new source of ionisation, but this is not so. The effect is due to the shrinkage of the outer layer of the atmosphere due to cooling, which brings about a concentration of both molecules and electrons. (Note that wireless methods measure not total ionisation but maximum ionisation per unit volume.) It is found that the concentration of electrons due to upper-atmospheric shrinkage can more than offset the dilution due to recombination processes, and an actual maximum of ionisation content is attained in winter, shortly after midnight. In midsummer no such marked cooling process takes place (for the sun never sets at heights of above 250 km.) and the ionisation (apart from occasional increases which are probably due to a nocturnal ionising agency) is generally found to decay steadily.

The theory of marked temperature changes also suggests an explanation for the curious alteration of structure which Region F undergoes on a summer day. It was shown in 1933 that there is found in our latitudes a subdivision of Region F during daylight in summer. When distinction is necessary we refer to the lower part, which forms a kind of 'step' on the upper part, as Region F_1, while the upper stratum is referred to as Region F_2. Since Region F_1 is found not to exhibit marked temperature changes, it is quite possible that the subdivision is partly, if not wholly, the result of the difference of the temperatures at the two levels, Region F_1 being at the lower temperature and Region F_2 at the higher temperature. According to this view, Region F_2 is, as it were, part of the main Region F forced upwards by expansion. At night, when the atmosphere shrinks, the two regions tend to merge into a single simple region. It is thus not improbable that differences of temperature in the atmosphere, as well as differences in molecular constitution, play a part in causing the composite structure of the ionosphere.

It might appear that these extraordinarily large changes of temperature at high atmospheric levels could not possibly have any influence on wireless communications, but such is not the case. Due to the expansion of the upper atmosphere on a summer day, the maximum electronic density, which determines the shortest wave-length usable in round-the-world communication, is abnormally low, and we are therefore unable to use a valuable range of short wave-length channels. Fortunately, however, Nature provides us to some extent with a form of compensation, for it is found that in summer there is very frequently produced a curious highly-reflecting stratum about the level of Region E, which provides abnormally favourable transmission conditions for short waves. But such conditions do not occur daily and so cannot be relied on wholly to remove the unfavourable conditions brought about by the solar heating and expansion of Region F_2 on a summer day.

Implementiferous Gravels of the Vaal River at Riverview Estates

By Prof. C. van Riet Lowe, Bureau of Archæology, Dept. of the Interior, Johannesburg

TOWARDS the end of April last, Mr. F. W. Webber, chairman of Carrig Diamonds, Ltd., very generously presented a collection of stone implements and a variety of deeply mineralised faunal remains to the Bureau of Archæology recently established at the University of the Witwatersrand. These had been recovered from diamondiferous gravels on the property of Carrig Diamonds, Ltd., at Riverview Estates on the left bank of the Vaal River immediately opposite Windsorton (lat. 28° 20′ S., long. 24° 44′ E.) shown on the accompanying sketch plan (Fig. 1). As similar remains were still being recovered, I immediately requested Dr. S. H. Haughton, director of the Geological Survey of the Union of South Africa, to accompany me to the site with the object of a detailed investigation. Mr. F. W. Webber had kindly offered to accompany and guide us, and an examination of the area was accordingly carried out during the second week in May.

The ancient gravels were found to be extremely rich in implements and faunal remains, and the occurrence, as a whole, unusually interesting and embracing. Until we are in a position to publish detailed reports, however, the following occurrences are noteworthy.

1. The 60 ft. terrace, shown as Site No. 5 on the accompanying 'composite sections' drawing (Fig. 2), comprises a thin layer of gravels that caps the old peneplain some sixty feet above the present flood plain. Inclement weather precluded the possibility of a thorough examination, but in the time at our disposal we were unable to find even traces of the manufacture of stone implements.

2 (*a*). In the lower terrace, actually an old river gravel, marked 'G' on sections 1, 2, 3 and 4 in Fig. 2, we recovered a few heavily rolled Lower Stellenbosch (Chelles plus Clacton type) tools and a great abundance of rolled and unrolled Upper

Stellenbosch (Acheul plus Proto-Levallois type) tools and the completely mineralised remains of a variety of extinct animals which Dr. Haughton will describe when he publishes his geological and other data.

In this Upper Stellenbosch congeries we have further definite proof, were this indeed required, that the so-called Victoria West industry merely represents the factory-site debris of the Upper Stellenbosch culture[1], for in addition to very many fine hand-axes and cleavers worked on flakes, we found numbers of detaching hammers and typical Victoria West cores from which the flakes (large and small) used for these axes and cleavers were struck. Several cores are normal in size, that is, up to about 9 in. in length, but others are more than 15 in. long by 8–10 in. broad and deep and up to 150 lb. in weight. Twelve-inch flakes were struck from these great cores—cores frequently trimmed in typical Victoria West fashion *before* the flakes were removed. The materials preferred comprise varieties of Ventersdorp lava and quartzites, the weathering properties of which are entirely different from those of Victoria West (Karroo) dolerites, where insolation is common. No doubt whatever can be cast upon the purposeful shaping of these cores as a preliminary to the removal of the flakes that were ultimately trimmed into hand-axes and cleavers that vary from about three to ten inches in length.

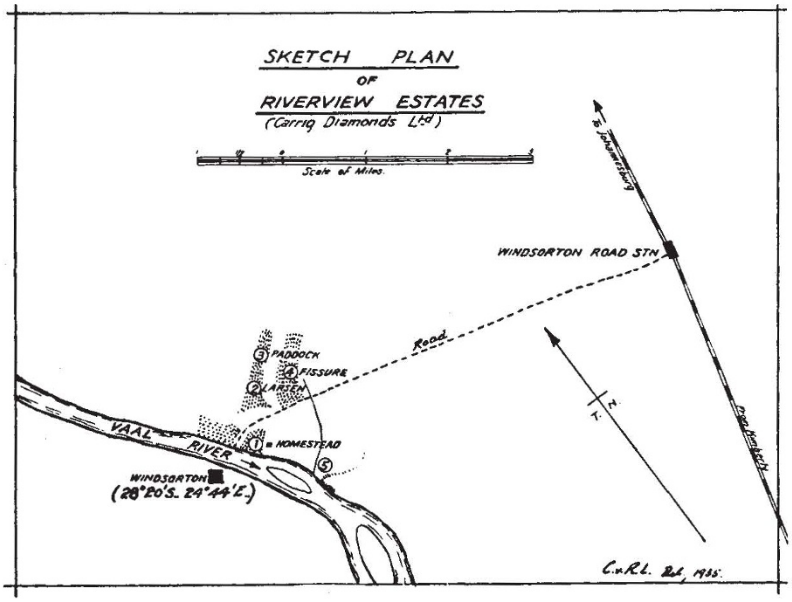

FIG. 1.

It is this technique that I have in the past referred to as Proto-Levalloisian[2]—a highly specialised technique that enabled the manufacturers to produce axes or cleavers at will—a technique apparently unknown out of South Africa, though, I must confess, I suspect its occurrence in southern India. Once this special technique is understood and it is realised what a great proportion of the tools are cleavers, the necessity for breaking away from the use of such terms as 'Chellean' and 'Acheulean' will be more readily appreciated.

(*b*) The occurrence of rolled and unrolled implements and factory site debris at all levels in the gravels establishes the fact that the makers of Upper Stellenbosch tools occupied the valley before and during the deposition of these gravels. Dr. Haughton is equally satisfied that the animals, the fossil remains of which we recovered, also occupied the valley during this period. The animal remains include horse, buffalo, antelope, at least one large carnivore, hippopotamus, etc.

3 (*a*). Overlying these ancient gravels is a layer of silt and calcareous tufa that varies appreciably in texture and depth. But for a single *biface* (not seen) reported by Mr. Larsen as having been found at a depth of 15 ft. below the natural ground surface at Site No. 2, the silts and tufas of Sites Nos. 2, 3 and 4 appear to be sterile. At Site No. 1, marked 'Homestead' in Fig. 2, the silt is a loose sandy soil that is subject to movement by wind and rain. At Site No. 2 ('Larsen'), the silt is well consolidated and toward the surface passes into a calcareous tufa. The fact that 35-ft. high walls remain vertical without supports is illustrative of the high degree of consolidation. Except for three feet immediately over the gravels, penetration can only be effected by means of picks. This is largely, if not wholly, due to the formation of calcareous tufa in the deposit. Larsen's Site (No. 2) is probably the most interesting.

The diamondiferous gravels occur 35 ft. below the present ground surface and extend laterally over several acres, at a distance of 1–1½ miles from the river. They are reached by vertical shafts through the calcareous tufa and silt, and are 'worked' by means of tunnels. Shafts are sunk at fairly close intervals and intercommunication is maintained until the gravels are 'worked out' or a collapse occurs. We were able to walk about in these underground corridors, and with the aid of torches, to examine the undisturbed gravels in comfort.

At Site No. 3 ('Paddock'), situated about a quarter of a mile from Site No. 2, the excavation is a huge open hole the walls of which are vertical and the silt therefore obviously also well consolidated. Immediately above the gravels the silt is a fine, clean sand—water-worn and false-bedded. Higher up the calcareous tufa occurs again. All these walls, both in shafts and open excavations, appeared to be sterile.

Between Sites Nos. 3 and 4 there occurs a barren patch, and at Site No. 4 the gravels and silt alternate as shown.

(*b*) At Site No. 1 ('Homestead'), the silt and later loose sand that cover the surface yielded a complete assemblage of Lower Fauresmith (mainly Micoque and Old Levallois type) tools. As this is only the second discovery of Stellenbosch-Fauresmith stratification, it is most important. The first was recorded six years ago[3]. Small and well and neatly trimmed hand-axes, two cleavers, a scraper, several Levallois type flakes, fabricators, etc., were recovered—a good assemblage in a stratum very much more recent than the underlying gravels with their Upper Stellenbosch remains. The tools are almost exclusively of indurated shale (lydianite), though lava and quartzite appear also.

4. Lying entirely on the natural ground surface or just below the superficial shifting sands at Site No. 1 and at the foot of the scarp at Site No. 5, I collected deeply weathered Middle Stone Age (Late Levallois cum Moustier type) and slightly weathered remains of the Middle Smithfield (Capsio-Aurignacian type) culture.

The Middle Stone Age material is recognisable, but somewhat nondescript—mainly unworked flakes and a few small and inferior cores—but the Later Stone Age (Smithfield culture) comprises the usual variety and number of duckbill end-scrapers, side- and thumbnail scrapers, one bored-stone, one grindstone and one well-worked elongated phallus-like cylindrical artefact, truncated at one end and nosed at the other, $8\frac{1}{4}$ in. long with a maximum diameter of $2\frac{1}{4}$ in.

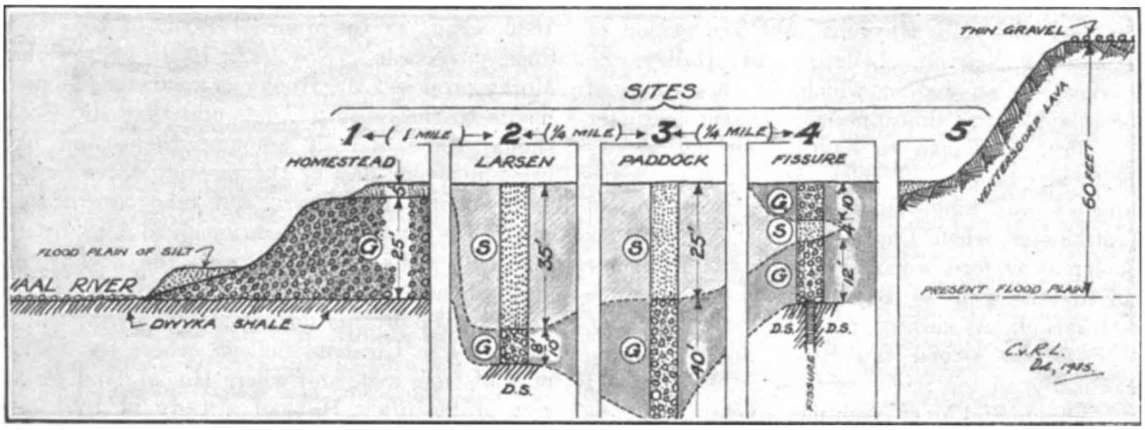

FIG. 2. Composite (diagrammatic) sections of the left bank of the Vaal River at Riverview Estates

SUMMARY OF STRATIFICATION

1. Slightly weathered Middle Smithfield (Capsio-Aurignacian type) and much weathered Middle Stone Age (Late Levallois cum Moustier types) on surface at Site No. 1 and at foot of scarp at Site No. 5.

2. Deeply incrusted Lower Fauresmith (La Micoque cum Old Levallois types) in silt and loose sand capping gravels at Site No. 1.

3. Rolled and unrolled Upper Stellenbosch (Acheul plus Proto-Levallois type) implements and factory-site debris (Victoria West cores ≡ Proto-Levallois technique) and heavily rolled Lower Stellenbosch (Chelles plus Clacton-like flakes) throughout gravels at Sites Nos. 1, 2 and 3.

4. Three heavily rolled Clacton-like flakes of the Lower Stellenbosch recovered from mounds of 'worked' gravels removed from Site No. 4 after excavation. Horizon unknown.

In submitting this preliminary report, I do so with the hope that the larger and more detailed publications will not be long delayed. Dr. Haughton has very kindly undertaken to deal with the geology, palæontology and climatology of the area and the periods affected, and in doing so will, I have no doubt, add weight to my oft-expressed opinion that such closely related major problems as these that do not fall within the strictly specialised field of the prehistoric archæologist *qua* archæologist, should be left entirely to the other specialist or specialists concerned. It is only with the fullest support of the pleistocene geologist that the archæologist can hope to solve the problems of early human cultures not only in Africa but also elsewhere.

In conclusion, I would like to express my great indebtedness to Mr. Webber and to Messrs. R. W. Hardy and Larsen, who put themselves, their discoveries and vast knowledge of the 'diggings' entirely at our disposal. To Mr. and Mrs. Hardy we are deeply indebted for hospitality during a particularly inclement week.

[1] Van Riet Lowe, C., "Fresh Light on the Prehistoric Archæology of South Africa", *Bantu Studies*, **3**, No. 4, 388; 1929.
[2] "The Prehistory of South Africa in Relation to that of Western Europe", *South African J. Sci.*, **29**, 756; 1929.
[3] Van Riet Lowe, C., "Notes on the Archæology of Sheppard Island", *Ann. South African Mus.*, **27**, 235; 1929.

Tercentenary of Robert Hooke, 1635-1703

OF all the scientific worthies of the seventeenth century, none will be remembered longer than Robert Hooke, whose views and activities influenced the progress of scientific thought and practical physics in an incalculable degree. Somewhat younger than Boyle, Wilkins, Wren, Mariotte, von Guericke and Huygens, but the senior of Flamsteed, Newton, Leibniz and Halley, he belonged to an age in which, in the words of Macaulay, "it was almost necessary to the character of a fine gentleman to have something to say about air-pumps and telescopes". Born when James I was king, Hooke was a schoolboy in Westminster when Charles I was beheaded, a scholar at Oxford when Cromwell was Protector and an assistant to Boyle at the time of the Restoration. As curator, and sometime secretary, he faithfully served the Royal Society during practically all the reigns of Charles II, James II and William and Mary, and died a year after Anne ascended the throne. Affairs of State and Church, however, made little difference to Hooke, and in the main his life was taken up with writing, lecturing and experiment. In the records of the first forty years of the Royal Society, no name is more frequently met with than his, and in his various capacities of curator, Gresham professor of geometry and Cutlerian lecturer on mechanics, he probably delivered more scientific discourses and made more experiments than any other man of his day. His influence was felt both at home and abroad, and the story of his life belongs to the history of our race in the same way as those of his contemporaries Dryden, Locke, Evelyn and Pepys.

Hooke was the son of the Rev. John Hooke, a curate of Freshwater, Isle of Wight, where he was born on July 18, 1635. He was a somewhat delicate child, and was kept at home until his father's death in 1648, when, after a short time with Lely, the portrait painter, he entered Westminster School and thus came under the famous Dr. Busby. Studious and inventive far beyond the average, at eighteen years of age he became a chorister and servitor at Christ Church, Oxford, and during the next eight or nine years gained the friendship of Wilkins, Ward, Willis, Petty, Boyle and other men of science, whose meetings at Oxford had much to do with the inauguration of the Royal Society in 1660.

The turning point in Hooke's career came in 1662 when, as the Journal Book of the Royal Society records, "Nov. 12, 1662. Sir Robert Moray proposed Mr. Hooke as a curator of experiments to the Society . . . and that Mr. Hooke should come and sit amongst them, and both bring in every day of the meeting three or four experiments of his own, and take care of such others, as should be mentioned to him by the Society". His connexion with the Society was strengthened next year by his election as a fellow, and in 1665 by his appointment to the chair of geometry in Gresham College, where the Society at that time met, and where Hooke lived for the rest of his life. He had already in 1664 been appointed to the lectureship founded by a city merchant, Sir John Cutler, Bt., and thus at thirty years of age Hooke found himself established in surroundings which must have appeared to him as congenial as those at the Royal Institution did to Faraday a century and a half later.

Of Hooke's versatility, originality and inventiveness ample evidence is to be found in his writings, but new and valuable information as to his activities in early middle life is contained in the "Diary", the recent publication of which we owe to Mr. H. W. Robinson and Mr. W. Adams. This diary covers the years 1672–80, when, in addition to his other appointments, Hooke was one of the surveyors of the City of London. The biographical index to the diary contains several hundreds of names, among them most of his scientific contemporaries.

Hooke himself was at once a physicist, an astronomer, an inventor, a mechanician and an architect. To horologists he is known for his application of the balance spring and the invention of the anchor escapement; by engineers he is remembered for his universal joint and his views