SECTIONS OPENED ON THE NEW RAILWAY FROM FAREHAM TO NETLEY.

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The following notes are descriptive of a diagram exhibited in the Hartley Institution, and reproduced in the accompanying illustration. The gradients have been neglected in this sketch, excepting where required to express a geological fact.

Fareham railway station is situated on the London clay, near the western extremity of the Portsdown range. Fossils characteristic of the London beds have been found in the neighbourhood, and lately in a digging for brick-earth, opened close to the station, tabular claystone, abounding in shells, has been met with. A collection of them has been made by Mr. H. Keeping; a species of Pinna occurs abundantly and in unusually fine condition, and Pectunculus decussatus and P. brevirostris are also plentiful. Blocks containing these shells have been distributed to several museums.

About eighteen other species have been found, an assemblage evidently characteristic of the London clay, and of not a high horizon in it. It closely resembles the Bognor fauna.

The new line from Fareham to Netley runs to the Titchfield valley in a westerly direction, and thence W.N.W. to the Hamble river, slightly inclined to the westwards of the general strike. The succession of beds from the London clay to the lowest of the Bracklesham series is thus brought into section. West of the Hamble River, the line turns towards the south-west, and higher beds of the Bracklesham series are cut into. With the exception of the somewhat unusual development of a pebble bed in the London clay, and the discovery of abundance of Terebratula in it, the strata so displayed present their ordinary features, and may be compared with those of the section at Whitecliff Bay, to

which they bear a close resemblance. In describing them I adhere to the classification and names at present generally adopted.

A short distance from Fareham the rail enters a cutting, not exceeding 30-ft. in depth, excavated in beds of massive clay, with a pebble-bed, septaria, and fossils. The section was first examined by Messrs. W. Whitaker and T. W. Shore, who determined the clay to be the London. Mr. H. Keeping soon after made considerable collections of fossils, which he considered characteristic of the upper beds of this stratum. No drift overlies the clay, with the exception of a little scattered gravel, the London clay being here as bare as it so often is of high level drift. Sand is found at the tunnel on the Bishopstoke line, probably an outlying portion of the Lower Bagshot, the main outcrop of which lies to the south and west. The hill the new railway intersects is apparently wholly composed of the London beds.

West of Catisfield arch, the section is as follows:—

1.—Stiff clay, blue at the floor of the cutting, weathered green-grey, and brown above, with fossils in a bad state of preservation. This clay extends without important change to the west end of the cutting. Pinna occurs abundantly a few feet above.

2.—Well rounded black flint pebbles, in two seams, in a dark sepia coloured nearly black clay, with dark green grains, and some bright green matter coating and staining some of the pebbles. Ostrea and many other fossils fairly preserved lie among the pebbles; they are also scattered between the two seams in clay two feet in thickness, containing Terebratula 4-ft. The shells are occasionally waterworn.

3.—Blue grey sandy clay. Immediately below the pebble bed masses of Ditrupa, and other fossils; 3 to 4 feet below it, a bed of flattened spheroidal septaria. A variety of fossils lie scattered in the clay, but not forming a bed—Dentalium, Leda, Turritella. The fossils in this bed have often a slight pink tinge, not unlike that of the species from the Venus bed of the Middle Headon series.

The blue clay with Dentalium extends east of the arch, becoming less sandy; it includes occasional septaria, some of which contain wood bored by Teredo. Midway between the arches, in a stiffer brown clay (4) with a conchoidal fracture, occurs a vein of Turritella imbricataria, and below it one of Cyprina, the latter in a poor state of preservation. Ditrupa at several levels. East of this the clay continues to the end of cutting, the bottom of it not being seen.

The pebble bed in some respects resembles the basement bed of the London Clay. There is a recurrence of the

pebbles, green grains, and bed of Ditrupa, which so often occur, associated at the junction of the W. and R. and London beds, though there is an absence of the pellets of red clay. Mr. Meyer (Q.J.G.S., 1871) has endeavoured to show that the London clay of the neighbourhood of Portsmouth may be divided into three series, pebbles occurring at the base of each, and whether this can be maintained generally or not, this cutting clearly furnishes evidence of an upper division of this nature, the pebble bed occupying the same position as bed H at Portsmouth Docks, and the underlying E, F, and G Grains of a green mineral appear at this level at both localities. The pebble bed is overlaid by a stiff clay with Pinna, which gradually changes above to a sand, and is underlaid by a more sandy one, which, as at Portsmouth, contains Dentalium (D). The pebbles rest on an uneven surface of the bed below, and though there is not very clear evidence of an erosion, a slight one may be suspected. There is evidence below the pebbles at Portsmouth of shallow water, the shells being "often slightly worn." Brachiopoda flourished, Lingula at one locality, Terebratula at the other. At St. Denys we have the same fauna, apparently on the same horizon as the pebble bed in the Southampton well, and at Crowd Hill, near Bishopstoke, pebbles are found with a very similar assemblage of fossils.

COMPARATIVE SECTIONS OF PEBBLE BEDS.

Portsmouth Docks. (*Extract from Mr. Meyer's paper*).		Catisfield Arch, Nr. Fareham:
I. Zone of Pinna in clay		bed of Pinna in clay.
2-ft. above pebbles		
H. Rounded black flint pebbles in brown clay 8-inches	9-ft. 4-ft.	pebbles in shelly brown
G. F. E. Shelly sands, with green chloritous mineral Lingula		Terebratula clay with pebbles green grains.
D. Argillaceous sands with Dentalium		Sandy clay with Dentalium
		Septaria, 3-ft. below pebbles.

It is proposed to publish in the next proceedings of the Club as complete a list as possible of the fossils found in this cutting. The fauna clearly resembles that found at Portsmouth Docks, and also more closely that at St. Denys, a fact which furnishes an additional argument for the age of the bed at the latter locality.

Terebratula.—The discovery of the greatest interest is that of a species of Terebratula. This rarity in Eocene beds here occurs almost as plentifully as in some of the secondary. The shells lie for the most part in clusters midway between the two pebble seams, and to this horizon they seem to be confined. The largest patches overlie a species of Polyzoon, to which they were probably attached in a living state. Several such clusters have been found, and though most of the specimens are somewhat distorted through pressure, a good series has been obtained; even the loop can be displayed. This species had previously been found at St. Denys (Hartley Museum). Specimens have been presented to the British Natural History Museum by the Council of the Hartley Institution.

In the excavations for the culvert at the Titchfield river, beds of alluvial clay were opened. At the mouth of the cutting beyond this valley, light blue sandy clay, weathering brown, is in section, apparently the highest of the London beds. In the cutting (6-ft.), light green, grey, and brown sand, in alternate layers, is overlaid by sand free from clay, of a light grey tint. This succession of beds is evidently that from the London clay to the Lower Bagshot sand, the equivalents of beds 4 and 5 of Mr. Prestwich's, Whitecliff Bay section.

The line now takes its course to the Hamble River, over the outcrop chiefly of Lower Bagshot sand, overlaid in places by the clay bed of the Bracklesham (bed 6). The sand occupies the whole of cutting II, except where two small patches of the clay intervene between it and the drift gravel which overlies the whole. It is a very fine light-tinted sand, laid in horizontal beds, with little or no false bedding, stained more or less with iron oxide from the overlying gravel. Close to the eastern end the beds show an inclination towards the Titchfield valley, but this is a local one, and west of the first arch is much slighter, or does not exist. A

few feet only, under thirty, are exposed below the gravel, and the bed is evidently a thin one.

A little west of the first arch the section is as follows :—

Superficial loam and soil. Subangular gravel in sandy matrix, with some pebbles. Ferruginous sand, with light grey partings of clay.	10-ft. Drift.
Mottled light green and brown clay, at one place mottled red, resembling somewhat the Reading beds, a colour due to iron stain. A thin bed of pebbles, a foot of clay below them. Light grey sand.	10-ft. Eocene.

This patch of clay is about 200 yards in length. The second lies on both sides of the next arch, and is a larger one. The surface of the sand rapidly inclines west; small pebbles appear in two thin irregular seams, at the bottom of a bed of sandy clay, and six inches to one foot of lignitic matter rests on the sand. At the arch, the clay occupies the floor of the cutting, and some of it is unweathered and of a bright blue colour. West of it, the sand rises again, the pebbles re-appear, several feet of lignitic clay underlying them.

These clay beds are evidently portions of the Bracklesham (bed 6), either outliers or spurs connected beneath the drift with the main mass of that bed to the southwards.

The Lower Bagshot sand retains its covering of drift, which extends throughout the length of this cutting; probably, the sand being more porous, it is less liable than the clay to form channels for its removal. The drift is about 15-feet in thickness, and consists of the ordinary subangular and iron-stained gravel, in a more or less sandy matrix, and including sand in places, especially at the base. Pebbles occur in it immediately above the sand, occasionally even exceeding the angular gravel, especially at the west end. The gravel is thin, and mixed with clay where it overlies the patches of bed 6. It forms a sheet stretching away to the south, and to the north ending at a scarp. Further west there is no drift in section, but the scarp is to the south of the line, and the drift rises a little.

In the third cutting, a very clear section of the junction of the Lower Bagshot sand with the overlying clay has been obtained :—

1.—Bright brown sandy clay, 10-ft.
2.—Thin bed of pebbles.
3.—Friable shaly clay, 5-ft. The equivalent of the lignitic clay in II.
4.—Sand, light-tinted, and free from clay or ferruginous stain.

These beds show an inclination towards the west at the east end of the cutting, but they are horizontal at the middle of it. At the west end the sand exhibits the effects of the pressure of the overlying clay. A sarsenstone was found here.

The fourth cutting affords a section of the same clay. It forms a massive bed, 30-ft. in thickness, bright blue in colour in the deepest parts of the section, grey, and a bright reddish brown, showing a tendency to mottling in the weathered portion. The blue tint is striking, and more brilliant than that of the London beds in cutting I. The blue clay contains *small* septaria in a partly-decomposed state, with two species of shells, Turritella sulcifera and Ostrea (O. flabellula?) The Turritella also is not rare in the clay, but in too perished a condition for extraction. These species are abundant in the Bracklesham series, near the base of the more fossiliferous portion, but are not sufficient to found an argument upon as to the horizon of this bed.

In the fifth cutting, sand is excavated, overlaid by a deposit of sandy clay, containing angular fragments of gravel. The inclination of the eocene beds is a slight easterly one. It may therefore be inferred that this sand is the Lower Bagshot rising again from beneath the clay of the last cutting.

The section of the eocene beds is the following:—

1.—Brown clay, a small cap at the deepest part of the cutting, 6-ft.

2.—Fine light grey sand, almost free from ferruginous stain, weathering almost white, with drab coloured layers. This sand contains small lumps of carbonaceous matter, and a yellow ferric oxy-sulphate appeared in excrescences on the surface of the sand, after weathering, probably due to the oxidation of pyrites.

The patch of clay (1) is perhaps a relic of the overlying Bracklesham; pebbles are not quite absent at the junction with the sand. In (2) a thin seam of brick-red and green mottled clay occurs. This resembles the W. and R. beds, but more closely some clay I have seen near Iron's Well, Fritham. The colour may be due to oxidation.

On the uneven surface of the eocene beds lies a deposit of sandy clay, containing small angular pieces of gravel scattered throughout, but for the most part crowded on the surface of the underlying sand. This is a rainwash of greater thickness than usual, the result of the redeposition of a portion of the clay and gravel derived from eocene and drift beds in the immediate neighbourhood.

To refer the beds exposed in the last three cuttings to the W. and R. series and London clay, which they in many respects resemble, an upthrow or faulting may be invoked, but the bed of Lower Bagshot sand (5) may be traced along the escarpment, south of the rails, between the second and third cuttings; the published map agrees with this view. Thus a spur or neck of bed 6, stretching towards Swanwick Elm, from the mass of it which enters into the formation of the scarp rising to the south, is cut across by the railway.

A portion of the sixth cutting was moulded over when I visited it; the remainder is in clay of a bright blue tint, very like that in II. and IV., overlaid by a weathered brown, and including a bed of pebbles, a thin seam of sand, and two or three small decomposed septaria. From the similarity of this clay to that in the other cuttings, I consider it the same bed; apparently it overlies Lower Bagshot sand. In a neighbouring brickyard, a light grey clayey sand underlies clay of a mottled brown tint, and a spur of sand projects in this direction from the opposite bank of the river Hamble. The pebble bed is nearly horizontal; the bottom of the clay below it is not exposed, the clay underlying this pebble seam evidently thickening in a westerly direction.

The clay beds overlying the sand are doubtless the equivalent of No. 6 of Mr. Prestwich's Whitecliff Bay section, a bed which, owing to its close resemblance to the London clay, has given rise to some dispute as to which series it should be classed with, but is at present usually associated with the Bracklesham beds. Small shifting and local beds of sand occur in the London clay, and also in the equivalent of bed 6, but No. 5, commonly named the Lower Bagshot, is generally a well-defined one, forming a marked feature in the series, and continuous with that formation in the west. Occasionally, however, this sand, which is thin in the eastern parts of the basin, thins out, and in this case it is not easy to distinguish the two clays. The bed differs considerably from the overlying portion of the Bracklesham, notably in being but sparingly fossiliferous. Small septaria characterize it at Whitecliff as well as in this district, a fact which agrees very well with a deficiency of calcareous matter. The Bracklesham beds proper are highly fossiliferous, but though at the open sections at Whitecliff and Bracklesham Bays the fossil beds

apparently form a definite horizon, it is not evident that they always do. Thus a clear dividing line is not established, and the lower beds remain associated with the overlying series. A well-defined eroded surface, with a massive pebble bed, occurs at the base at Otterbourne and neighbourhood.* Glauconite appears abundantly with the commencement of the highly fossiliferous beds (9); a slight erosion also is observed (O. Fisher, Q.J.G.S., 1862, p. 72 and 76).

On the west side of the Hamble the line runs in a south-westerly direction, afterwards curving westwards to Netley Station. Through cutting VII. it crosses the escarpment, at the north foot of which it has run on the opposite side of the river, and then intersects the gravel-covered plain to the south of it.

The seventh cutting is in ferruginous brown sand, about 30ft. in thickness, thin bedded friable brown clay with a southerly dip occupying the south end. I did not see the junction between sand and clay, it being moulded over at the time of my second visit. The sand may be inferred to be the Lower Bagshot, no other so considerable a mass of it occurring among the eocene beds at this level, unless the possible equivalent of bed 7 ever attains so great a bulk. It is treated as Lower Bagshot on the survey map. The space between the 7th and 8th cuttings may be occupied by the equivalent of bed 6, the base of which is represented at the south end of this cutting, and perhaps the summit in the next. The sand bears on its surface several feet of ferruginous drift gravel.

In the remaining cuttings, various beds of the Bracklesham series are exposed, which it is scarcely possible to so strictly correlate with those at Whitecliff as the preceding.

In the eighth, mottled light green and brown clay and clayey green sand are found, the latter prevailing at the south end; the dip is apparently towards Netley. This bed had commenced to slip at the time I saw it; it may be traced in the neighbourhood, and is probably the same as that which is observed at Netley Cliff, at Woolston, Hill Lane, and other spots around Southampton. There is a small wash of gravel lying on it.

*H. Bristow, Survey Map, No. 11, Pebbles, Bishopstoke.
W. Whitaker, Geol. Mag., 1887, note 2, p. 115.

Light greenish grey sand, with minute black grains in nearly horizontal beds, occupies the first part of the ninth cutting. It weathers yellow and brown, and resembles the glauconitic sand at Hook, on the neighbouring coast. South of the first arch, a friable light brown clay, with surface uneven from pressure of the overlying gravel, rises abruptly, and there is perhaps a small local fault. I could not find evidence of an erosion. This clay is of a very dark blue (blue-black) colour when unweathered, as seen in the trench at the floor of the cutting. It occupies the cutting for some distance, becoming a light ferruginous yellow above, a puce colour at the junction with the blue, a change evidently due to weathering. Next glauconitic sand, apparently the same bed as that at the north end of the cutting, comes on above, the clay dipping beneath it at the south end. Gravel about 10-feet in thickness, rather small and pebbly, covers the eocene beds, thinning southwards and passing into a talus of gravelly brown clay.

The tenth cutting was not completed at the time of my visit. Flint gravel occurs here, underlaid by some glauconitic sand. I have not examined any of the gravel beds closely, with a view to ascertain whether they contain any other mineral or rock fragments. I have not seen any boulders.