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SOME IDIOSYNCRASIES OF GROUND WATERS[1]

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Most persons in this state, especially those residing north of an east and west line through Casey and Carlinville, have the deeply rooted opinion that the best water for a public water supply is to be obtained from subterranean sources.

In one sense of the word this, no doubt, is true, (provided the well is properly constructed to exclude wash from the surface), for as a general rule such waters are free from bacterial contamination and are pleasing to the taste. However, the bacterial purity of a water is not the only desirable attribute, especially in communities where prosperity and happiness depend upon industries and their development.

The State of Illinois may be called a "hard water" state for the average hardness of the ground waters is probably in the neighborhood of 350 p.p.m. or more.

From a chemical analysis of the mineral content of something over 400 well waters it is found that the hardness varies from 16 to 1130 p.p.m. The residue varies from 200 to 5050 p.p.m. and the iron content from 0 to 10 p.p.m.

From the standpoint of boiler use, undoubtedly the greatest industrial use to which water is put in the state, the hard scale forming minerals arc perhaps the most serious, while the corroding and foaming waters follow closely.

The hard scale forming elements vary from 4.5 to 1150 p.p.m. and there arc wells which are yielding from 1000 to 1250 p.p.m. of sodium chloride.

In general, those waters which are low in the calcium-magnesium hardness, arc high in the sodium salts and vice versa.

In a rather detailed study of waters from 22 wells located in the north tier of counties, some interesting information came to light.

In making this study the wells were first grouped in terms of the

[1]Presented before the Illinois Section meeting, May 13, 1929.

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water bearing rock, for example, the first group included wells drawing water only from the lime rock; the second included wells drawing water from the St. Peter and above; the third wells drawing water from the Dresbach and above; and the fourth wells drawing water from the Mt. Simon and above.

There are other wells in this zone than those considered, but the information on record was not complete enough to permit them to be compared with the 22 selected.

In the first group, namely water drawn from the lime rock only, there is but one well, that at Elizabeth in Jo Daviess County, the

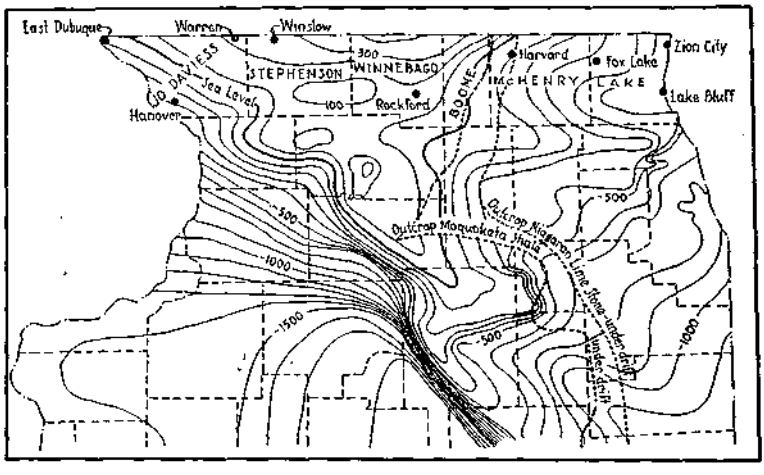

FIG. 1. STRUCTURE MAP OF NORTHERN ILLINOIS SHOWING CONTOURS ON TOP OF DRESBACH SANDSTONE

westerly county of the strip. This well is so constructed that all the water is obtained without question from the lime rock which in this location is of the Galena-Platteville formation.

As would be expected the water is high in calcium and magnesium with a hardness of 477 and a residue of 559 p.p.m. The chlorides are low, but the sulfates are sufficient to produce some hard scale if the water is used for boiler purposes.

In Lake County, which is on the easterly end of our strip the limestone is known as the Niagaran, a younger formation than the Galena, and water from it is very likely to be highly sulfurous.

The St. Peters sandstone which underlies this strip of Counties was the first sandstone to receive attention as a source of water supply.

Eight wells into this horizon have an average hardness of 323, the lowest having a hardness of 149 and the highest 416 p.p.m.

While all these wells terminate in the St. Peters sandstone all but one are open to the superimposed lime rock and are, therefore, not

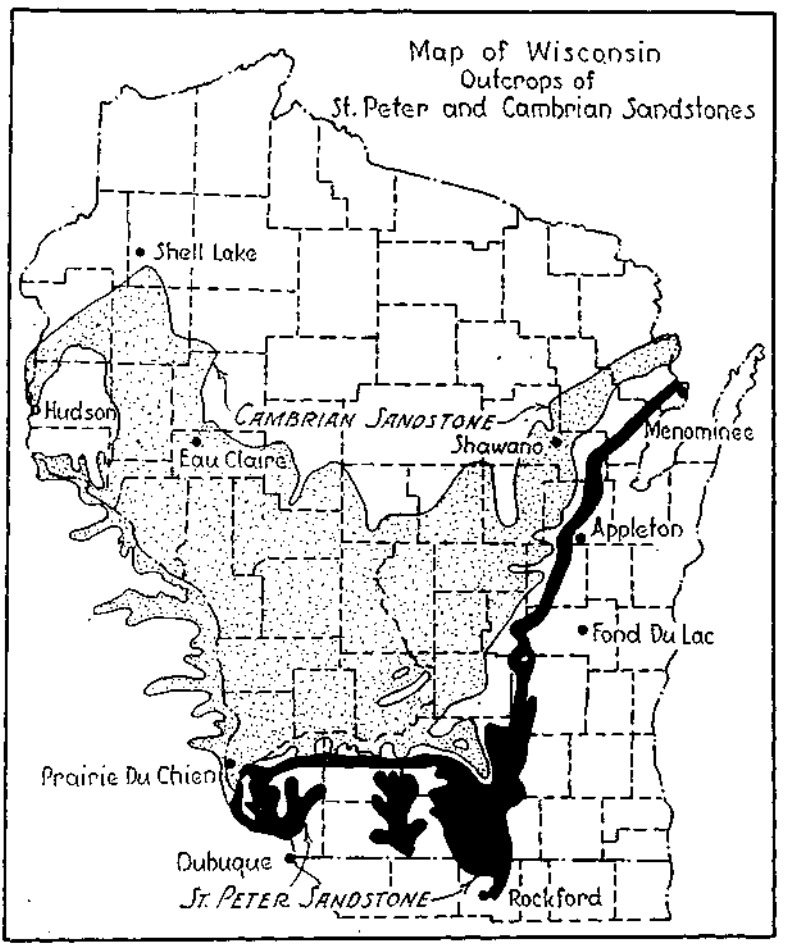

FIG. 2

strictly representative of St. Peter water, but are a combination of the water from both water bearing rocks. In the case of the one well at Winslow, the limestone water is cased off and the analysis may be considered as a sample of St. Peter sandstone water.

In this group of 8 wells there is a progressive deepening of the wells from west to east and an increase in temperature in the deeper over the shallower wells.

Perhaps the most interesting feature, however, is that the four wells west of Rockford show an average hardness of 361, while the four east of Rockford show an average hardness of 284 p.p.m. The residue, however, remains about the same on either side of the line at an average of 400. The methyl orange alkalinity averages 341 for the west group and 278 p.p.m. for the east group.

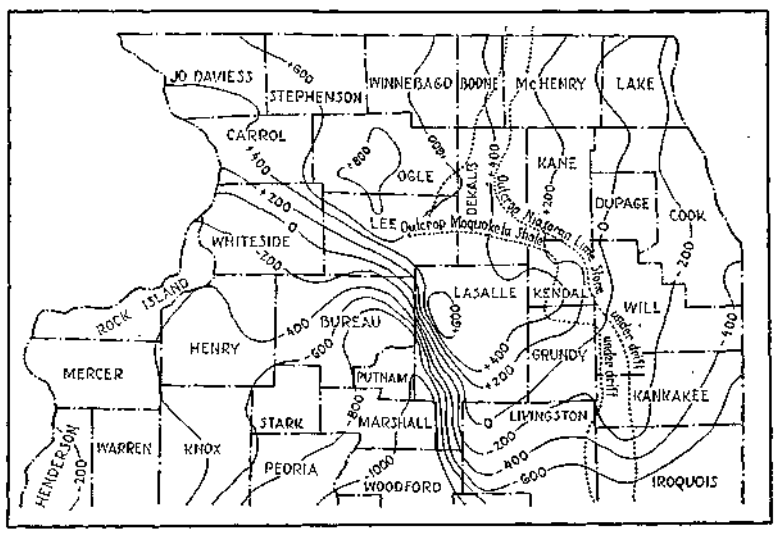

FIG. 3. STRUCTURE MAP OF NORTHERN ILLINOIS SHOWING CONTOURS ON TOP OF ST. PETER SANDSTONE

The four westerly wells show a total of all sodium salts of 192, while the easterly wells have a total of 397 p.p.m. In general, there is a greater concentration of sulfates in the four eastern wells but a less concentration of carbonates.

In connection with the St. Peters sandstone and the mineral quality of water thereform, it may be interesting to note the shape of the contours of the top of the St. Peter sandstone, as shown on figure 3.

This map indicates the great disturbance that took place after the deposition of the various rocks up to and including the Niagaran limestone. Later erosion planed off the arch this formed and with

it a considerable portion of these more recently formed rocks. This is particularly true of the portion of the strip from somewhat east of the west line of McHenry County, west, where practically all of the Niagaran limestone has been removed together with much of the Maquoketa shale which immediately underlies it.

It may be that the increase in hardness in the westerly group of wells is due to the removal of the protective coating of the Maquoketa shale thus permitting the absorption by the St. Peters sandstone of water which has passed through the Galena Plalieville limestone and thus has become more heavily charged with calcium and magesium.

The next group of wells are those which enter the Dresbach sandstone. This sandstone is the youngest of the Cambrian system and is one of the so-called Potsdam water horizons.

There are five wells into this horizon where the hardness varies from 198 to 360, with an average of 272 p.p.m. This is a figure that is 12 points lower than the average hardness of the 4 easterly wells in the St. Peters group.

These wells are cased through the first lime rock thus excluding water from this zone, and two of them have cased off the water from the St. Peter sandstone. They indicate that it may be reasonable to find an increase in hardness and residue from west to east together with an increase in iron concurrent with the increasing depth of the Dresbach from west to east.

There may be a slight increase of the chlorides but the sulfates remain low.

Taking it altogether this is a water having many desirable qualities, and, if found in sufficient quantity to supply the demand, can be economically developed, as it is not excessively deep.

The last group consists of eight wells extending into the lowest of the water bearing sandstones, namely the Mt. Simon. It may be pertinent to state at this point that this sandstone is the deepest from which we may expect to secure satisfactory water.

This horizon is prolific in its yield, but is more highly mineralized than the others. We have no way of knowing just what the mineral content of water exclusively from the Mt. Simon is because all the wells from which waters have been analyzed are a mixture of water from all the water horizons passed through, it being the practice to leave open all the strata which are sufficiently rigid to sustain and maintain the open bore.

The eight Mt. Simon wells vary in depth from 1343 at E. Dubuque to 2269 feet at N. Chicago. As a group the hardness varies from 245

to 440, with an average of 353 p.p.m. The residue varies from 263 to 776, with an average of 479 and the M.O. alkalinity from 228 to 340, with an average of 277 p.p.m.

The interesting thing, however, is that in this group we apparently again have a demarkation between an easterly and westerly subgrouping, with the line of separation again somewhere between Rockford and Belvidere.

For the three westerly wells the average hardness is 263 while for the five easterly wells it is 408. Similarly the average residues are 285 and 595 p.p.m., respectively and the M.O. alkalinity 249 and 293, respectively.

While the chlorides show a rather marked increase the five easterly wells are the greatest offenders by a large margin. The same five easterly wells also show a great increase in sulfates.

The explanation of this interesting phenomenon is not easy, but it may be that, since the Mt. Simon sandstone lies higher in the westerly part of the state and continues so up through the westerly part of Wisconsin, the absorbed water has a much less distance to travel and also because of its lesser temperature does not take up soluble mineral matter so easily, while in the easterly part of the state the reverse condition is true.

The increase in temperature of the water in deeper wells has been mentioned and in the records available indicates a difference of from 50° F. in waters from the shallower lime rock wells to 65° F. and 70° F. for waters from the deeper Mt. Simon wells. The temperature, therefore, is an index of the depth from which the water is drawn.

In a comparison made recently of the mineral content of waters from the Mt. Simon sandstone wells in the vicinity of Maywood to Elmhurst it was found that in those wells deeper than 2050 feet there was a distinct tendency to high concentrations of sodium chloride. For instance, at Melrose Park with a depth of 2117 or — 1485 sea level, the NaCl amounted to 1256 p.p.m. At Bensonville with a depth of 2291 or —1616 sea level the NaCl was 712, at Elmhurst with a depth of 2219 or — 1554 sea level the NaCl was 850 p.p.m. Altogether there are eight wells in this general territory that have waters containing 400 p.p.m. or more of sodium chloride.

From this hasty outline it is evident that much information of scientific value would be obtained if we could arrange to have samples of water taken at intervals as the well progresses. The Water Survey is prepared to furnish containers for these samples and to make the analyses if advised from time to time of the progress of the work.

So far, deep or rock well waters have been discussed and it may be of interest to recite the efforts of a Central Illinois city in the hunt for an adequate supply of soft water. It is one of those cities which must secure its water from the drift if well water is to be used.

This little city is well located for development into a small industrial center and could easily become such if it had an adequate supply of soft water which it could offer to prospective as well as existing enterprises.

The Water Survey and Geological Survey were requested to cooperate with the municipal officials. The first step was a survey of the present water supplies for the various industries. In this survey some 17 waters were analyzed for their mineral content. The wells from which these waters were obtained are contained within a circle, the center of which is the Court House Building and having a radius of about 4800 feet.

This survey developed the information that the hardness of these waters varied from 175 to 800 p.p.m. The two wells from which the city obtained its supply had a hardness of 659 and 707 p.p.m., even though they were only about 65 feet apart.

A tabulation of the analyses showed that the hard waters were in the southwesterly, south and west parts of the city while the soft water wells so far developed were in the northeasterly part of the city.

It may be of interest to mention that the six wells giving waters with a hardness factor ranging from 175 to 250 p.p.m. were all located in a very restricted area, the extreme distance between any two wells being not more than 300 feet.

Some previous studies for a possible future water supply of better quality for this city indicated the possible location of such a source and this second survey confirmed the preceding conclusions to a considerable degree and recommendations that test wells be drilled were concurred in by the municipal authorities.

Four test wells all about 100 feet deep were constructed. The hardness of the water from these wells indicates very clearly that a water of a hardness around 200 p.p.m. is to be had, but that such water is located to the northeast of the city and outside the municipal corporation.

Complete delineation of the water bearing area has not been made, but it is hoped that the city administration will continue the work already started.