on the submerged terraces of the Southampton Water indicates deposition of gravel on the floodplains of the rivers of this area during the glacial stades. In the Denny area deep drillings through the Newer Alluvium would be necessary to discover whether these low terraces of gravel extend this far inland, but it is clear that deposition of the Lower Gravel on the mature surface of Newer Alluvium (the 35 ft. floodplain) was followed by erosion and transport of these deposits of gravel once the rejuvenation of the drainage had extended this far upstream. Some further changes of drainage pattern accompanied this polycyclic rejuvenation.

The Newer Alluvium probably represents mainly illuviation accompanying the post-glacial rise of sea level (the Flandrian transgression), but it may also include some deposits of the Last Glaciation—either deposits resulting from illuviation during the interstadials and not completely removed by erosion accompanying lower sea levels of succeeding periods, or perhaps some deposits of the glacial stades themselves preserved beneath overlying interstadial or post-glacial alluvium. The chances of preservation of these fluviatile deposits of the Last Glaciation would clearly be greater in those channels which were abandoned due to river capture. Detailed surveys of the Newer Alluvium by borings and pollen analysis might yield interesting information on the history of erosion and illuviation in this area during the Last Glaciation and Post-Glacial times.

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5. One may be represented by the 15 ft. raised beach of the South Hampshire coast (Everard 1954B, Fig. 1).

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