

proofs of design which arise out of the investigation of its actual condition, and of its relations to the organized beings which are placed upon it.

Nearly three-fourths of the earth being covered with the sea, whilst the remaining dry land is in need of continual supplies of water, for the sustenance of the animal and vegetable kingdoms, the processes by which these supplies are rendered available for such important purposes form no inconsiderable part of the beautiful and connected mechanism of the terraqueous globe.

The great instrument of communication between the surface of the sea, and that of the land, is the atmosphere, by means of which a perpetual supply of fresh water is derived from an ocean of salt water, through the simple process of evaporation.

By this process water is incessantly ascending in the state of vapour, and again descending in the form of dew and rain.

Of the water thus supplied to the surface of the land, a small portion only returns to the sea directly in seasons of flood through the channels of rivers.

A second portion is re-absorbed into the atmosphere by evaporation.

A third portion enters into the compositions of animal and vegetable bodies.

A fourth portion descends into the strata, and is accumulated in their interstices into subterranean sheets and reservoirs of water, from which it is discharged gradually at the surface in the form of perennial springs, that form the ordinary supplies of rivers.

As soon as springs issue from the earth, their waters commence their return towards the sea; rills unite into streamlets, which, by further accumulation, form rivulets and rivers, and at length terminate in estuaries, where they mix again with their parent ocean. Here they remain, bearing part in all its various functions, until they are again evaporated into the atmosphere, to pass and repass through the same cycles of perpetual circulation.

The adaptations of the atmosphere to this important service in the economy of the globe belong not to the province of the geologist. Our task is limited to the consideration of the mechanical arrangements in the solid materials of the earth, by means of which they co-operate with the atmosphere in administering to the circulation of the most important of all fluids.

There are two circumstances in the condition of the strata, which exert a material influence in collecting subterraneous stores of water from which constant supplies are regularly giving forth in the form of springs: the first consists in the alternation of porous beds of sand and stone, with strata of clay that are impenetrable by water. The second circumstance is the dislocation of these strata by fractures and faults.

The simplest condition under which water is collected within the earth is in superficial beds of gravel which rest on a substratum of any kind of clay. The rain that falls upon a bed of gravel sinks down through the interstices of the gravel, and charges its lowest region with a subterraneous sheet of water, which is easily penetrated by wells, that seldom fail except in cases of extreme drought. The accumulations of this water are relieved by springs, overflowing from the lower margin of each bed of gravel.

A similar result takes place in almost all kinds of permeable strata which have beneath them a bed of clay, or of any other impermeable material. The rain-water descends and accumulates in the lower region of each porous stratum next above the clay, and overflows in the same manner by perennial springs. Hence the numerous alternations of porous beds with beds impenetrable to water, that occur throughout the entire series of stratified rocks, produce effects of the highest consequence in the hydraulic condition of the earth, and maintain an universal system of natu-

ral reservoirs, from which water overflows incessantly in the form of springs, that carry with them fertility into the adjacent valleys.

The discharges of water from these reservoirs are much facilitated, and increased in number, by the occurrence of faults,* or fractures, that intersect the strata.

There are two systems of springs which have their origin in faults; the one supplied by water descending from the higher regions of strata adjacent to a fault, by which it is simply intercepted in its descent, and diverted to the surface in the form of perennial springs; the other maintained by water ascending from below by hydrostatic pressure, (as in Artesian wells,) which, at their contact with the fault, are often at a great depth; the water is conducted to this depth either by percolation through pores and crevices, or by small subterranean channels in these strata, from more elevated and distant regions, whence it descends, until its progress is arrested by the fault.

Beside the advantages that arise to the whole of the animal creation, from these dispositions in the structure of the earth, whereby natural supplies of water are multiplied almost to infinity over its surface, a further result of vast and peculiar importance to man consists in the facilities which are afforded him of procuring artificial wells, throughout those parts of the world, which are best adapted for human habitation.

The causes of the rise of water in ordinary artificial wells are the same that regulate its discharge from the natural apertures which give origin to springs; and as both these effects will be most intelligibly exemplified by a consideration of the causes of the remarkable ascent of water to the surface, and often above the surface, in those peculiar perforations which are called "Artesian wells," our attention may here be profitably directed to their history.

ARTESIAN WELLS.

The name of Artesian wells is applied to perpetually flowing artificial fountains, obtained by boring a small hole through strata that are destitute of water, into lower strata loaded with sheets of this important fluid, which ascends by hydrostatic pressure. The name is derived from Artois, (the ancient Artesium,) where the practice of making such wells has for a long time extensively prevailed.

Artesian wells are most available, and of the greatest use, in low and level districts, where water cannot be obtained from superficial springs, or by ordinary wells of moderate depth. Fountains of this kind are known by the name of *blow wells* on the eastern coast of Lincolnshire, in the low district covered by clay between the wolds of chalk, near Louth and the sea-shore. These districts were without any springs until it was discovered that, by boring through this clay to the subjacent chalk, a fountain might be obtained, which should flow incessantly to the height of several feet above the surface.

In the King's well, at Sheerness, sunk in 1791, through the London clay, into sandy strata of the plastic clay formation, to the depth of three hundred and thirty feet, the water rushed up violently from the bottom, and rose within eight feet of the surface. In the years 1828 and 1829 two more perfect Artesian wells were sunk nearly to the same depth in the dock-yards at Portsmouth and Gosport.

Wells of this kind have now become frequent in the neighbourhood of London, where perpetual fountains are in some places obtained by deep perforations.

* "Faults consist of fissures traversing the strata, extending often for several miles, and penetrating to a depth, in very few instances ascertained. They are accompanied by a subsidence of the strata on one side of their line, or (which amounts to the same thing) an elevation of them on the other; so that it appears, that the same force which has rent the rock thus asunder has caused one side of the fractured mass to rise, or the other to sink. The fissures are usually filled by clay."—Conybeare's *Geology of England and Wales*.

rations through the plastic clay.

Important tre wells have late Thury, and M. Bruckmann, in extensive district under certain conditions at certain levels surface of strata and will afford cultural and domestic for moving machinery obtained in Artesian wells.

In the tertiary of Tours, there is an enormous Artesian well in feet above the surface. Arago states the force, that a Artesian well is a stream.

In some places, for nonical purposes water rising from Von Bruckmann Artesian wells to bronn, and to procure around his mine adopted at Alsace. It has even been ascending springs Artesian wells in the duchy of Modena applied in By means of which may be raised sandy deserts in contemplation along the Nile and Suez.

I have felt it of Artesian wells will add to in many regions level districts, inaccessible to the theory of their most important the subterranean production of nature.

By these conditions of the strata the entire crust and connected operating in the atmosphere, to over the habitations.

Among the from the intrusion strata, into the pervade the earth may further fractures are mineral and alleviate man.

Thus, in the and the application, through

* In common is used, if the water is continued down pure water; if water, it ascends through whatever impure water is being excluded ascending from below.