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1902.

ORDINARY GENERAL MEETING.*

MARTIN L. ROUSE, ESQ., B.L., IN THE CHAIR.

The Minutes of the last Meeting were read and confirmed.

The following elections were announced :—

ASSOCIATES :—John Hill Twigg, Esq., M.A. (Dub.), Commissioner, Bengal Civil Service (ret.); Rev. William Charles Penn, M.A., Noble College, Masulipatam.

The following paper was read by the author :—

ARTESIAN WATER IN THE STATE OF QUEENSLAND, AUSTRALIA. By R. LOGAN JACK, LL.D., F.G.S., late Government Geologist of Queensland.

1. INTRODUCTORY.

TO the pastoralists who occupied the western interior of Queensland, Nature presented a formidable riddle under her familiar sardonic condition of "Solve this or perish!" Underfoot were illimitable downs covered with the most nutritious grasses, and overhead a pitiless sky which refused to yield, except at long and irregular intervals, moisture enough to fill even these poor remnants of rivers which are known as "waterholes." Sometimes, indeed, the rain came in startling volume, and after such outbursts there might be waterholes enough to last for two or three dry seasons. The Diamantina is a chain of depressions, which may be ridden over, as I have done, in clear moonlight without the traveller being aware that he is in the presence of a river. Yet it has, within the memory of man, been fifty miles wide. In other parts, between the goldfield of Croydon and the Gulf of Carpentaria, I have seen miles of telegraph

* Monday, January 20th, 1902.

poles submerged, and a few years before my acquaintance with Queensland began, an area of over 12,000 square miles south of the gulf was flooded.

In what may be called ordinary dry seasons it was nothing uncommon to have intervals of 40 miles between one waterhole and the next. Travellers on horseback and on foot carried canvas water-bags, and the mail coaches were lumbered with barrels of water to carry the horses over the dry stages.

2. *Loss of Stock Owing to Droughts.* — But while the hardships incidental to travel could be mitigated by human foresight, the lot of the flocks and herds scattered over the vast area seemed to admit of no remedy. When the poor animals had "fed back" a few miles from the spot where they had last enjoyed a drink of water, thirst would compel them to retrace their steps. The area of available pasture was thus rigorously circumscribed, and the grass was eaten bare, eaten to the very roots, as I have seen sheep grubbing up the roots of the grassy tussocks like pigs, while, too far from water, and hence unattainable, were long leagues of grass untrodden by a hoof. Day by day the remaining waterholes were shrinking, and when the enfeebled cattle returned to slake their thirst they had to wallow through a sticky clay littered with the carcases and bones of their fellows. Having drunk, if they were comparatively strong and lucky, after a life and death struggle they wallowed their way out again. Perhaps they did not; and the dingo was always waiting for his prize of a dead or helpless beast.

Frantic efforts were made to cope with the evil. When drought threatened, pastoralists or the Government made large dams or tanks, but it was very costly, and in some cases years elapsed before the rain came to fill them. Water was carted to incredible distances, but it is needless to say that the support of the draught animals themselves made sad havoc with the supply before it reached its destination.

3. *History of Boring Operations for Water.*—But this condition of things has been changed for the better. In 1881, while on a trip to meet the late General Fielding with a view to accompanying him on his "Transcontinental Railway" expedition, while travelling with the expedition to the Nicholson River, and while returning *viâ* Winton and Charters Towers, I had come to the conclusion that the basin-shape in which the Cretaceous strata were disposed

gave good grounds for the belief that artesian water would be found. Years before this Daintree and Tenison-Woods had founded a belief in artesian water on the presence of hot springs; but the argument was hardly logical, and perhaps the wish was father to the thought. A strong agitation in the Press began to make itself felt, and among others, Mr. W. Gibbons Cox, in 1883, insisted upon the experiment being made, arguing from its success elsewhere. In 1885 a drought had slain its hundreds of thousands of cattle, and was even threatening some of the western townships with extinction. The Government deputed Mr. J. B. Henderson, Hydraulic Engineer, and myself (I was then Government Geologist) to go to the drought-stricken district and make suggestions for the permanent or temporary mitigation of the distress. A more detailed examination than had been possible in the "Transcontinental Railway" expedition satisfied me that the whole of the western downs ought to be capable of yielding artesian water. Mr. Henderson indicated Blackall as the site of the first experiment, as that township seemed to him to be in the most immediate need of succour, and operations were commenced as soon as possible. Water was eventually struck at a depth of 1,645 feet, a supply of 291,000 gallons per day flowing over the surface with a pressure of 64 lbs. to the square inch, although as a matter of fact, owing to an accident to the bore, Blackall was not the first to tap an artesian supply.

4. *Extent of Boring Operations*:—According to the latest statistics accessible to me, viz., those given in Mr. Henderson's Report for the year ending 30th June, 1900, there have been in all 976,711 feet, or 185 miles, of boring in search of artesian water in Queensland. Out of 839 bores 515 flow over the surface, while it must not be hastily concluded that the remainder are failures. Some are still in progress, some have been abandoned too soon, some yield only salt or otherwise defective water, some yield "sub-artesian" supplies of water; that is, water which rises, but not to the surface, owing to the hydrostatic pressure being insufficient. The deepest boring is the "Bimerah," No. 3 Whitewood, 5,045 feet, which gives a daily flow of 70,000 gallons. The warmest is the "Dagworth No. 1," 196° F., where a daily flow of 775,000 gallons was met with at 3,100 feet. The largest flow is believed to be that of the Coongoola (Longland's) bore, estimated at 6,000,000 gallons

per day, although the output has not been officially gauged. The water was struck at 1,900 feet. The total output of the 515 flowing bores is estimated at 321,653,629 gallons per day, or 117,403,574,585 gallons per annum. In cubic yards this is 695,724,886, *i.e.*, a cube of water with sides of about 900 yards. In other words, these artesian wells would fill a canal 100 feet wide, 20 feet deep, and 1,779 miles in length in one year, or fill up Loch Katrine in a year and a-half. Loch Katrine has an area of $4\frac{3}{4}$ square miles and a mean depth of 199 feet. The above figures represent no small achievement in the space of 16 years for a country with a population of 490,000 and an area of 668,497 square miles. It must be remembered that no feverish desire for oil or even gold led to the sinking of the 185 miles of bores, but only the necessity for water to drink. It is needless to say that 515 flowing wells of this description dotted over the previously dry country, large though it is, have already produced an important change in the conditions of life in the Queensland interior. The cattle-carrying capacity of the district has been enormously increased by the multiplication of centres from which the animals can reach pastures hitherto unattainable.

Before entering on questions strictly geological, I may state that the discovery of such a bounteous supply of artesian water does not furnish a perfect cure for all the evils of drought, as might at first be imagined. There may be—and unfortunately there has recently been—a drought so prolonged that not only the sub-aerial water, but even the grass itself, fails. Large as it is, the amount of artesian water brought to the surface, were it ten times as much, is a mere drop in the bucket to what would be required for the thorough irrigation of the vast pastures. The 695,724,886 cubic yards of water annually turned out by our 515 artesian wells, after all only represent a rainfall of ·03 inch per annum on the 264,600 square miles of the area under which it is calculated that artesian water may be obtained. Nothing but the rain from Heaven will enable the grass to defy droughts of such virulence as that through which Queensland has recently passed.

5. *Variation in Pressure and Extent of Supply.*—A variation in the pressure and flow of some of the wells has been observed. It is possible that there may be some connection between the variation and periods of heavy and light rainfall on the intake beds, but until accurate measurements of a large

number of bores have been made over a series of years, speculation on the subject is hazardous.* The pressure of some bores has diminished and again increased. Some bores have ceased—perhaps temporarily—to flow over the surface. In some cases a diminished flow has been traced to wearing out of the tubing and consequent caving in. In others, the pipes have been more or less filled up with a mineral deposit. But in the great majority of cases there has been no failure in the flow.

6. *Geological Conditions.*—The greater part of the western interior of Queensland is composed of soft strata of Lower Cretaceous age, consisting of clay shales, limestones, and sandstones. These strata are so disposed that the lower members of the series crop out on the western flanks of the coast range, where not only is the elevation of the surface greater than in the downs to the west, but where also the rainfall is comparatively abundant. In the year 1894 I went out, accompanied by Mr. A. Gibb Maitland, now Government Geologist of Western Australia, with the view of delimiting the artesian-water-bearing area, and collecting information regarding the lower members of the series of rocks in which the water is found. We observed all along the eastern margin of the Cretaceous area a great thickness of an exceedingly porous sandstone so incoherent that when saturated with water a piece of it would crumble instantly into sand. To this rock we gave the name of the "Blythesdale Braystone." Owing to the low dip, the outcrop of this ideally permeable stratum occupies a belt varying from five to 70 miles in width, but the "Braystone" finally disappears beneath the argillaceous and calcareous upper members of the series which form the soil of the downs to the west. Roughly speaking, there is a mean annual rainfall of 27 inches in the regions where the "Braystone" comes to the surface. Several great rivers, such as the Flinders, commence their career as running streams of considerable volume, but, except in wet seasons, disappear while crossing the outcrop of the "Braystone," and the water must be carried, with the permeable stratum, beneath the clay-shales of the downs. The records of bores show, as a rule, that the

* In Lancashire and Cheshire the effects of dry and wet seasons do not show themselves in the deep wells of the new red sandstone till about six months after their occurrence, this period being required for percolation.—ED.

artesian water is met with in "sand," and it has already been mentioned that the "Braystone," when wet, is sand and nothing more. It must be remembered that the "Braystone" not only takes in all the rain that falls on it, except what is accounted for by evaporation, but that it receives also what is poured into it by the rivers already referred to.

The outcrop of the "Braystone" is not visible for the whole of the distance from north to south to which our mapping extended, as it is partly concealed by nearly horizontal table-lands of what has been called "Desert Sandstone." The Desert Sandstone is an upper division of the Cretaceous formation and lies unconformally on the lower. Where it directly overlies the permeable Lower Cretaceous strata it does not, however, seriously interfere with the absorption of water by the latter, being itself of a fairly permeable nature.

But the loss of the rivers which flow across the outcrop of the Braystone is itself sufficient to suggest a serious difficulty. The water must, to some extent, escape, or the Braystone could not continue to absorb it, and the rivers would continue to run over the clay soil of the western downs. It follows that these *must* have some outlet; and, as has been pointed out by Professor David, of Sydney; Mr. E. Pittman, Government Geologist of New South Wales; and Mr. W. S. Griffith, there are strong grounds for believing that the underground water finds an outlet in the Great Australian Bight. The sea-bed is not open to observation, but if the water escapes where we suppose it does, the Blythesdale Braystone must, after dipping and undulating beneath the soil of the interior, crop out somewhere to the south of Australia. This conjecture, as will be shortly seen, is supported by observations on the water-pressures of the artesian wells themselves. It is now almost equally certain that a portion of the water escapes into the Gulf of Carpentaria.

7. *Mr. Maitland's Views.*—In a highly suggestive paper read before the Royal Society of Queensland in April, 1896, Mr. Maitland demonstrated that the principal artesian-water basins of the world "are not disposed in the shape of those ideal basins, sections of which have done duty for many years in geological manuals." The basins are, in fact, irregular, in so far as the rim of the trough varies in altitude. In other words the "basins" are in most cases "broken

basins," and the break gives rise to leakage either on land or beneath the sea.

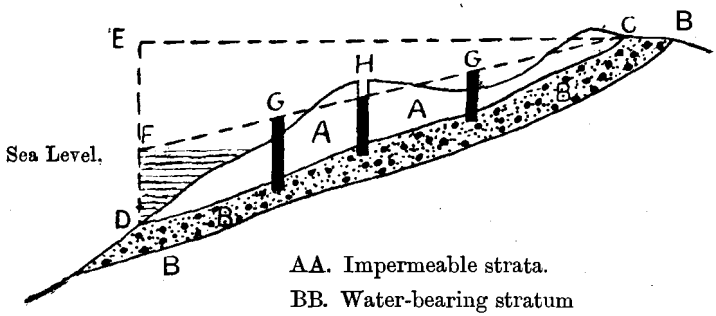
Speaking of the Tertiary beds of the Llaño Estocado, north of the Canadian River, Mr. Maitland says the leakage due to the broken rim of the basin supplies many of the rivers flowing from the Great Plains. Of the Gulf and Atlantic border regions the same author says:—"No discharge is witnessed from the water-bearing portions of the strata which crop out beneath the sea; but that such must be the case may be inferred from the fact that the pressure on the coastal deep wells is not nearly so great as it ought to be were the water confined in a sealed basin. The hydrostatic pressure of the body of water stored in the inland portion of the strata has a tendency to force the fresh water outwards, and thus to cause a permanent seaward flow. The water flows with a velocity due to the difference of level, the intake and the level of discharge, less the frictional resistance of the rock through which it flows."

8. *Theoretical Form of an Artesian Basin.*—In the case of a perfect artesian basin, with a rim of permeable strata of equal altitude all round, and with the necessary impermeable stratum above it—a condition of things which must be rare in Nature—the water would rise in a bore to the altitude of the intake or head of pressure. Should the surface of the ground at the site of the bore be lower than the head of pressure, the water would overflow. It has been found convenient to call "sub-artesian" water which rises in a bore but does not flow over the surface by reason of the site being higher than the head of pressure.

9. *Report on the Extension of the Underground Waters under the Mallee Scrub.*—In 1897, on the invitation of the Minister for Mines and Water Supply of Victoria, I joined Mr. James Stirling, Government Geologist, and Mr. E. Checci, Chief Assistant Engineer of Water Supply, in an investigation of the chances of the Queensland artesian water being found under the agricultural area of the Mallee Scrub. The conclusion arrived at was that, after flowing subterraneously southwards into New South Wales, the Queensland water was prevented from reaching the Mallee country by a bar of palæozoic rocks, and its possible outlet to the ocean was narrowed down to that part of the southern coast-line between the 124th and 134th meridians of each longitude. Mr. Checci took infinite pains in constructing a model showing, by means of wires planted on a

large map, the success of all the bores regarding which reliable information as to the altitude of the sites was available. In some cases, the wires protruded over the surface, denoting an artesian supply, while in others the wires stopped short of the surface, denoting sub-artesian water. We also drew diagrams, of which this is a generalisation, in which the line E C shows the hydrostatic

DIAGRAM TO ILLUSTRATE THE CONDITIONS GOVERNING THE RISE OF THE UNDERGROUND WATERS.



AA. Impermeable strata.
BB. Water-bearing stratum
C. Intake of water-bearing stratum.
D. Outlet of water-bearing stratum.
EC. Hydrostatic surface.
FC. Hydraulic surface.
GG. Flowing bores (artesian).
H. Non-flowing bore (sub-artesian).

surface, *i.e.*, the height of the head of water, to which height water would rise in a bore with a perfect artesian basin with no outlet, F C the hydraulic surface—a line drawn from the intake to the sea, being the line to which water should rise in a bore between the two points on the theory of an outlet to the sea, giving artesian water where the surface of the land is below the hydraulic surface and sub-artesian where the land surface is above the hydraulic surface. The piezometric height is represented by a vertical line dropped from the hydraulic surface through the site of the bore to the water-bearing stratum. The piezometric height is above the surface where there is artesian water and below the surface where there is only sub-artesian.

Actual measurements of pressure in the flowing bores—from which, of course, the height to which water would rise in a pipe can be calculated—show that the hydraulic surface of fact corresponds so closely with the hydraulic surface, on the theory of a submarine outlet, that I regard the theory as practically justified.

10. *Mr. Henderson's Iso-Potential Map.* — From the data afforded by the existing bores, Mr. Henderson (who watches the progress of the bores with paternal care) has prepared a chart, of which a second issue is given with his "Report for the year ending 30th June, 1900," showing what he calls Iso-potential lines, or lines along which the pressure would raise water to equal heights above the sea. The value of these iso-potentials cannot be over-estimated; for where the observations are sufficiently numerous to allow them to be drawn with accuracy, they enable an intending borer to judge beforehand, if he knows the level of his ground, whether he can hope to strike a flowing supply or whether his expenditure will be thrown away.

11. *Mr. Cameron's Equi-Altitudinal Map.*—Mr. Walter E. Cameron, of the Geological Survey of Queensland, has constructed an "Equi-altitudinal" map, in which, by treating the various bores as so many soundings, he has given a fair idea of the contour of the upper surface of the water-bearing beds at the base of the Cretaceous formation. From this map it appears that these beds come near the surface, or even reach the surface, on a saddle extending east and west from the Woolgar to the Cloncurry in a manner which is suggestive of a delta thrown across one of the narrowest parts of the sea which in Cretaceous times divided Australia into two islands. By referring all the bores to the sea-level, and making contour lines joining those in which the beds are the same height above or depth below the sea, Mr. Cameron brings out the fact that the water-bearing beds form two basins or scoops, one deepening northward to the Gulf of Carpentaria and the other deepening from Hughenden to the south-west, or towards Lake Eyre and the Great Australian Bight. This, to my mind, amounts to a demonstration of the seaward flow of the underground water.

12. *Regarding the Permanence of the Underground Supplies.*—The questions of the permanence of the present flow of subterranean water and how far it may be increased are of

vital importance. The progress of boring for 17 years, culminating in the present large output, has revealed no symptoms of a failure of the supply. I have no doubt that so long as rain falls on the intake beds, water will flow underground; *but to what extent?* It is on this question that I have recently been exercising my arithmetic.

It may be postulated, on geological grounds, that Queensland derives the whole of its underground supply from Queensland alone, and it may be assumed that the whole of it comes from the eastern outcrop of the basal strata of the Cretaceous formation. The assumption is based, first, on the comparatively low altitude of the western margin; and secondly, on Mr. Cameron's observation that in the west the basal strata do not come to the surface, but abut against the older rocks, and are overlapped by the argillaceous rocks, which succeed them in the Cretaceous series. Calculating the area between the line where the "Blythesdale Braystone" dips westward beneath the argillaceous beds and a line representing the eastmost extension of any rock which could possibly drain into the "Braystone," I have arrived at an area of 55,000 square miles as the absolute maximum of possible intake. The mean annual rainfall over this area being taken as 27 inches, we get (allowing nothing for evaporation) a total possible absorption of 127,776,000,000 cubic yards of water per annum. Of this amount we are, even now, recovering by means of artesian wells the $\frac{1}{183}$rd part. It may be said that in $\frac{182}{183}$ we have still a large margin to be drawn upon. But there *is* a limit, and moreover it is unimaginable that by any conceivable multiplication of bores we could draw the whole supply to the surface, since an unascertainable portion of it must always escape to the sea. As for irrigating the whole artesian area, the entire 127,776,000,000 cubic yards of water (if we could raise it, which is impossible) would only be equal to an annual rainfall of $5\frac{1}{2}$ inches, which every pastoralist knows to be insufficient for the purpose.

Discussion.

Mr. W. Gibbons Cox.—I have listened with particular interest to what Dr. Jack has said on the question of artesian water in Queensland, than whom there is no man better able to treat the

subject. I was one of the initiators of the movement for artesian water, having had five or six years' experience in the United States of America, following on a previous professional education in England, and when I arrived at Victoria and Melbourne in 1877, I and my colleagues did all we possibly could to get the pastoralists to take up this question of the vital importance of supply of water to the land. Unfortunately in Victoria there was no indication at the time of deep artesian water being there, and we had to put up with the "sub-artesian" or shallower water. From that experience I turned my attention to Queensland, and in 1883 I arrived there in the Government service. Working as we did with boring operations for the sub-artesian water, there were very clear indications of the existence of the deeper artesian supplies, and, as Dr. Jack has mentioned, there was an agitation in Brisbane at that time, in 1883, to further the deeper boring for artesian water, and I was connected with it as a hydraulic engineer. The matter went on until we arrived finally at the figures that the author has given, which are the official figures. Of course the work that had been carried out, the iso-potential map of Mr. Henderson, and the equi-altitudinal map of Mr. Cameron, were very good and necessary, but those had been based upon the actual borings; the data that had been arrived at by those gentlemen had been got from the actual borings themselves. I merely mention this so that some credit may be given to the actual borers themselves. (Hear, hear.) As far as the results go and the utilization of the water resulting from these bores, we know that over 800 bores have been put down, but only 515 are actually supplying up to the last report in 1901, yielding 351,000,000 gallons per day. That is an enormous output of water. Then the question arises, what has been done with that water? The water has been simply used for the direct requirements of the squatters in keeping the stock alive. In normal seasons the grass is of very highly nutritious quality, and in normal weather Queensland is probably as fine a feeding country as any in the world; but unfortunately droughts come occasionally, and then the whole country is dried up. All that the squatters have done, in fact, with that water has been to cut channels from the bores and lead the water into the different paddocks, so that at least the stock should be able to quench their thirst, otherwise they would have died right out. But having

entirely turned their attention and their money in that direction, they have neglected to irrigate even small portions from each bore, so as to grow fodder to feed their stock during the severe droughts. The amount of water in Queensland alone in the water-bearing rocks is inconceivable. There is the fact that there is an enormous outflow of water, even now, at what I might call the initial stages of the movement—an outflow of 351,000,000 gallons every twenty-four hours. Two-thirds of that would supply London itself, and one single bore discharging through a six-inch pipe would supply with water the city of Brisbane, the capital city of Queensland. I think the geology of the subject is extremely interesting, and of course, hydraulic engineers have to study the geological structure of the country, although it is simple as compared with gold-mining geology. I submit that the science of the thing is very clear. There is the fact of the water being there to the extent that has been stated; there is the fact, also, of the land of Queensland, taking that state alone, being of such high quality for pastoral purposes. I think this is one of the questions which is now arising connected with the welfare of the British Empire. (Hear, hear.)

Mr. JAMES STIRLING (Government Geologist for Victoria).—I am afraid I cannot add much of interest to the discussion. In the first place I know very little of the actual artesian water system of Queensland or of its geology; but in those matters I am quite content to rest upon the conclusions which my friend Dr. Jack has drawn, with his more intimate geological knowledge. I might say with regard to Victoria, as Dr. Jack has been good enough to refer to that part of Australasia, that the Victorian Government are very anxious if possible to ascertain whether those immense subterranean supplies of water extend from Queensland through Central Australia to Victoria, especially the western part of Victoria, a district where there is a very small rainfall and which would benefit very much by artesian supply. I have been very pleased to hear that in the early years geologists in Victoria were among the first to trace out the rocks in Queensland, but it seems that they had to wait until our friend Dr. Jack took control of the survey to get his advice in respect of artesian boring in Victoria. At any rate, the Government is so impressed with the magnificent work which Dr. Jack has done in Queensland, that they invited him to find out if such borings

could be equally successful in Victoria. I might say that it is not possible for the Queensland water to come down into Victoria. There happens to be a barrier of palæozoic rocks in New South Wales which seems to interfere with the flow. I was present when Mr. Checci was drawing the map to which Dr. Jack referred, in which he indicated by wires the success of the bores as to which reliable information was available as to the altitude of the sites. That map shows that the water would not rise to the surface of certain portions of Victoria. The map is now in the Geological Office in Victoria. With regard to the general question of artesian supply, there can be no doubt that Mr. Cox has given the meeting much information upon the matter, and there can be no doubt it is of great value to that portion of Australia. From observations that I have made in Victoria, I think it is just possible that in the extreme western portion of the Colony there may be sub-artesian supplies, but I do not think those sub-artesian supplies will come from Queensland; they will come from the watershed, say of the Australian Alps. The amount of rainfall over that area is very great, 60 or 70 inches a year; therefore there is a very considerable amount of water discharged from that area through the western portion of Victoria and underneath the Tertiary beds. Dr. Jack has shown clearly that there is a flow towards Central Australia on the one hand, and another flow northward to the Gulf of Carpentaria. I think that flow which goes southward will flow towards the Australian Bight.

Mr. E. T. Scammell.—As representing, to some extent, the West Australian side of the question, I would like to press home a little more a matter to which Mr. Stirling has incidentally referred, and to ask whether there is any chance, according to Dr. Jack, of the West Australian people finding subterranean water anywhere in the direction either of the North Australian Bight or further north still, and if so, I should be very glad if Dr. Jack would say a word upon the matter.

Mr. Woodford Pilkington.—I think it would add greatly to the usefulness of the paper if Dr. Jack could make it so clear where artesian boring would be likely to be of service—in such Colonies as the Cape of Good Hope, for instance—that it would cause more useful attention to be paid to the subject than it now obtains. People are perpetually recommending artesian boring

as though it were everywhere applicable. Everyone said, "Oh, why don't you adopt artesian boring and get water?" where it was not to be found. If the geological conditions that are necessary for artesian boring were brought a little more fully into view, so as to lead one to see exactly where artesian boring can be practised with useful effect, I think the paper would have a very useful application indeed.

Dr. LOGAN JACK.—While the things are fresh in my memory, I had better begin with the last question and work back. Of course the paper might have been made very much more useful, and might have gone into greater detail, but for the necessity for fixing a limit to its length. It was not intended to cover the whole world with information regarding artesian water. In the first place, I was not competent to give such information, and, secondly, I was afraid it would have very much tired the patience of the meeting if I had gone over too much ground. But there are many ways in which the question might be answered to some extent. To begin with, if anybody put such a question to me as, "Is there artesian water in this particular land, in the Cape of Good Hope or elsewhere?" such a person should in the first place procure the best geological map of the district available, and should study especially the contour which the outcrop of the different *strata* took, and must consider where permeable beds come to the surface, and whether those permeable beds are covered by impermeable beds, which would keep the water carried down by them under such conditions that it could only be liberated by penetration by the boring rod. That is where the geologist comes in. Of course I might go to such a new country and give special attention to the question of artesian water. Geological maps are constructed for what they are worth, though they serve many purposes, among others that of throwing light upon artesian water. But it is not necessary to map out a district specially with a view to the bearing of the map upon the question of artesian water. Such mapping might very usefully be done specially with that object in such countries as have been referred to, such as the Cape of Good Hope. Another question was asked, as to whether artesian water could be expected in Western Australia. That question is of very considerable importance to Western Australia, and again, it is very much a question of mapping, but I think I can answer that where it is

mostly wanted in Western Australia is in the neighbourhood of the goldfields. It is not likely to be obtained, because just there the older rocks, as a general rule, come to the surface. I have no doubt there are many sub-artesian supplies of water to be found in portions of Western Australia, and perhaps in some cases not very far from the goldfields, where the water is most wanted. It is known that there is artesian water in, or near, the capital city of Perth; but where it is chiefly wanted is in the interior, where, unfortunately, so far as I understand (for I am speaking without having been on the spot), water is not likely to be obtained. Irrigation, as the Chairman has pointed out, has been very extensively practised in ancient times and in distant lands, and may yet be expected to be practised to a much greater extent in Queensland, where there is such a magnificent supply of water running, as it were, to waste. The stock of course benefits by it; but a great deal more might be made of it, as Mr. Cox has very forcibly pointed out. If, all along those rivulets, natural or artificial, where the water now runs for the supply of the cattle and then runs to waste, some use were made for agricultural purposes of the artesian water, it would be a very good thing indeed; but my object in referring specially to the subject of irrigation was to show the inutility of the hope that the whole of these western downs may be converted into rich pastures or enduring pastures by the use of artesian water, for which I contend that the supply, great as it is, is inadequate. I hope Mr. Cox has not understood, from anything which I have said, that I have not given full credit to the borers who have practically demonstrated the value of these supplies. Of course I depend very largely upon them for the information which I was constantly, while in Queensland, accumulating on the subject, and I watched the progress of each bore, so far as was possible.

After some remarks by the Chairman, a cordial vote of thanks to the author was unanimously carried, and the Meeting adjourned.