Gault, and along the ridge the party proceeded, passing the old and extensive Merstham Chalk quarries, exposing a fine section of the Lower Chalk, until the London Road was reached. Almost coincident with the road a considerable fault is indicated by the boundaries of the formations, and a depression in the Downs in the line of this fault forms the Merstham Pass, through which the road runs to London.

Near Merstham the impervious bed of the Gault is indicated by a pool of water supplied by a neighbouring spring. At the picturesque village of Merstham the party rested, and after a refreshing meal left for London by train.

REFERENCES.

Geological Survey Map, Sheet 8.

Ordnance Map, New Series, Sheet 286.

The Oldhaven Beds and Upper Greensand are described by Mr. WHITAKER in 'Proc. Geol. Assoc.' Vol. v, p. 495.

EXCURSION TO INTERNATIONAL HEALTH EXHIBITION.

SATURDAY, JUNE 28TH.

(*Report by C. E. DE RANCE, F.G.S., Assoc. Inst. C.E.*)

The meeting was attended by the President, Dr. Hicks, F.G.S., and the Secretary, Dr. Foulerton, F.G.S., and was met in the Water Company's Pavilion by Colonel Sir Francis Bolton, C.E., Water Examiner to the Local Government Board, and Director of the Hydraulic Department of the Exhibition, and by Mr. De Rance, Assoc. Inst. C.E., F.G.S., member of the General Committee of the Exhibition.

The building was octagonal in shape, each side representing a distinct Water Company, and it was approached by four entrances, the entrance-doors of the outer corridor being flanked by cast-iron mains, placed vertically, ranging in diameter from 13 inches to 48 inches. These trophies, flanked with ferns, had a very imposing and novel effect.

In one portion of the outer corridor was an interesting exhibit, lent by the "Aqueous Works and Diamond Rock-boring Company Limited," including cores from some of the borings round the Metropolis which have proved the Palæozoic rocks under the Secondary rocks underlying the London basin. The rough black diamond,

called "carbonado," is the cutting instrument used. This peculiar form of carbon was discovered in the Diamond Gravels of Brazil, in 1842, and appears to be a transition between the ordinary diamond and graphite. The "crowns," or cylinders of soft steel, in which these are imbedded were also inspected. As they are used the diamonds sink back into the steel, from which they are again brought to the surface by filing. One crown, of 22 inches diameter, with five diamonds in it, ready for work, was noted, as were also a diamond drill, and a core-extractor for breaking off and raising the cores, which are now lifted in lengths of many yards.

Much interest was felt in a case of specimens passed through in the bore-hole at Streatham, exhibited by the Southwark and Vauxhall Water Company, who sent it specially for the visit of the Association, at the request of Sir F. Bolton.

The following section has been constructed from the samples by Mr. G. F. Harris, a member of the Association :—

		ft.	in.		ft.	in.	
London Clay to 159 feet.	1. Gravel and Mud	...	10 0	19. Hard layer of Shells	...	0 3	Wool- wich and Reading Beds, to 204ft. 6in.
	2. Yellow Clay	...	6 0	20. Oyster Shells	...	1 3	
	3. Blue Clay	...	62 0	21. Greensand	...	2 6	
	4. Blue Clay and Sand	...	25 0	22. Mottled Clay	...	2 6	
	5. Claystone	...	1 0	23. Conglomerate, Shells, &c.	...	0 3	
	6. Blue Clay	...	22 0	24. Clay Shellsand Grey Sand	...	5 6	
	7. Blue Clay and Sand	...	33 0	25. Sandy Clay	...	1 3	
Basement Bed, or possibly Oldhaven & Blackheath Beds, to 160-9.				26. Black Clay and Shells	...	1 6	
	8. Pebbles	...	1 0	27. Mottled Clay	...	19 6	
	9. Pebbles and Shells	...	0 3	28. Hard Peaty Clay & pebbles	...	0 6	
	10. Conglomerate	...	0 6				
Wool- wich and Read- ing Beds.	11. Black Clay and Shells	0	9	29. Claystone and Greensand	2	0	Thanet Sands, to 211ft. 6in.
	12. Conglomerate	...	0 6	30. Hard Greensand	...	6 0	
	13. Hard Conglomerate	...	1 0	31. Very hard Sandstone	...	0 6	
	14. Black Clay and Shells	1	0	32. Grey Sand	...	13 3	
	15. Black Clay and Sand	0	3	33. Black Sand	...	2 6	
	16. Black Clay and Shells	3	3	34. Grey Sand	...	13 3	
	17. Hard Shells	...	0 3	35. Flints (green-coated)	...	...	
	18. Black Clay and Shells	1	9	36. Chalk.			

Water-pipes of wood, stone, and concrete were examined with curiosity. The distribution of a domestic water-supply in London dates back to Peter Morrice, who in 1582 created waterworks for the City of London by means of pumps actuated by water-wheels placed in the first two arches of London Bridge. He distributed the water under pressure through leaden pipes, but these were replaced eventually by wooden pipes consisting of trunks of elm-trees, cut into lengths and bored longitudinally to an internal diameter of from 6 to 12 inches, in accordance with the pressure they had to bear, the lesser thickness on higher ground, where the pressure was little, the

greater on the low ground, where the pressure was extreme. The joints were made by cutting the end of a tree into a cone-shape, and making a corresponding hollow into the next to fit it. The New River Company laid down pipes of this class in 1628, and eventually had 400 miles of them; but they were found to only last twenty years, so that the company must have renewed at least twenty miles each year; and, moreover, owing to the small size of the internal bore of the thick pipes, when they had to stand any pressure, it was necessary to have, in many cases, no less than eight or nine lines of pipes to provide the requisite supply. The leakage and waste from these was a very serious item, and the more objectionable from there being no drainage in those days. In 1820 the whole of these pipes were taken up by the New River Company, and replaced by cast-iron mains, but though this was a great advance, they were rough and full of imperfections, being cast horizontally, and often far from symmetrical, and they are as great a contrast to the specimens of the mains now used as can be well imagined.

In the outer corridor were exhibited hydrants, valves, and water meters, and especial attention was called to the "Deacon's Waste Water Meter," which is at once not only a waste-detector and localiser, but also a self-acting registrar of the exact extent and amount of waste at any particular spot. It is a self-acting registrar of the velocity at which the water is passing through it at any moment, the results being registered by a diagram on a sheet of paper, placed on a drum worked by clockwork. It is so sensitive that the opening of a single tap in a main supplying 3,000 to 4,000 persons is at once shown by a drop in the line.

The interior of the Pavilion was decorated with some picturesque views of the various Waterworks Stations on the banks of the Thames. At the angles of entrance of the various doors are sections of the actual materials used in the filter-beds of the various Companies.

Filters have been used in the arts from time immemorial, the oldest contrivance of this sort being now known as the "jelly-bag," and the word may be etymologically traced in most languages to the word "felt," *i.e.*, pulled wool. The first "filter-bed" made in London was constructed by the Chelsea Company in 1829, and since then all the London Companies have erected filter-beds.

The Chelsea filter-bed section is as follows :—

				ft.	in.
1. Fine Sand	...	...	...	3	6
2. Shells	...	...	...	0	4
3. Shingle	...	...	...	2	0
4. Coarse Shingle	...	...	...	2	2
				<hr/>	
				8	2

The Fine Sand is taken from the Thames, and when charged with impurity is cleaned with a hose. No. 2 is used to separate No. 1 from No. 3, which is gradually increased in coarseness, to prevent the pipes being clogged. The rate of filtration is two gallons per hour.

An analysis of the sand by Mr. Wethered, F.G.S., shows that it contains of

Silica	...	...	...	...	90·05
Alumina	...	...	...	...	·40
Oxide of Iron	...	...	...	...	6·90
Carbonaceous Matter	...	...	...	...	·70
Carbonic Acid	...	...	...	...	1·50
Magnesia	...	...	...	...	·01
Moisture	...	...	...	...	·26
					<hr/>
					99·97

The process is purely mechanical, and due to the oxygen of the air lodging between the grains of the sand.

In the retiring angle, south of the entrance, was a specimen of a flexible pipe, as used by the Southwark and Vauxhall Company; and, in the retiring angle to the north, a complete section of a main, as used in a London street, was pointed out, with the necessary cocks and appliances, and also a complete section of a house, supplied with fittings, as required by the Metropolis Water Act of 1871. The Pavilion was left by its principal doorway on the east side, which was in the form of a Gothic arch, constructed entirely of drain-pipes, joints, and bands used by the Companies for the supply of water. After inspecting the largest pump ever constructed, for the great outfall works at the mouth of the Thames, a vote of thanks was proposed by the President to Sir Francis Bolton, and suitably acknowledged. The party then left for the Belgian Court, under the guidance of Mr. De Rance. Attention was drawn to educational appliances for teaching geology used in the normal schools, consisting of contour maps, models, collections

of minerals from Vielle Montagne, or Altenburg Calamine deposits, between Aix-la-Chapelle and Verviers, and other districts yielding metallic ores, rock-specimens and fossils of various geological ages, and an interesting collection of neolithic implements, and a few of palæolithic age. In the case of metals, the manufactured material was in each case shown by the side of the raw material, the locality of the latter being written on each specimen, with its "usage" on the label. Mr. De Rance then referred to the contorted Z-shaped bendings of the Belgian Coal-measures, and the long and narrow troughs in which they occur.

Attention was then drawn to the exhibit of the Porter-Clark process. The modern invention for carrying out the Clark process, which was patented by Dr. Thomas Clark, of Aberdeen, in 1841, may be described as the application of machinery to the saving of time, space, and labour. Of those in general use, the Porter-Clark process comes first in order of date, and is probably the most generally adopted. In the ordinary Clark process lime-water, in known quantity, is first admitted into a tank, to which the water to be softened is added, not less than sixteen hours being required for the softening and subsidence of the matters separated from the softened water. In the Porter-Clark modification, instead of allowing the particles of carbonate of lime to separate and subside, a brisk agitation is maintained, so that these particles remain in suspension to permit chemical reaction with the lime and the purification of the hard water, which is passed onward to filter presses, where the carbonate of lime adheres to the filtering cloth. The subsequent operation of filtering through the deposit on the cloth then takes place, and the water is passed away at once in a fit state for use, so that the process is continuous in action; any quantity may be carried on just as quickly as water can be pumped from a well, provided the apparatus is of sufficient capacity to allow time for the water to remain in contact with the lime in passing through the machine. The lime, in this case, is passed through horizontal cylinders, which are termed lime-churns, and is constantly churned up with the water, and the lime-water so made is, by suitable arrangements, allowed to mix with the ordinary water in proper proportions, after which it is again agitated. The apparatus is now in use at Edge Hill, Liverpool, where the London and North Western Railway filter 15,000 gallons per hour, or more than a ton a minute, for use in their Lime Street Hotel, and for the locomotive-

boilers, the area of the works only occupying a space of 40 feet by 25 feet.

Another modification of the Clark process, that of M. Maignen, was noticed at work. In this system of filtration, a powder called "anti-calcaire," is used, of variable composition, in order to meet the special characteristics of the water to be treated; the ingredients used for ordinary hard water being lime, soda, and alum, in suitable proportions. The apparatus is used for softening the water in some of the fish-breeding tanks; the water entering the apparatus gives motion to a water-wheel, which, in its turn, works an arrangement for distributing a given quantity of the softening agent, and causing it to pass into the water. The water is then allowed to subside in a small tank, and is then filtered through filters lined with asbestos cloth, a part of the carbonate of lime and magnesia deposited from the water adhering to the filtering surface, and the softened water filtering through it.

When the opening day of the Fisheries Exhibition approached, it was found that the aquarium would not be ready; the sea-water in the tanks was very muddy, partly on account of the sediment in the water, as it came in barrels from Brighton, and partly through suspended particles of cement detached from the new rock-work in the tanks. The water was passed through Maignen's *Filtre rapide* with excellent results. It was also used for the freshwater tanks, causing a parasitic disease that attacked the fish to disappear.

The fountains were next visited, the water-supply for which is obtained from the West Middlesex Water Company, by means of a nine-inch main, which is connected with one of their mains in Kensington Road. It passes through three 8-inch Tyler meters, which measure it for payment, with the least possible loss of pressure. From them it passes under the water of the central lake to the chamber in the middle, which is 20 feet square. It there branches into three pipes, two of nine inches diameter and one of six inches, the two former uniting at the end of the room, and forming the main from which the supplies for the four rings of jets in the basin, and for the jets on the top of the chamber are obtained, and the third branch being gradually reduced to three inches, and supplying the central jet only. Cutting off the supply to the four corner jets, over the chamber, causes the centre jet to jerk up suddenly 30 feet higher than the point it reaches by the pressure of the mains alone.