In many regions, owing to the removal of the forests and the construction of drainage ditches, the water from rainfall and snowfall runs off more rapidly than formerly and much less sinks into the ground. As a result the ground-water level has been lowered over large areas, and wells which once afforded good supplies are now dry. In many places there is still plenty of water in the ground, the only difference being that its level has sunk below the bottom of the well. In such places the deepening of the well brings complete relief.

In the course of time an accumulation of material entering the well as dust at the top, or washed in through the ground, forms considerable amounts of silt in the bottom and on the sides. In some wells this deposit is sufficient to hinder, to a certain extent, the entrance of water into the well and to lessen its storage capacity. Some relief is usually afforded by cleaning out the well.

Deep Wells.

Depth is one of the most important factors to be considered in sinking a well. On it both the type and the location often depend. The benefits which the owner expects to realize from a deep well as compared to a shallow well are (1) larger supply, (2) higher head, and (3) purer water.

Location.—In the location of deep wells the chief consideration is the obtaining of a supply, slight differences in location seldom seriously affecting the cost, while the prevailing use of casing in soft deposits insures safety from ordinary sources of pollution. The occurrence of deep waters depends on the character and structure of the rocks far below the surface. No indications of these features are usually found at the surface, and the well may as a rule be located independently of surface relief, though where artesian flows are expected the well should be located on as low ground as possible. Information as to the best location for a deep well may often be obtained from a careful study of the records of wells in adjacent regions, which can be made by the more experienced and intelligent drillers, or from a study of the rocks and their structure, which often requires the services of a trained geologist.

Relation of Supply to Depth.—It is a widespread, in fact an almost universal, belief, that the amount of water increases with depth, and that water may be had anywhere if one only "goes deep enough." This is, however, far from the truth. Rainfall appears to be the source of at least 99 per cent. of the fresh water found in the ground, the remainder being water included in the rocks at the time of their accumulation beneath the sea, together with a small amount derived from volcanic sources. As would be expected from its atmospheric source, water actually decreases rather than increases in amount with depth, a great many rocks encountered by the deeper wells and mines, especially at depths below 1,000 feet, being entirely destitute of water.*

However, if only the more superficial portion of the crust is considered, there is in general an increase of water with depth. Except in valley bottoms and other depressions the surface soil and rocks, although carrying much moisture, are rarely saturated; but at depths which vary, according to climate, soils, and topography, from a few to several hundred feet, a saturated zone constituting the ground-water body is encountered. Wells starting anywhere above drainage level will in general encounter water in increasing amounts at least down to the drainage level. Again, the surface beds may be of non-porous nature, and may, therefore, be destitute of water, while the underlying beds, if porous and below drainage level, are likely to be saturated.

Of course, there is a constant tendency for the surface waters to penetrate downward and fill the porous rocks below. That these are at present destitute of water may be due, at least in certain rugged regions, to the draining of the deeper and in places relatively porous beds by deep valleys. Elsewhere, and this is doubtless the most common cause, the water is kept from percolating downward by impervious beds near the surface. The deeper rocks are largely of the granitic type and hold but little water. Except where they constitute the surface rock and are somewhat broken by joints it is of little use to penetrate them in search of water.

To speak broadly, it may be said that there is no general increase of water with depth, and that the finding of deep supplies is entirely dependent on local geologic conditions. Unless there is some proof that deep water-bearing beds exist, the sinking of a deep well should be regarded wholly in the light of an experiment, although in sedimentary rocks it has the decided advantage that it may penetrate a number of water strata, which may afford in the aggregate a fair supply where a single stratum might not suffice.

Relation of Head to Depth.—As with regard to volume, there is a general belief that the head of water increases progressively with depth. This belief has a better basis than the other, for in some places such a relation of head to depth exists, as in the artesian system shown in Fig. 19, in which the deeper beds outcrop at successively higher levels.

The reverse condition is shown in Fig. 20. Such conditions are not the result of universally prevalent structures, although it is perhaps more common than otherwise that the strata are higher at the rims than they are at the centres of the great structural troughs. In many structural basins, the outcropping beds of the rims, in fact, lie high up on the flanks of mountains, while the beds of the centre constitute low plains.

Relation of Quality to Depth.—Another prevailing idea is that the deeper waters are purer. Within limitations this is generally true as regards the shallower waters, which, being close to the surface and without the protection afforded by overlying clays or other impervious beds, are susceptible to pollution. Deeper waters, on the other hand, are almost always overlain by relatively impervious beds that serve to keep out polluting materials, and as a rule they are entirely safe. In many places, however, the amount of mineral matter dissolved in the water shows a general increase with depth, the amount in deep waters averaging several times that in surface waters, which are largely made up of recent rainfall. There are some exceptions to this law, due mainly to variations in the character of the materials in which the waters are found, the waters in a calcareous glacial drift or in an alkaline flat, for instance, often being very much harder than those in underlying beds. Limestone waters, too, are generally harder than sandstone waters. The maxim of certain drillers, "The harder the rock, the harder the water," is based on the prevailing softness of the sandstones in many districts as compared to the hardness of the limestones.

In addition to the impervious beds mentioned, the casing plays an important part in preventing the access of pollution to deep waters. When the casing has been corroded, pollution from sources near the surface is often admitted through the minute holes eaten in the iron, spoiling the deep waters. Where the casing does not entirely fill the hole, contamination may pass down outside of it, while in uncased rock wells pollution may enter through any of the numerous fissures that usually exist in the upper part of the rocks. Even in such wells, however, the danger of contamination decreases rapidly with depth.

*Fuller, M. L., "Total Amount of Free Water in the Earth's Crust: Water-Supply Paper, U. S. Geol. Survey, No. 160, 1906, pp. 64-70.