MINERAL CONTENT IN WATER FROM FIFTY THREE WATER-WELLS IN DEKALB AND SYCAMORE QUADRANGLES, ILLINOIS

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ABSTRACT. — Water samples from 53 selected wells located in the DeKalb and Sycamore quadrangles of northern Illinois were analyzed for mineral content. Total hardness values are related to the kind of aquifer and to the amount and nature of the overlying strata.

The area selected for this study is located in DeKalb and Sycamore Quadrangles, northern Illinois. The wells are located in the townships of Sycamore, Cortland, DeKalb, Malta, and Milan in DeKalb County.

Water samples from 53 selected wells analyzed for mineral content to determine the relation between the total mineral hardness values and the aquifers from which they were pumped. The 53 wells were selected and classified into three types according to the aquifer horizon in which they were based; 38 Galena-Platteville wells, 2 St. Peter and deeper aquifer wells, and 14 glacial drift wells. The 38 Galena-Platteville wells were divided into sub-groups I, II, III, and IV, representing four different aquifers with four different overlying strata situations.

GEOLOGY OF THE STUDY AREA

The glacial drift consists of unconsolidated materials which form a mantle of varied thickness in these five townships. It is thicker along the western edges of the DeKalb Quadrangle and generally thins toward the eastern edge of the Sycamore Quadrangle (a distance of some 18 miles). The maximum thickness of the glacial drift is about 360 feet; the average, about 150 feet; and the minimum, about 15 feet. The reason for this variable depth lies in the preglacial erosional events that provided a general southwestward slope to the preglacial topography. This topography was an expression of erosional effects of the early drainage system known as the ancient Troy River system. The main Troy valley lies somewhat west of the boundaries of the study area, but one of its tributaries underlies this study area as reported by Caldwell in 1962.

All strata studied here dip about 14 feet per mile southeastward. A 50 foot upwarp in this dip trend occurs in the southwest corner of this study area as reported by Caldwell (1962). An indication of the eroded surface may be seen on Figure 1, which gives the relief of this landscape prior to the deposition of glacial drift.

The Niagaran Dolomite is the topmost strata of the buried bedrock surface. This Niagaran Dolomite in the study area occurs as an erosional remnant in portions of Cortland, DeKalb, and Sycamore townships (Fig. 2). Its variation in thickness results from partial chemical and physical removal before the glacier buried the area with drift. The Niagaran Dolomite is a compact dark to light gray dolomite. It serves as a caprock for lower aquifers.

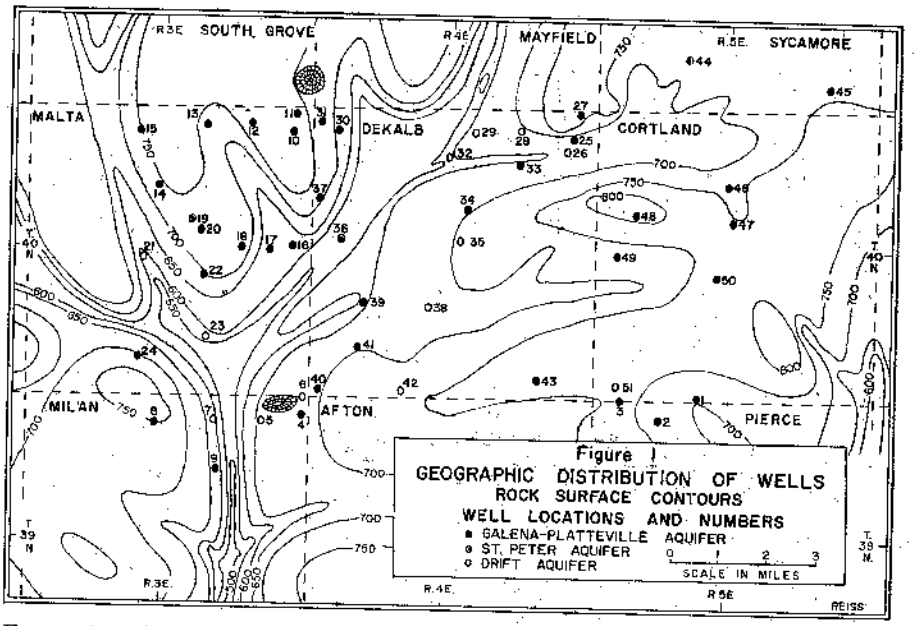

FIGURE 1.—Contour map of bedrock surface showing the study area located in the DeKalb and Sycamore Quadrangles of DeKalb County, Illinois. This map shows the geographic distribution, well numbers, and type of wells.

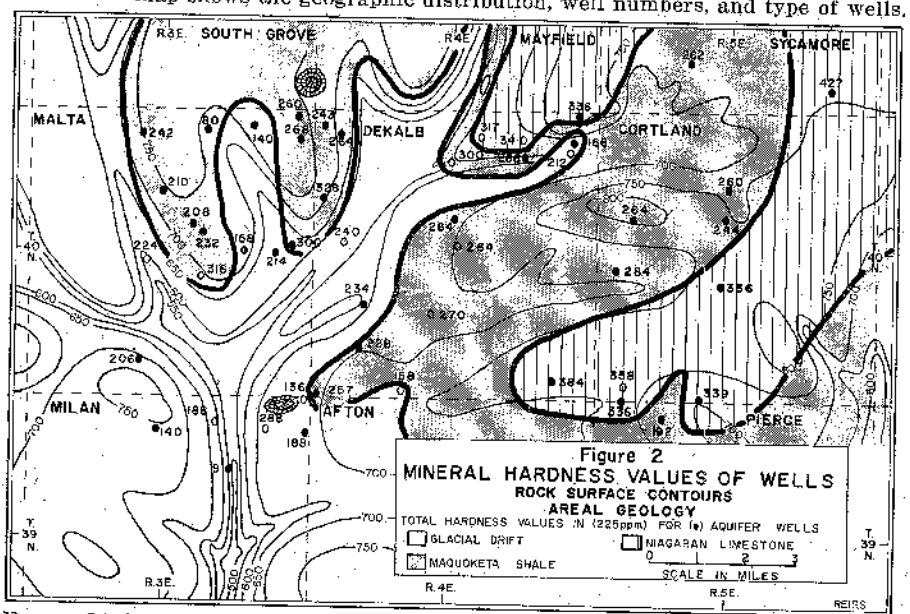

FIGURE 2.—Map showing total hardness values and overlying rock strata for wells located in the DeKalb and Sycamore Quadrangles of DeKalb County, Illinois. The area enclosed by the heavy black line in the upper left part of the figure is Maquoketa Shale.

The Maquoketa Shale, which lies beneath the Niagaran Dolomite has a thickness of 127 feet in the eastern part of the area, changing to zero thickness to the west and southwest. It is composed of calcareous shaly dolomite, compact dolomite, and soft black shale, interbedded with dolomite from top to bottom. It is a partially effective cap rock for lower aquifers.

The Galena-Platteville strata were originally about 345 feet in thickness but locally is less due to preglacial erosion in the western portion of the study area. It is dolomitic, light to dark buff, cherty, and is fine to coarse. It is composed of calcium and magnesium carbonate.

The Glenwood-St. Peter strata lie beneath the Galena and in the area varies from 55 feet in thickness in the eastern part of the study area to 95 feet in the west. The Glenwood Shale is a dolomitic, sandy, silty, argillaceous, grayish green, fine to coarse-grained sandstone. It is friable and contains some gray-brown shale. The St. Peter Sandstone is white, fine-to coarse-grain ed, silty, stained yellow, brown and is shaly. It contains oolites and it is cherty, siliceous, and compact. The top level of the St. Peter aquifer lies at 334 feet elevation in the area of this study. The St. Peter aquifer is separated from the aquifers about it by the impervious Glenwood shale.

This study area has a buried bedrock topography consisting of the pre-glacial Troy River, located west of this area. The buried Troy River channel lies at an elevation near 400 feet, while the Shabbona Tributary stream, flowing from north to south through the center of the DeKalb Quadrangle, follows closely along the bedrock surface contact of the Galena and Maquoketa strata. The Galena Dolomite lies west and the Maquoketa Shale lies northeast of this buried outcrop contact line. Long tongues of the Galena Dolomite are exposed in the lower portions of the stream valleys in the south and the central portions of the Sycamore Quadrangle. The Galesville Sandstone aquifer of middle Cambrian in age underlies the entire study area at depths averaging 1300 feet beneath the present surface, as described by Hackett (1960).

Procedure for Gathering Data

Description of wells—The location of the 53 are shown on Figure 1. Each well is cased to bedrock. Thirty-eight wells that terminated in the Galena-Platteville aquifers were chosen. These wells are described on Tables 1, 2, and 3 and total hardness values are given in Figure 2. The analyses of the 53 water samples were made by Solyom (1962, unpublished thesis). The 53 water samples of the study were also analyzed by the laboratories of the Illinois State Water Survey, Urbana, Illinois. The Illinois State Water Survey data was used where differences in data occurred between the two analyses.

The well data for 38 water samples from the Niagaran, Maquoketa, and Galena-Platteville aquifers are described in Table 1 and their locations appear on the bedrock surface map (Fig. 1). The data of this figure enables a comparison of total hardness (as $CaCO_3$) with aqui-

TABLE 1.—Water Analysis Data from 38 Well Samples Pumped from Galena-Platteville Aquifers. Elevation and Depth Data in Feet.

Township	Well no.	Surface elevation	Well depth	Bottom of well elevation	Elevation of rock surface	Calcium (ppm)	Magnesium (ppm)	Iron (ppm)	Total hardness (ppm)	Total dissolved minerals (ppm)	Alkalinity as $CaCO_3$	Laboratory no. State Water Survey
I. NIAGARAN DOLOMITE—(only overlying strata) Base Elevation approx. 735'												
T39N R5E	3	890	140	750	775	60	45	2.7	336	378	372	160956
T40N R4E	43	810	75	735	760	86	41	3.0	384	410	364	160973
T40N R5E	50	870	110	760	770	70	39	0.6	336	344	332	160965
Average ppm									352			
II. MAQUOKETA SHALE—(only overlying strata) Base Elevation approx. 620'												
T39N R5E	1	880	200	680	760	71	39	7.8	339	372	350	160953
T40N R3E	14	920	180	740	750	41	26	0.4	210	290	274	160718
T40N R3E	15	900	180	720	750	46	31	0.3	242	327	318	160719
T40N R3E	16	900	260	640	650	49	43	0.8	300	356	332	160723
T40N R3E	19	910	200	710	725	32	31	0.6	208	270	276	160726
T40N R3E	22	880	202	678	700	59	41	6.3	316	358	346	160963
T40N R4E	27	840	172	668	750	70	39	2.4	336	340	344	160948
T40N R4E	34	890	200	690	760	44	37	1.1	264	344	331	160731
T40N R4E	37	890	205	685	700	57	45	1.6	328	368	360	160966
T40N R5E	46	860	150	710	725	53	31	4.0	260	300	294	160957
T40N R5E	47	880	210	670	750	44	33	1.9	244	274	285	160955
T40N R5E	48	900	185	715	800	67	23	1.7	264	330	316	160959
T40N R5E	49	900	215	685	720	62	31	1.1	284	347	330	160960
Average ppm									276			
III. MAQUOKETA AND GALENA-PLATTEVILLE—(only overlying strata) Base Elevation 334' approx.												
T39N R5E	2	880	215	665	725	38	24	0.9	192	264	254	160954
T40N R3E	10	885	485	400	750	48	36	1.5	268	326	320	160709
T40N R3E	11	880	476	404	750	45	36	0.7	260	314	312	160711
T40N R3E	13	905	250	655	750	41	19	0.6	180	258	244	160715
T40N R3E	17	910	550	360	620	43	26	1.3	214	272	260	160724
T40N R4E	20	910	300	610	730	38	33	0.7	232	292	296	160727
T40N R4E	30	880	490	390	700	46	36	1.3	264	316	318	160722
T40N R4E	31	870	225	645	725	44	32	2.3	243	324	306	160951
T40N R4E	33	860	250	610	650	56	36	1.7	286	332	320	160961
T40N R4E	40	870	250	620	700	46	35	1.6	257	350	348	160971
T40N R4E	41	880	275	605	700	42	30	2.4	228	262	276	160970
T41N R5E	44	850	240	610	725	58	28	1.1	262	318	300	160949
T41N R5E	45	850	270	580	740	93	47	13.0	427	504	500	160958
Average ppm									254			

Township	Well no.	Surface elevation	Well depth	Bottom of well elevation	Elevation of rock surface	Calcium (ppm)	Magnesium (ppm)	Iron (ppm)	Total hardness (ppm)	Total dissolved minerals (ppm)	Alkalinity as $CaCO_3$	Laboratory no. State Water Survey
IV. GALENA-PLATTEVILLE—(only overlying strata) Base Elevation 334′ approx.												
T39N R3E	4	870	420	450	675	40	21	1.6	188	262	256	160714
T39N R3E	8	870	200	670	750	24	19	0.8	140	224	232	160716
T39N R3E	9	880	520	360	560	26	16	0.6	132	266	254	160721
T40N R3E	12	880	196	684	750	31	15	1.1	140	250	220	160712
T40N R3E	18	910	250	660	720	33	18	0.6	158	232	236	160725
T40N R3E	24	920	305	615	700	29	32	0.3	206	268	264	160735
T40N R4E	25	830	385	445	700	41	15	1.1	166	248	236	160710
T40N R4E	39	890	300	590	650	50	27	2.2	234	284	277	160969
Average ppm									170			

TABLE 2.—Water Analysis Data from 2 Well Samples Taken from Wells in the St. Peter Aquifer and in the Galesville Aquifer.

Township	Well number	Surface elevation	Bottom of well, elevation	Elevation of rock surface	Well depth	Calcium (ppm)	Magnesium (ppm)	Iron (ppm)	Total hardness	Total dissolved minerals	Alkalinity as $CaCO_3$	Laboratory number State Water Survey
T39N R3E	36	900	260	550	St.P. 640	46	30	1.6	240	292	296	160732
T39N R3E	52	880	135	535	Gales. 745	71	38	1.6	332	376	352	160962

fer source and with the overlying strata which covers the aquifers as shown in Figure 2.

The dissolved mineral analysis data from the St. Peter aquifer samples are described in Table 2. The amount of total hardness values are related to depth in this Table.

Data shown in Table 3 describes 13 wells terminating in the glacial drift. These data of total hardness (as $CaCO_3$) are reported along with the well depth and bedrock surface elevations at the well locations. The samples were analyzed for dissolved content of calcium, magnesium and iron compounds by Solyom.

Water samples were collected in bottles, labeled with the owner's name, address, and location. The

TABLE 3.—Water Analysis Data from 14 Well Samples Taken from Various Levels in the Glacial Drift.

Township	Well number	Surface elevation	Well depth	Bottom of well, elevation	Elevation of rock surface	Calcium (ppm)	Magnesium (ppm)	Iron (ppm)	Total hardness	Total dissolved minerals	Alkalinity as $CaCO_3$	Laboratory number State Water Survey
T39N R3E	5	880	140	740	650	45	28	1.7	228	292	282	160713
T39N R3E	6	870	147	723	700	26	17	0.3	136	244	226	160720
T39N R3E	7	880	160	720	600	39	23	0.6	188	276	282	160717
T40N R3E	21	890	190	700	600	40	34	1.2	240	306	300	160730
T40N R3E	23	920	305	615	550	30	34	1.0	213	296	274	160734
T40N T4E	26	840	180	660	655	41	27	1.2	212	312	296	160728
T40N R4E	28	850	90	770	700	60	40	1.6	314	358	354	160950
T40N R4E	29	850	80	770	650	57	42	1.1	317	362	348	160952
T40N R4E	32	870	180	690	650	52	41	0.8	300	352	348	160733
R40N R4E	35	870	160	710	700	37	42	0.2	264	306	312	160964
T40N R4E	38	860	100	760	675	50	35	1.8	270	334	324	160967
T40N R4E	42	860	137	723	750	26	23	1.4	158	208	198	160972
T40N R5E	51	890	100	790	775	82	37	1.6	358	386	328	160968
T38N R3E	53	870	000	870	750	134	55	0.1	560[1]	640	384	160729

[1] The total hardness value of well number 53 is 560 parts per thousand. This high total hardness value should be associated with the fact that well number 53 pumps water from the surface in a spring.

bottles were rinsed three times with the water that had been running for several minutes from the well, filled to overflowing, and capped securely.

Water analysis.—The following procedure was employed in water sample analysis. For the determination of total hardness, calcium, and magnesium, the Versenate method was used as described by the American Public Health Association (1961). This is a widely accepted method for the accurate determination of these dissolved minerals in water samples.

These analytical data were recorded on mineral-analysis recording sheets showing the wellowner's name, address, geographical location, and the date of well sampling. Less than half of the pint water samples were used in analyses. The remaining sample is stored with the Northern Illinois University, Department of Earth Sciences.

INTERPRETATION OF DATA

The three wells of group I were bottomed in the Niagaran Dolomite of the study area. These three water samples are numbered 3, 43, and 50. Their average total hardness is 352 ppm. The Niagaran Dolomite has an average base elevation of 735 feet in the area of these wells. The highest total hardness average was obtained from these wells.

Group II has thirteen wells which are based in the Maquoketa Shale. Their well numbers are 1, 14, 15, 16, 19, 22, 27, 34, 37, 46, 47, 48, and 49. Their average total hardness

value is 276 ppm. The average base elevation of the Maquoketa Shale where it occurs in the study area is 620 feet. As reported by Caldwell in 1962, there is a stratigraphic dip in the southwest portion of this study area which brings the base of the Maquoketa Shale to approximately 670 feet. This situation allowed wells numbered 8, 12, and 18 to be in group IV and wells numbered 2, 13, and 31 to be in group III. Well numbered 17 is listed with group III because of its nearness to the margin of the Maquoketa Shale as shown on Figure 2.

Group III has thirteen wells which take water from the Galena-Platteville aquifer with Maquoketa Shale overlying the aquifer. Their total hardness values range from 180 to 286 ppm if well number 45 is excluded from the group. Well number 45 has a total hardness value of 427 ppm which may be due to some local ground water situation which this study did not identify. The base elevation of this Galena-Platteville aquifer is 334 feet.

Group IV has eight wells based in the Galena-Platteville aquifer with no overlying strata. Their total hardness values average 170 ppm.

The thirteen wells based in the glacial drift and the two deep wells based in the St. Peter sandstone and the Galesville Sandstone show no significant total hardness values as related to the aquifers and the overlying strata. Therefore Table 2 and Table 3 are given no interpretation in this study.

Summary

The total hardness values for group I average 352 ppm. Group II water samples have a total hardness average of 276 ppm. Group III water samples have an average total harness of 254 ppm. Group IV water samples have total hardness values with an average of 170 ppm. When these average values are related to the aquifer strata in which each group is bottomed and to the overlying strata for each aquifer, it is apparent that the three wells bottomed in the Niagaran Dolomite with only a glacial drift cover had the highest total hardness average value; thirteen wells bottomed in the Maquoketa Shale with only a glacial drift cover had the second highest total hardness values; thirteen wells bottomed in the Galena-Platteville aquifer with the Maquoketa Shale and the glacial drift overlying the aquifer had total hardness values that averaged 254 ppm which is third in rank. The group IV wells had the smallest total hardness value average of 170 ppm among the four groups of wells in the Type I Maquoketa-Galena-Platteville bottomed wells. These wells were bottomed in the Galena-Platteville aquifer with no overlying strata; only a thick glacial drift cover lay above the aquifer strata. Type II and III wells were given no interpretation in this study.

It seems apparent from the above summary that total hardness values in ground water samples taken from cased drilled wells as selected in this study are significantly related

to the kind of aquifer furnishing the water sample and to the kind and amount of overlying strata above that aquifer.

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