MEMOIRS OF THE GEOLOGICAL SURVEY. ENGLAND AND WALES. SOILS AND SUB-SOILS, FROM A SANITARY POINT OF VIEW

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HORACE B. WOODWARD

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ENGLAND AND WALES.

SOILS AND SUB-SOILS

FROM A SANITARY POINT OF VIEW;
WITH ESPECIAL REFERENCE TO
LONDON AND ITS NEIGHBOURHOOD.

By
HORACE B. WOODWARD, F.R.S.

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PREFACE.

At the Offices of the Geological Survey constant enquiries are made by the public for information regarding sites for houses and other questions involving the practical applications of geological science. In view of this great and ever-increasing demand for advice, it seemed desirable to put in popular and accessible form a summary of what is known as to the relations between the nature of soils and sub-soils and the sanitary requirements of the community, and to select, for the purpose of illustrating the subject, the district of London and its suburbs.

Accordingly, Mr. Horace B. Woodward has prepared the present treatise. His long connection with the Geological Survey has given him special fitness for the task. Besides a wide acquaintance with the geology of the southern half of England, he formerly took part in the detailed mapping of the London area, and in his capacity as Resident Geologist at this Office he is now thrown into daily contact with those who are practically engaged in well-sinking, draining, building, and other occupations in which geological assistance is sought for. He has thus been able to gather much general information on the subjects discussed in the following pages, his own personal observations being supplemented by those obtained from medical officers, engineers, and architects, as well as from house-hunters, who have communicated their various experiences.

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In the preparation of this hand-book to the soils and sub-soils of London and its neighbourhood the author has consulted the valuable "Transactions of the Sanitary Institute" and other works, and among those individuals to whom he is more particularly indebted for assistance he desires to express his thanks to Dr. James Murie, Mr. Harold L. Barnard, M.R., F.R.C.S., Mr. George Abbott, M.R.C.S., Mr. Frederick Meeson, Architect, and Mr. W. Whitaker, F.R.S.

The small sketch-map which accompanies this pamphlet may serve as a guide to the more detailed information contained in the larger maps of the Geological Survey. A full index has been added, in which the heights are given of all places mentioned on the map or referred to in the text.

ARCH. GEIKIE,
Director-General.

Geological Survey Office,
28, Jermyn Street,
London, S.W.
6th November, 1897

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INTRODUCTION.

THE problem of choosing a place of residence exercises the minds of many whose homes are not fixed by the bonds of inheritance nor by the necessities of their mode of livelihood.

In every civilized country a constantly increasing proportion of the population has to seek abode within a certain limit in or near some large town or city. Together with this aggregation of humanity around crowded centres it has slowly been realized that especial attention requires to be paid to the sanitary conditions which depend on the nature of the sub-soil. Around London, for example, the idea has become widespread that a site on Chalk, on gravel or sand, or on some other dry and porous material is to be preferred to one on clay. Increasing attention is now given to the subject by Architects and Physicians. Nevertheless, a good deal of misapprehension exists with regard to the advantages of gravel as a sub-soil, and of the disadvantages of clay: in certain circumstances either may be good, or both may be bad as sites for houses.

The object of the present little work is therefore to supply such information as may be needed by those who are compelled to be careful in the choice of their place of residence. All house-hunters indeed would do well to consider the general sanitary conditions connected with proposed sites; and to bear in mind that a healthy habitation depends on several considerations, apart from the nature of the sub-soil. There are the elevation of the ground and other local circumstances, and more important still the construction of the house itself, its damp-proof basement, its airy and sunny position, and the system of drainage. Lastly, the water-supply is a question of vital importance.

LONDON AND ITS NEIGHBOURHOOD.

London being the chief centre of attraction to Britons, it is desirable to describe in some detail the nature of the various sub-soils which occur over the large area embraced by the city and its suburbs.

If we take the district known at the General Register Office

as "Greater London," we have an area of 701 square miles, including "all parishes wholly comprised within a circle of 15 miles from Charing Cross, and all other parishes of which any part is included within a circle of 12 miles radius from the same centre." * Barnet on the north, Barking on the east, Croydon on the south, and Staines and Uxbridge on the west, come within the range of Greater London.

By far the larger portion of this area may still happily be regarded as rural, for the thickly populated region, now known as the County of London, extends over no more than 121 square miles.

This nucleus of Greater London requires distinct treatment with regard to the sanitary conditions of its sub-soils. In the "Outer Ring," which includes the large area outside the home-county, nature still exercises a good deal of sway. In the County itself, which may be spoken of simply as London, nearly all is changed. Some forty or more villages have been merged in one vast concourse of buildings; and it may be said that few areas are so little influenced by the *original* soil and subsoil, as this densely populated metropolis. The streams no longer course in the open, but the rainfall, whose access to the soil is arrested over so much of the area, is diverted, together with the ancient brooks, into subterranean channels. In some parts, indeed over extensive areas, the sub-soils have been dug up for "ballast" or gravel, as at Kensington, and for brickearth as at Highbury, and the pits have been filled with rubbish. Elsewhere new buildings have been erected on the crumbling remains of old houses, so that over a great part of London the soil is what is known as "Made Earth" or "Made Ground."

So much of the soil being thus of artificial origin, it is evident that geological maps can possess but little value in reference to sites suitable for houses in a large city. Such a map of London, for instance, may depict an area of gravel or of loam (sandy clay or brickearth), while on the site of a particular row of buildings there may have been a gravel-pit or a brickyard. Thus, a house standing on some 6 or 8 feet of "Made Ground" over gravel may be no better and may be a good deal worse, as regards its sanitary conditions, than one situated on a similar thickness of more ancient "Made Ground" over clay. A house built directly on clean London clay, with a good cemented basement, may be decidedly better.

Geological Considerations.

Various earths or strata appear at or near the surface in different parts of the area, and these are represented on the map accompanying this work. The *soil*, which comprises the superficial layer of mould and the more or less disturbed earth, is not distinguished. Practically it covers the entire area.

The *sub-soil* is the earth which lies directly beneath the soil. In the area under consideration it may consist of gravel, sand

* Report of the Royal Commission appointed to inquire into the Water Supply of the Metropolis, 1893, p. 5.

sandstone, loam, clay, silt (sandy mud), marl (calcareous clay), peat, or chalk. Several distinct layers or groups of gravel and sand, sand and sandstone, loam, clay, &c., are met with. Belonging to different periods in the earth's history they are known individually or collectively under such group-names as the Bagshot Beds, London Clay, Gault, &c. It may, however, be taken for granted that the character of each tract of clayey land, apart from other circumstances, is practically the same, whether composed of Weald Clay, Gault Clay, or London Clay; and the same may be said of sandy areas, whether formed of Bagshot Sand or Thanet Sand. The sub-soils will therefore be treated with regard to their natural characters, and the text will be arranged in accordance with these rather than with geological age or sequence. A few remarks on the structure of the London area may, however, serve to render the subject more intelligible.

London is situated in what is termed in geological language a "basin"—the "London Basin." The solid foundation at some depth underground (150 to 300 feet, and less in places) is composed of the Chalk, a formation here about 650 feet in thickness. This it is which constitutes the so-called basin, whose broad rim comes to the surface in the Chiltern Hills on the north and north-west, and in the North Downs on the south. (See Fig. 1.) The basin is in reality an irregular and broken one, for the framework of eastern England comprises only the western portion of it, the eastern part being covered by the German Ocean; while to the south-east of London a part of the basin is fractured, as the Chalk, through disturbance of the strata or "faulting," appears at the surface in the midst of the area near Charlton and Lewisham. The general structure of the Basin is shown in the accompanying section drawn from north to south across London (Fig. 1).

Beneath the Chalk there occur in succession the Upper Greensand, Gault clay and Lower Greensand; and they are based on the south side of London, on the Weald Clay and Hastings Beds, which form the great area known as the Weald in the south-east of England. The strata all outcrop, or appear at the surface of the ground, successively from below the Chalk escarpment of the North Downs; while the Upper Greensand (in places), the Gault, and Lower Greensand occur below the Chalk escarpment of the Chiltern Hills beyond Wendover, Tring, and Dunstable. In parts of this area north of London the Lower Greensand rests on the Oxford Clay; a stiff clay of considerable thickness which does not elsewhere appear in the district to which attention is now directed. These older strata form part of the framework of south-eastern England outside the rim of the London Basin. Together with the Chalk they are grouped with the Secondary formations.

The hollow of the basin is filled by a series of sedimentary formations, which are classed as Tertiary. Conforming generally to the gentle fold into which the Chalk has been bent (see Fig. 1), they consist of a lowermost group of sands, pebble-beds, and clays (8), known as the "Lower London Tertiaries," and