ARTESIAN WELLS--NOT EVERYWHERE ATTAINABLE.

[For the Scientific American.]

The popular theory prevailing a few years since, that artesian wells might be obtained anywhere by penetrating the earth's crust to a sufficient depth, received its refutation in the grand experiment made in 1858 by the legislature of Ohio, at the capitol of that State.

Artesian wells are obtained by boring into the earth's crust until subterranean reservoirs or streams of water are reached; but unless these supplies have their sources at an elevation higher than the mouth of the wells, the water cannot rise to the surface. These subterranean reservoirs are not lakes, or large bodies of imprisoned waters, but beds of sand, or porous rocks, saturated with water capable of motion. Such borings have produced an abundance of water at Paris and other places in France; and also in portions of Mississippi, Alabama, South Carolina, and other States in our own country. Now, to understand why one district will yield water in every boring made to the proper depth while another will yield none, we must examine the difference in their geological characteristics. Geological science only can solve the mystery.

Surrounding Paris, at a considerable distance from the city, there appears at the surface an immense bed of porous silicious rocks, through which water easily percolates, and which rests on strata impervious to water. The strata of this porous bed of rock dip from all directions toward the city, indicating that they pass beneath it, thus forming a vast basin, having a depth of about fifteen hundred to two thousand feet at its center. This basin is filled by the rocks of the chalk and tertiary formations, so as to bring the surface of the country to nearly a common level—the outer rim of the basin, however, having a higher elevation than its center. The chalk formation rests upon the porous silicious rocks, and is impervious to water. The tertiary formation overlies the chalk, and the two together have a thickness of many hundred feet. The rains, falling upon the outer margin of the basin, sink freely into the porous materials there exposed at the surface; and, keeping the strata constantly saturated with water, create a pressure of that fluid toward the center, where they are overlaid by the newer formations. These porous rocks, may therefore be called water bearing, as an abundant supply of water everywhere pervades their strata, where its evaporation is prevented by the overlying chalk and tertiary. By boring down through these two beds into the porous strata, at suitable distances within the margin of the basin, the water is forced up to a hight corresponding to that of the source of its supply, and in some cases reaches an elevation of thirty feet above the surface. The artesian well in the city of Paris is bored to a depth of eighteen hundred feet, and the water rises through a tube to an elevation of sixty feet above the surface, and has a temperature of ninety-four degrees, Fah. The first well of this kind was bored at Artois, in France: hence the name, artesian wells.

In Mississippi and Alabama, the region furnishing artesian wells is not in the form of a basin as at Paris, but is an inclined plane, commencing near the base of the Alleghanies and descending toward the Gulf of Mexico. The water-bearing formation of this section of country is a loose, sandy deposit, occupying a large extent of surface. It is overlaid, further south, by the chalk and tertiary formations, which are known, locally, by the name of rotten limestone. This is an immense deposit of carbonate of lime, existing almost as pure marl, but occasionally including some beds of limestone, and in many places abounding in fossils. It has often a thickness of only a few feet at its northern margin—as at Purdy, Tenn.—but increases rapidly in depth southwardly, until it attains a thickness of nearly two thousand feet; the increase in some localities being at the rate of thirty feet to the mile. The marl is impervious to water, and none can penetrate down through it, however heavy the rains at the surface, or rise up through it by capillary attraction, whatever may be the extent of the evaporation from the soil above. Planters dig cisterns in it, in the form of immense demijohns, and fill them with water from the roofs of their buildings. These cisterns require no wallings of cement to make them water-tight, and retain the water during summer in all its original sweetness.

The bed of sand which underlies the marl must be of considerable thickness, as it has been penetrated to a depth of three hundred feet in some of the artesian wells. It rests upon the older secondary rocks, which, being impervious to water, serve as a flooring to the sand, and prevent the water from sinking lower in the earth. This sand bed, as before stated, occupies the surface all around the northern margin of the marl, and the rains descending upon it are readily absorbed. The water thus supplied is arrested in its descent by the flooring before described, and it flows along the inclined plane, among the sand, until it passes beneath the great marl bed, from whence there is no retreat or escape except by a forward movement. Far down toward the coast, where it has gained power by accumulation, the water is found bursting up through the marl in large springs. Wherever artesian wells have been bored at proper distances within the marl formation, water has been secured; but when attempts have been made at points too near its northern margin, they have either failed or the water does not rise to the surface. The more northern wells in Alabama have a depth of two hundred and seventy to three hundred feet—the water rising in them to within eighty or ninety feet of the top, from whence it is drawn up by the bucket and windlass. There are other wells in the river valley near by which is eighty or ninety feet lower, in which the water overflows at the surface. Further south, where the common level of the country is a hundred feet lower, the artesian wells have the water flowing from their mouths in a constant stream; but, owing to the increase in the thickness of the marl in that direction, they have to be sunk to the depth of five hundred to eight hundred feet, to reach the water.

In all these wells the water rises to a common level, whether it stops at ninety feet below the surface, barely overflows at the tops of the wells, or ascends in tubes prepared to allow it to reach its maximum elevation. This shows clearly enough that the water has a common origin in a single broad bed of water-bearing sand, everywhere underlying the whole region covered by the rotten limestone. Some exceptions have to be made to this general statement. It has been said that the sand bed includes some strata of hard sandstone. These strata are at different depths, and some of them serve as floorings for the water, or secondary lids to the basin, or rather to the inclined plane upon which the water runs. Consequently, after reaching the water immediately below the marl, if the boring is continued two hundred or three hundred feet through these occasional strata of sand rock, it will rise to a higher elevation than when first reached. This is only true, however, of points distant from the margin.

The artesian well at Columbus, Ohio, may now be considered, and the reasons of its failure stated. The geological strata of this region vary but little from the horizontal, and at many places not very distant, the same rock which is found a thousand feet below Columbus can be seen exposed along the hills of the Ohio River, from Cincinnati, up and down that stream, for a hundred miles. The order is as follows, using western names to designate the formations:—

Beginning at Columbus, the cliff limestone, which is the surface rock, has a thickness of four hundred feet. It is composed of alternating layers of gray limestone and soft marlite. The marlite is as impervious to water as the marl of Alabama or the chalk of Paris. The limestone strata are not what can be considered as water-bearing, though often cellular and containing many seams and small fissures. The dip of this formation is toward Columbus, from the westward, at the rate of a foot or two to the mile, for a distance of sixty or seventy miles. Water penetrating the strata at that distant point, if it could pass on to Columbus, should have been found at the depth of two hundred and fifty feet. But the boring shows that no such supplies are coming in from the westward, thus proving that the cliff limestone has no water-bearing strata. The dip of the strata increases eastward of Columbus, so that at Zanesville, Ohio, it has attained a dip of about twenty-five feet to the mile, and this continues as far as Wheeling, Virginia. No water, therefore, can come to Columbus from that direction, so long as fluids refuse to flow up hill.

Immediately beneath the cliff limestone, but occupying the surface in a large area surrounding Cincinnati, the blue limestone prevails. This formation is composed of alternate beds of blue limestone and marlite, and is not water bearing. It conforms in its dip, of course, to that of the overlying cliff limestone. Its exact thickness is unknown in Ohio, Indiana, and Kentucky, as the whole formation is not exposed at one place within these states. In Pennsylvania it is estimated as having a thickness of six thousand feet; while in the vicinity of Cincinnati only six hundred feet of it are presented, and at Frankfort, Ky., an additional six hundred feet, of still lower strata, are brought up to view. This gives an exposure of about twelve hundred feet of the blue limestone for examination; leaving, it is supposed, about two or three hundred feet beneath, which cannot be seen. It is estimated that its thickness must be greater at Columbus than at Cincinnati, as the former place is over a hundred miles nearer than the latter to its greater development in Pennsylvania.

The strata of this formation are composed of alternate layers of crystalline limestone and soft marlite, both of which are impervious to water. The marlite predominates in the upper half of the formation, and the limestone in the other. It includes no water-bearing strata; but at Frankfort, Ky., there is a portion of the limestone, a little above the river bed, which is cavernous. The same character is presented in it at Tazewell, Tenn., indicating that the lower members of this formation may possess this character throughout great distances.

Now, although these strata, as well as those of the cliff limestone, include none that are water bearing, in the sense in which the term is employed when applied to artesian wells, yet they retain sufficient water for the supply of springs and common wells: but in these cases the water is only found pervading the loose surface deposits or running in veins in the open joints of the rocks, and not, as every one knows, in the body of the rocks themselves.

The marlite, at depths where the frost cannot act upon it, is usually unbroken in its strata, and serves to conduct water along its upper surface, where porous materials allowing its passage exist. But water can never flow along in the midst of compact marl or clay as in deposits of sand. The whole of the cliff limestone, and the blue limestone also, are therefore unsuitable formations in which to attempt the production of artesian wells.

But there is another point which should be noted. Cavernous limestone, as well as that which has openings along the joints, often affords subterranean passages for streams of water. If the quantity in any instance be greater than can pass along the narrower parts of the channel, and the water be thus dammed back, and the source of supply be at a higher elevation than the surface above, a flowing well may be supplied from it, and will secure the surplus which is held back for want of sufficient width in the passage below. The only difficulty will be in striking the vein of water, and to succeed in this, must be the result of accident and not of foresight in the operators.

Beneath the blue limestone, there exists a heavy formation of sandstone, very compact in its structure, and not likely to have any reliable water-bearing strata. It is known in the New York survey as the Potsdam sandstone. This formation rests upon the primary rocks, and artesian wells canno be expected in rocks of that age and depth.

The facts stated conducted me to the conclusion, that the geological formations existing beneath the capital of Ohio, were not of a character to justify the expenditure of the money necessary to bore through them. That city is located near the margin of a great basin, having its center in Virginia, and the dip of the rocks was all from it and not to it as a center. In short, the water basin was turned upside down, and Columbus was upon the bottom, with the water all running away from it, instead of converging toward it as is the case at Paris.

But the Legislature made a new appropriation, and the boring progressed until a depth of twenty-seven hundred and seventy-five feet and four inches (2,775 $\frac{4}{12}$ feet) was obtained. The temperature at 2,575 feet was 82° Fah. and at 2,750 feet it was 91°.

The last 190 feet gave no sedimentary borings to the sand pump, the whole seeming to be carried away by currents of water moving at that depth. But where did this water go? This is a question of a curious nature. These currents were moving at a depth of nearly two thousand feet below the sea level. They could only have an outlet into the bed of the ocean, and the fresh water, rising to the surface through the salt water, on account of its less specific gravity, established a current that allowed the continual movement forward of the water filling fissures, or connected cavities, existing at great depths in the earth.

The existence of artesian wells, in minor localities, may be explained on the principles here stated. D. C.

[Our Foreign Correspondence.]

THE LONDON FIRE DEPARTMENT.

LONDON, Dec. 25th, 1866.

I have recently, through the politeness of Captain E. M. Shaw, Chief Executive Officer of the Metropolitan Fire Brigade, had an opportunity of acquainting myself with the organization and working of the London Fire Department, and I think some of the particulars will be of interest to your readers.

INSURANCE FIRE SYSTEM.

In most of the cities of England the work of extinguishing fires is intrusted to the insurance companies. These each own their separate engine and hire a certain number of men to manage it, but depend on volunteers picked up on the emergency, for the complement necessary to work the engine properly. They subdue all fires that occur, but if the property is not insured, the expense of extinguishing is charged to the owner. If it is insured by another company, the expense is charged to them. Somewhat similar, until the present year, was the system in London also. Now, however, the Board of Works have assumed control of the brigade and considerably extended the district to be protected, increasing at the same time the number of stations and the force employed. Just at present, therefore, the organization is in a transition state; but a tolerably correct idea may be formed of the system as it is intended to be.

ORGANIZATION—TELEGRAPH SYSTEM.

The extent of the metropolis is not far from 120 square miles. This is divided into four districts—three on the north side of the Thames, and one comprising all on the south side. In these there will be altogether sixty stations, although at present there are but forty. Each district is under the superintendence of a foreman, who is stationed at a central point and in telegraphic communication with each station in his district and also the head office in Watling street. He attends to the dispatching of engines and all the working of his district, and is responsible for its proper management to Captain Shaw. The telegrams from these four foremen are the only ones that go to the central office. No bells are rung, the whole signaling being done by telegraph. The instruments are very simple and can be worked by all the employees in the station. They are operated by merely turning a handle around over a dial on which are marked the letters of the alphabet; so that any one can receive or send a message. The endeavor of the officers is to keep the existence of a fire as quiet as possible, so that they may get there before the crowd.

LOCATING FIRES MATHEMATICALLY.

As some of the stations on the outskirts of the district are necessarily very far apart, a very effectual means is adopted for locating the precise position of a fire seen at a distance. On the roof of each of the stations is placed a compass, so that the bearing of any light may be readily observed. The officer at the central station telegraphs to two stations at a considerable distance on either side of the direction of the light, to know its bearing from that point. He has a map on which the position of each station is marked by a raised point, so that they can be readily found by the touch, and on which the points of the compass are plainly indicated. It is then but the work of a moment to find where the bearings telegraphed from the outlying stations will intersect, and then the orders can be sent to the various stations with certainty. As everybody knows, nothing is more deceptive than following a light seen at a distance.

FORCE AND APPARATUS.

The number of men composing the brigade is 230, but is constantly being increased. The number of engines is 70, of which 19 are steamers, 27 old manuals, and the others new manuals. A special and most important feature of their force is the use of "curricles," or very small engines, which can be started off at the instant of alarm, and managed by one man. These consist of a box mounted on a pair of wheels, and containing three or four lengths of hose—say 200 feet—coupled