THE MT. SIMON SANDSTONE IN NORTHERN ILLINOIS[1]

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Wells in northern Illinois penetrate from 1600 to 2100 feet of upper Cambrian Mt. Simon sandstone between the Eau Claire formation and pre-Cambrian crystallines. In most of the region the sandstone is pure and light colored, but in the vicinity of Boone County all but the uppermost beds are silty, argillaceous, and dark red. The light-colored sandstone long has been correlated with the Mt. Simon formation of northwestern Wisconsin, but recently the red clastics were assigned provisionally to the pre-Cambrian and correlated with the Fond du Lac formation of eastern Minnesota. The present study shows that the red clastics of northern Illinois are a local facies of the light-colored Mt. Simon sandstone. On the basis of differences in grain size, the formation is divisible into seven regionally persistent members. Evidence is presented which suggests that the Mt. Simon sandstone of Minnesota and the upper part of the Mt. Simon at the type locality belong to the Eau Claire formation.

Previous and present studies.—Early subsurface studies in northern Illinois referred all sandstone beneath Eau Claire dolomitic strata to the Mt. Simon, although a possible Keweenawan age for the red clastics at Dixon was suggested (Thwaites, 1923, pp. 534, 553-555). Thwaites' tentative Keweenawan correlation at Dixon was rejected by Knappen (1926, pp. 34-36). In later studies the red clastics of northern Illinois and similar strata in eastern Wisconsin were stated to be of unknown age but were not separated from the Mt. Simon formation (Thwaites, 1931, p. 742; Twenhofel, Raasch and Thwaites, 1935, p. 1693, pl. 151). Possible correlation of the arkosic basal Mt. Simon strata of southern Lee County, Illinois, with the supposedly Keweenawan Hinckley sandstone of eastern Minnesota has been suggested (Payne, 1942, p. 54). Recently the red clastics of northern Illinois were correlated tentatively with the supposedly pre-Cambrian Fond du Lac formation of eastern Minnesota (Bays and others, 1945, p. 1146; Weller and others, 1945), and the regional lithology and thickness of the "Mt. Simon-Fond du Lac (?)" sandstones were summarized (Workman and Bell, 1949, pp. 2041-2043). In the present study all available cuttings from wells in central northern Illinois which penetrated the Mt. Simon and "Fond du Lac (?)" formations were carefully examined, as well as samples from deep borings in part of northeastern Illinois.

Name and definition.—At the type locality the Mt. Simon formation, named from exposures on and near Mt. Simon at Eau Claire, northwestern Wisconsin (Ulrich, 1914, p. 354), consists mainly of coarse-grained, partly conglomeratic, thick-bedded sandstone 234 feet thick, which overlies pre-Cambrian granite and underlies fine-grained thin-bedded *Cedaria*-bearing Eau Claire

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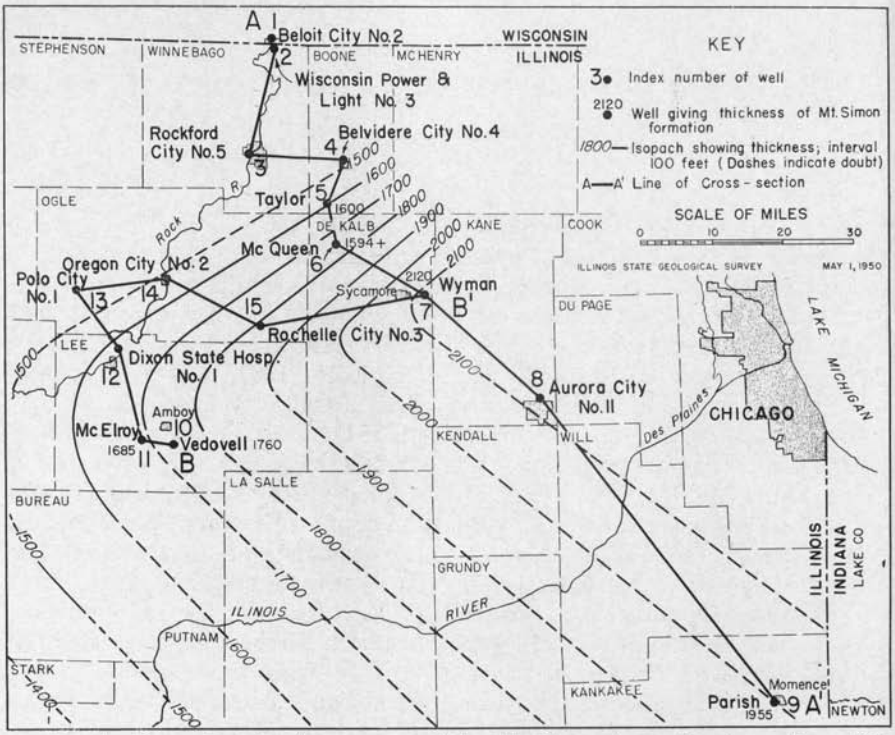

FIG. 1.—Isopach and reference map of the Mt. Simon formation in northern Illinois. (Modified from Workman and Bell, 1948, fig. 4.)

sandstone (Twenhofel, Raasch and Thwaites, 1935, pp. 1693, 1739-1740). In this report the name Mt. Simon is applied to all sandstone between pre-Cambrian crystallines and sediments which are classed as Eau Claire but probably underlie the *Cedaria* zone.

Thickness.—In northern Illinois only four wells (fig. 1, wells 5, 7, 10, 11) have completely penetrated the Mt. Simon sandstone, although two other wells (6, 9) are believed to have passed almost through the formation. The sandstone is thickest in a basin extending from DeKalb to Cook counties in northeastern Illinois and attains a maximum known thickness of 2120 feet in northeastern DeKalb County. From this area it thins rapidly to thicknesses of 400 feet or less in most of the states surrounding Illinois, and lenses out in northeastern Wisconsin and southwestern Ontario (Cohee, 1945, 1948).

Lithology.—In northern Illinois the Mt. Simon sandstone is divisible into a light-colored facies, which constitutes the bulk of the formation in most of the region, and a red facies, which is best developed at Belvidere, Boone County. Much gradation and interfingering characterize the transition zone between the two facies, which in places is less than 6 miles wide (fig. 2, wells 4, 5). Both facies are nonfossiliferous.

Light-colored facies.—The light-colored Mt. Simon facies is white, yellow, or pink to light brown. The sandstone ranges from very fine to very coarse grained and locally is silty. Much of it is conglomeratic, containing quartz granules from 2 to 4 mm. in diameter and quartz peb-

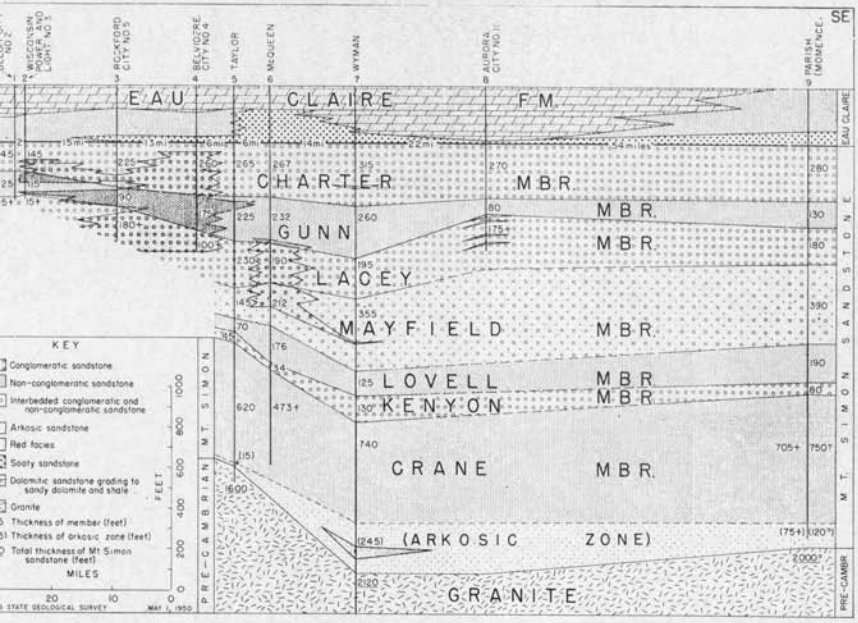

FIG. 2.—Northwest-southeast cross section of the Mt. Simon formation from loit, Wisconsin, to Momence, Illinois. (Line A-A', fig. 1.)

es from 4 to 8 mm. in diameter. As whole the sandstone is coarser ained than any other in northern inois. Sorting generally is poor, t some well-sorted beds are pres-t. Although the grains range from gular to well rounded, they are iefly subangular. The granules d pebbles are well rounded. Most the sandstone is incoherent, but in layers have been cemented by on oxide or silica. A zone varying om 15 to 249 feet thick at the base the formation is arkosic and local-contains biotite and muscovite kes as well as granite grains and bbles. Occasional grains of feld-ar and granite and very rare gab-o and quartzite pebbles have been served in higher beds. Thin layers dark-red or variegated, partly caceous shale and siltstone occur different horizons.

Red facies.—Where best developed e red facies is characterized by large amounts of disseminated dark-red hematitic clay and silt and by the presence of relatively thick interbeds of dark-red, partly micaceous, partly sandy shale and siltstone. Where weakly developed, as in southern Lee County, the facies is distinguished mainly by hematitic films on the sand grains.

Subdivision into members. — Throughout northern Illinois the Mt. Simon sandstone consists of a cyclic alternation of relatively fine-grained units and coarse-grained, granule-bearing units (figs. 2, 3). Although to the southeastward and westward granules become scarcer and smaller, and the entire formation grows more silty and finer grained, the sequence still is clearly distinguishable. Some lateral gradation or interfingering may take place along the contacts between the units. The seven major units present are herein regarded as members, and are

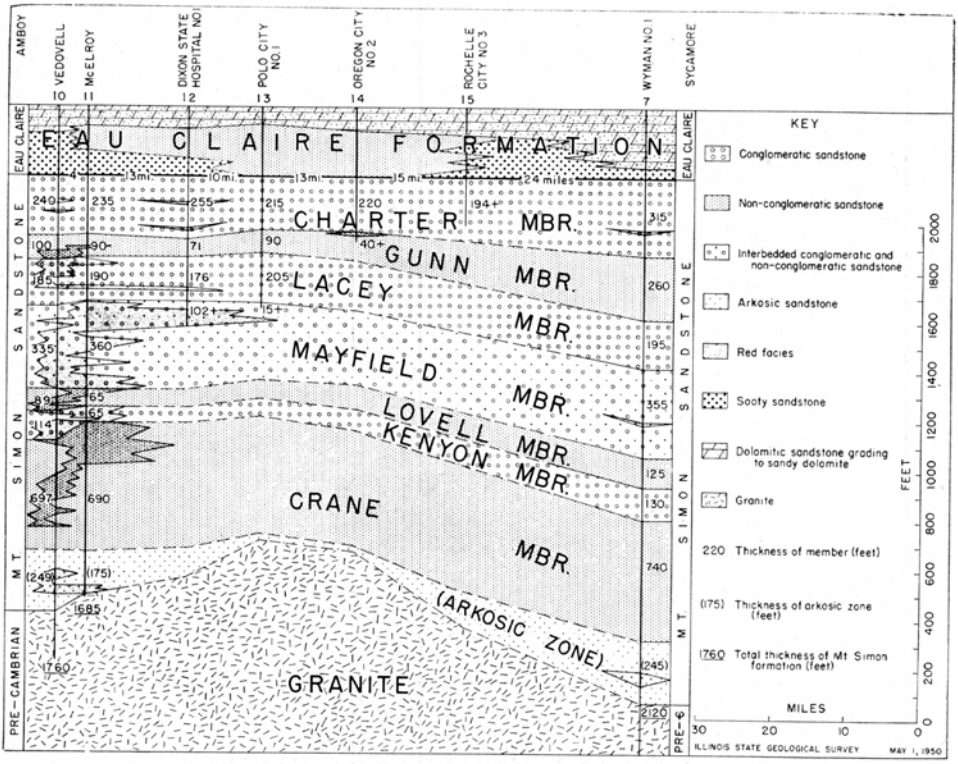

FIG. 3.—Cross section of the Mt. Simon formation from the vicinity of Amboy, Illinois, to the vicinity of Sycamore, Illinois. (Line B-B', fig. 1.)

named and described in ascending order. The members are made up of numerous subordinate units, many of which extend practically throughout the region.

The type well for the four lower members is Wyman No. 1 (well 7), a cable-tool well in the NE¼ NE¼ SE¼ Sec. 35, T. 41 N., R. 5 E., DeKalb County, Illinois, sample set 1301.[2] The type well for the three upper members is McQueen No. 1 (well 6), a cable-tool well in the SW¼ NE¼ NE¼ Sec. 27, T. 42 N., R. 3 E., DeKalb County, Illinois, sample set 1466.

Crane member.—For the relatively fine-grained basal member of the Mt. Simon formation the name Crane member is proposed. The name is derived from the Crane School, NW¼ NE¼ NW¼ Sec. 22, T. 40 N., R. 5 E. DeKalb County, 4 miles south of the type well. The "type section" consists of samples 387 through 491 in sample set 1301, extending from depths of 3105 to 3845 feet. The member ranges from 620 to 740 feet thick (figs. 2, 3). The grains range from very fine to very coarse, and a few granules are rarely present, but the predominant grades are fine and medium. The lower portion of the member generally is more or less shaly, silty, and arkosic.

Kenyon member.—For the thin conglomeratic sandstone overlying the Crane member the name Kenyon member is proposed. The name is derived from Kenyon school, NE¼ NW¼ NW¼ Sec. 17, T. 40 N., R. 6 E., Kane County, 3¼ miles south-

[2] Number of sample set in subsurface files of Illinois Geological Survey. Most samples in both sets represent five- or ten-foot intervals.

east of the type well. The "type section" consists of samples 367 through 386 in sample set 1301, extending from depths of 2975 to 3105 feet. The member ranges in thickness from 34 to 130 feet. Where less than 80 feet thick, it is composed chiefly of coarse-grained sandstone containing quartz granules, but where thicker it consists of conglomeratic sandstone interbedded with nonconglomeratic layers.

Lovell member.—The succeeding relatively fine-grained unit is here named the Lovell member for Lovell School, SW¼ NW¼ NE¼ Sec. 2, T. 40 N., R. 5 E., DeKalb County, three-quarters of a mile southward from the type well. The "type section" consists of samples 348 through 366 in sample set 1301, extending from depths of 2850 to 2975 feet. In thickness the member varies from 65 to 190 feet. Although grain sizes range from very fine to very coarse, the predominant grade is fine or medium. In the McElroy well (11) the member is partly coarse grained to conglomeratic but is clearly separable from the adjacent coarser-grained units.

Mayfield member.—Overlying the Lovell member is a thick sequence of interbedded conglomeratic and nonconglomeratic sandstones for which the name Mayfield member is proposed. The name is obtained from Mayfield Township, T. 41 N., R. 4 E., DeKalb County, Illinois, 5 miles west of the type well. The "type section" consists of samples 300 through 347 in sample set 1301, extending from depths of 2495 to 2850 feet. The thickness of the member ranges from 145 to 390 feet. The units composed of very coarse-grained to conglomeratic sandstone are from 5 to 125 feet thick; those made up of finer-grained nonconglomeratic sandstone are from 10 to 90 feet thick. In the McElroy well (11) most of the sequence is conglomeratic, but in the Taylor and Parish wells (5, 9) granule beds are very subordinate.

Lacey member.—The fifth Mt. Simon member consists principally of conglomeratic sandstone. It is here named the Lacey member from Lacey School, NW¼ NW¼ NW¼ Sec. 31, T. 42 N., R. 4 E., DeKalb County, 2½ miles east of the type well. The "type section" consists of samples 257 through 278, in sample set 1466, extending from depths of 1880 to 2070 feet. The thickness of the unit ranges from 176 to 230 feet. In most wells a bed or beds of comparatively fine-grained nonconglomeratic sandstone are present in the middle of the member, and in the Parish and McElroy wells (9, 11) interbeds of fine-grained sandstone occur in the lower part of the unit. Red shale layers commonly are more abundant in the Lacey and higher members than in the underlying strata.

Gunn member.—The Lacey member is overlain by a relatively fine-grained unit here named the Gunn member from Gunn School, NW¼ NW¼ NW¼ Sec. 16, T. 42 N., R. 3 E., DeKalb County, 2¾ miles northwest of the type well. The "type section" consists of samples 234 through 256 in sample set 1466, extending from depths of 1648 to 1880 feet. In thickness the member varies from 71 to 260 feet. The grain size ranges from very fine to very coarse, and a few thin beds of granule conglomerate generally are present. However, the grain size is conspicuously finer than in the adjacent members, and in several wells the dominant grade is fine.

Charter member — The coarse-grained to conglomeratic uppermost member of the Mt. Simon formation is here named Charter from Charter Oak School, SE¼ SE¼ SE¼ Sec. 2, T. 42 N., R. 3 E., DeKalb County, 3½ miles north of the type well. The "type section" consists of samples 204 through 233 in sample set 1466, extending from depths of 1381 to 1648 feet. The member ranges from 145 feet to 315 feet thick. In some wells it is composed almost entirely of very fine- to very coarse-grained sandstone which is mainly coarse grained and has one or more thin layers of granule conglomerate. In other wells conglomeratic sandstone makes up most of the member.

Stratigraphic relations.— The Mt. Simon sandstone rests unconformably on a pre-Cambrian basement complex. Where it has been penetrated by wells in northern Illinois, the complex consists of granite with local felsite dikes (Grogan, 1949). The Mt. Simon is overlain by the Eau Claire formation with apparent conformity in both Wisconsin and Illinois (Twenhofel, Raasch and Thwaites, 1935, pp. 1693-1696, 1714-1715).

Correlation.—In Kane County, northeastern Illinois, the basal two-fifths of the Eau Claire formation is composed mainly of sandy dolomite and shale which contains oboloid brachiopods in the lower half (fig. 2). Westward these beds grade laterally into gray, very fine- to coarse-grained sandstone which is given a sooty aspect by encrusting particles of black pyrite (Workman and Bell, 1949, pp. 2043-2049). The sooty sandstone extends into western Illinois and northward to Winnebago County. However, before reaching Beloit, Wisconsin, it passes laterally into light yellow sandstone which is distinguished from the underlying Mt. Simon sandstone by its finer grain-size and the absence of granules. Both the sooty and the yellow sandstone locally contain oboloid brachiopod fragments.

At the type section in Wisconsin the Mt. Simon sandstone shows the following sequence from the base upward: (1) granule-bearing, 3 feet, (2) without granules, 28 feet, (3) granule-bearing, 108 feet, and (4) without granules and containing oboloid brachiopod fragments, 95 feet (Twenhofel, Raasch and Thwaites, 1935, pp. 1739-1740). It is thought most likely that units 1 through 3 correspond, respectively, to the Lacey, Gunn, and Charter members and that unit 4 is equivalent to the basal Eau Claire sandstone of northern Illinois. Definite correlations must await detailed surface and subsurface tracing between Beloit and Eau Claire, Wisconsin. However, if this interpretation is correct, it would appear desirable to include unit 4 of the Mt. Simon type section in the Eau Claire formation because this unit (1) can be distinguished lithologically by the lack of granules, (2) is said to contain marine fossils, in contrast to the barren, presumably fresh-water beds beneath, and (3) grades eastward into dolomite which is entirely similar to the dolomite facies of the Eau Claire formation.

The sandstone termed "Mt. Simon" in eastern Minnesota directly underlies the Eau Claire *Cedaria* zone and in places contains much glauconite and glauconitic shale and siltstone (Atwater and Clement, 1935, pp. 1674-1676), which in Illinois is entirely confined to the Eau Claire formation. Most of this sandstone probably corresponds to the basal Eau Claire sandstone of north-

TABLE 1. TYPICAL HEAVY MINERAL ANALYSES IN PERCENTAGES

	Anatase	Apatite	Epidote	Garnet	Ilmenite	Leucoxene	Magnetite	Rutile	Titanite	Tourmaline	Zircon	Opaques	Unknown
Eau Claire sooty sandstone; base[1]	6	..	..	....	..	4	....	..	..	31	59	..	....
Mt. Simon light-colored facies; top[2]	1	..	..	....	1	3	....	..	..	27	68	..	....
Mt. Simon light-colored facies; lower[3]	1	..	..	Tr.	..	9	....	..	..	28	62	..	....
Mt. Simon light-colored facies; base[4]	..	..	..	9[a]	..	11	....	..	..	11	69	..	....
Mt. Simon light-colored facies; base[5]	..	..	..	20[a]	..	Tr.	40	..	..	20	20[b]	..	....
Mt. Simon red facies; upper[6]	..	..	..	....	5	1	....	..	..	19	76	..	....
Hinckley sandstone at Sandstone[7]	2	..	3[c]	....	..	18	Tr.[d]	2	..	12	63	..	Tr.
Hinckley sandstone at Net River[8]	1	..	1[c]	....	..	12	44[d]	1	..	13	27	..	Tr.
Fond du Lac sandstone[9]	..	50	..	7	..	A	....	..	..	23	13	4	2
Granite, Taylor No.1[10]	..	15	..	....	..	....	5	..	65	..	15[e]	..	....
Granite, McElroy No. 1[11]	..	C	R	....	C	P	P	P	..	..	C	..	....

[1]Well 7, 1710'-1720' (Herbert, 1944); [2]Charter member, Well 7, 1730'-1750' (Herbert, 1944); [3]Crane member, Well 7, 3790'-3805' (Herbert, 1944); [4]Crane member, Well 7, 3835'-3840' (Herbert, 1944); [5]Crane member, Well 5, 2900'-2905' (Marsden, 1933); [6]Gunn member, Well 5, 1645'-1650' (Herbert, 1944); [7]Tyler and others, 1940, p. 1512, sample P438B; [8]Tyler and others, 1940, p. 1512, sample P423B; [9]Tyler and others, 1940, p. 1508, sample P405; [10]Well 5, 2955'-2960' (Marsden, 1933); [11]Well 11, 3760'-3772' (Winchell, 1932; Grogan, 1949, pp. 98-99); [a]angular; [b]unzoned; [c]includes zoisite; [d]includes ilmenite; [e]zoned; A = abundant but not included in analysis; C = common; P = present; R = rare; Tr = trace.

ern Illinois, although true Mt. Simon strata locally may be included.

Except that it is indurated, the type Hinckley sandstone is exceedingly similar to the light-colored Mt. Simon sandstone of northern Illinois (Atwater and Clement, 1935, pp. 1669-1672, 1680; Stauffer and Thiel, 1941, pp. 15-23). The heavy mineral suites are fairly similar (table 1), although the Hinckley generally has higher proportions of magnetite, ilmenite and leucoxene and lower proportions of tourmaline and zircon. Feldspar is rare in the Hinckley, rare in the Mt. Simon of Illinois, except in the basal arkosic zone, and present only in very low percentages in the Mt. Simon of the type area (Stauffer and Thiel, 1941, p. 18, table 1).

The contact between the Hinckley and the underlying red Fond du Lac formation is gradational (Stauffer and Thiel, 1941, p. 17). The chief differences between the two sandstones are (1) the higher iron-oxide, shale, and feldspar content of the Fond du Lac, and (2) the presence of apatite and garnet and a higher percentage of leucoxene in the Fond du Lac heavy mineral suite. It seems most likely that the Fond du Lac is an arkosic, impure, basal facies of the Hinckley formation, the heavy minerals of which were derived from sources that later became buried. An analogous situation occurs in northern Illinois where the heavy mineral suite of basal Mt. Simon strata locally differs from that of the higher beds (table 1).

Raasch (1950) has presented evidence for the Cambrian age of the Hinckley and Fond du Lac formations. The writer tentatively correlates the entire Hinckley-Fond du

Lac sequence with the Mt. Simon sandstone of northern Illinois. Further study is needed to determine whether it has the same succession of conglomeratic and finer-grained members. Since no lithologic or physical evidence has been found for a formational break in the northern Illinois sequence, the name Mt. Simon is applied throughout.

The Mt. Simon sandstone of northern Illinois also is considered equivalent to the Bayfield and Jacobsville sandstones of the south shore of Lake Superior (Raasch, 1950) and to the Lamotte sandstone of eastern Missouri (Workman and Bell, 1948, pp. 2041-2043, figs. 2, 3).

Historical Interpretations

In Wisconsin the pre-Cambrian surface appears to have been a peneplain interrupted by monadnocks. The sparse data provided by wells in northern Illinois also suggest that the basement surface had slight relief.

It has been suggested that the Mt. Simon sandstone was rapidly deposited in a shallow, fresh- or brackish-water inland sea (Twenhofel, Raasch and Thwaites, 1935, pp. 1714-1715). The fact that the sandstone seems to be thickest in northern Illinois instead of thickening southward like most other Paleozoic formations supports this concept. Rapid sinking of the basement must have accompanied deposition to produce by far the thickest formation in Illinois. Periodic uplifts of the surrounding borderlands sent influxes of pebbly sand into the sea. Nonconglomeratic sand was laid down during intervals of crustal quiescence.

Probably the Mt. Simon quartz sand was derived mainly from weathered granites and gneisses to the north and was transported to the sea by streams. The general lack of rounding, frosting, and sorting indicates that the sand was not greatly reworked before deposition. The differences between the heavy mineral suites of the Mt. Simon and the underlying granite in northern Illinois (table 1) and the partial rounding of most Mt. Simon heavy minerals show that the bulk of the basal sand was not derived from the granite of that region. However, erosion of the granite contributed angular feldspar fragments to the initial sediments. The arkosic zone probably is thickest in the areas of greatest basement relief, as adjacent to monadnocks. That a minor part of the basement in northern Illinois or nearby areas consisted of schist is demonstrated by the presence of angular garnets in the heavy mineral suite of basal Mt. Simon strata in the Taylor and Wyman wells (5, 7) and by the occurrence of small schist fragments in the Mt. Simon of the Parish well (9).

In an area northward from Illinois a red clayey mantle probably developed on granitic rocks under conditions of low relief and a warm, humid climate, such as prevail at present in the southern Appalachian piedmont. It is believed that the Mt. Simon red facies was deposited off the mouth of a river which drained this area and discharged into the sea north of Belvidere, Boone County. The similarities in the heavy minerals of the red and light-colored facies suggest that both were derived from the same granitic terrane. Enlargement of the sea just prior to the marine invasion of Eau Claire time (Twenhofel, Raasch, and Thwaites, 1935, pp. 1714-1715) is reflected in abrupt overlap of the red sediments by a

relatively small thickness of white sandstone. Persistence of a drainage system which furnished red clastics is suggested by the recurrence of a similar red facies in the Franconia and uppermost Eau Claire strata of Boone County.

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