ART. XXIV.—*Is there a Huronian Group?* * by R. D. IRVING.

Synopsis of Contents.

I. STARTING with a statement of the values of the terms *System*, *Group* and *Formation*, as used in the nomenclature recently proposed by the Director of the United States Geological Survey, this paper enquires whether there can be carved off from the upper part of the great complex of rocks ordinarily known as Archæan, a *Huronian* series, entitled to rank with such groups as the Cambrian, Silurian, etc.

II. The rock series of the north shore of Lake Huron, between the Mississagui and St. Mary's rivers, mapped by Logan on Plate III of the atlas to the Geology of Canada, 1863, is the original or typical Huronian, and no other. The enquiry must then begin with this region.

III. This typical series of rocks is next shown to be entitled to the group rank by (1) its intrinsic characters, and (2) its structural, and consequently its chronological separateness from the older Archæan, and younger Cambrian and pre-Cambrian rocks of the region.

IV. The so-called Archæan rocks of the Marquette, Menominee, and Penokee districts of the south shore of Lake Superior are next considered, in the order of the districts named, and are shown to present the same divisibility into an upper detrital, and a lower crystalline schist member, which members are to be correlated respectively with the type Huronian, and with the crystalline rocks beneath

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t. This correlation is supported by: (1) a similarity of structural relations between the series correlated, in the different districts; (2) a similarity of lithological characters, group for group, and (3) a similarity in general stratigraphical position.

V. Attention is next invited to the region north of the western half of Lake Superior, the so-called Animiké series of which is the equivalent of the Penokee iron-bearing series, and hence of the original or type Huronian.

VI. The iron-bearing belt of the Vermilion Lake region of northern Minnesota is next considered, and found to furnish a case where newer detrital rocks have been folded in with the basement rocks, so as largely to obliterate the appearance of unconformity, a true schistose structure having at the same time been developed in the detrital series.

VII. The several discordances thus passed over in review—i. e., those respectively beneath the Animiké series, the Penokee iron-bearing series, the type Huronian of Lake Huron, the Marquette iron-bearing series, the Menominee iron-bearing series, and the Vermilion Lake iron-bearing rocks—form, in the order named, a graded series as to the degree of modification of the original discordances. When the subsequent disturbance has been great, cases must arise where the distinction between the two sets of rocks becomes very difficult, or even impossible.

But in all the several districts named there is plainly recognizable the same discordance, due to the same orographic disturbance, between the same sets of rocks.

Throughout the region stretching from the north shore of Lake Huron westward to the Mississippi River, in central Minnesota, there is recognizable the following order of succession, beginning below:

(1) The great basement or *Laurentian* complex of gneiss, granite and crystalline schists; as to whose further divisibility no opinion is now offered. This is separated by a great discordance from

(2) The *Huronian*, a detrital iron-bearing series. A further discordance severs this from

(3) The *Keweenawan* series of interleaved detrital and eruptive beds. This series again is entitled to the group rank. Above the Keweenaw series and separated from it by yet a third great discordance, follows:

(4) The *Potsdam* or Upper Cambrian sandstone.

VIII. Correlations of rocks of regions other than that now especially referred to, with the type Huronian, have generally been made without much foundation, having been based only on similarities to a fictitious lithological standard. Cautiously made correlations, however, for regions not too distant from each other, may have some value when based on a comparison of great discordances; since these discordances indicate the intervention of mountain-making movements of a necessarily wide-spread influence; but the more general correlation—collectively—of all the clastic groups, which in any one region intervene between the Cambrian and the basement crystallines, with any group or groups falling within the same interval in other regions, is the only one which is at present of any general application.

IX. The Huronian and the Keweenawan—and also such other groups of rocks as are found in other portions of the world beneath the Cambrian base, and above the Archæan schists—should be admitted to the geological column with the group rank. This admission, however, renders desirable a modification of the lower part of the column. It is suggested therefore that the term Archæan be used to cover only the pre-Huronian basement crystallines; that the Cambrian group remain as the basal member of the Palæozoic System, and that the new system name *Agnotozoic*, first proposed by Professor T. C. Chamberlin, be used to cover, at least provisionally, such clastic groups as intervene between the Cambrian base and the Archæan schists.

I. According to the system of nomenclature recently proposed by the Director of the United States Geological Survey,*

* As set forth in a paper presented at the International Geological Congress, (held in Berlin in 1885), and published in French at Paris in 1886, under the title of "Methodes de Cartographie Geologique Employés par L' United States Geological Survey."

the great fossiliferous rock complexes are classed in three orders of magnitude, namely: the *System*, the *Group*, and the *Formation*. Of these classes the most comprehensive is the *System*, which term is applied to those great divisions of the geological column which are defined by palæontology, and are recognizable the world over. Such are the Cenozoic and the Mesozoic Systems. Next in order cómes the *Group*, which term is designed to cover those great sub-divisions of the Systems which are "defined above all by palæontology, and subordinately by petrography, or are admitted by all geologists, for motives in part arbitrary. These are the groups. Those admitted by the Survey have been discovered in various countries; they have probably a universal distribution,* comprising all the formations of known clastic origin, and appear to be approximately comparable among themselves as to volume. It is not maintained that their limits are clearly marked, nor that they can be strictly traced along equivalent stratigraphical levels. Nor yet is it held that the testimonies of the different classes of fossils—vertebrates, invertebrates and plants—are always consistent with each other, or with that of petrography, as to their limits. These divisions are, then, to a certain extent arbitrary. We may increase or diminish their extent from time to time by adding or withdrawing formations in the neighborhood of their respective boundaries, just as the orders of biology are perpetually modified. . . . "† Such are the Cambrian, Silurian, Devonian and Carboniferous Groups. These generally recognized subdivisions of the geological column are *groups*, especially in the sense that they include each a number of subordinate divisions distinguishable from one another petrographically, genetically, and often even palæontologically. These subordinate members finally are the *Formations* of this system of nomenclature, though the use of the term formation is allowed also in a vaguer sense to cover any rock mass whose distinction from the surrounding masses is desirable on one ground or another.

In the paper referred to, this classification is proposed only for what are in it termed the clastic groups—*clastic*, in the sense that they are formed mainly of débris, whether it be of preëxistent rocks or of the hard parts of organisms. The rocks composing the groups have been deposited by the ordinary processes of sedimentation. Outside of these so-called clastic groups are left to be separately provided for the various rocks which have been termed collectively the crystalline schists, and which, in the paper referred to, are embraced under

* This is the signification of the French; but in the original English MS., from which the French translation was made for publication, this clause reads, "are presumptively world-wide in distribution."

† Translated from the French of the original article, op. cit., p. 15.

the general term of "non-eruptive crystallines." These are set off by themselves collectively because, while it is admitted that the larger part of them are of an age greater than those of the recognized clastic groups, it is desired to avoid for the present the still disputed points: (1) as to whether some of them are not altered clastic rocks of later geological age; and (2) as to whether those which unquestionably belong below the base of the ordinarily recognized Palæozoic groups are, or are not, divisible into members of a taxonomic rank equal with that of those groups.

It is with this latter question, or rather with a portion of it, that the present essay concerns itself. I say a portion of it because the general question as to what groups, if any, we should recognize among the pre-Cambrian rocks would be quite too broad a one for the space that can now be occupied. Not to speak of other points that would have to be considered, the answer to this general question would involve, in the first place, a discussion as to the separate existence, and taxonomic relations of the so-called Keweenaw Series of Lake Superior. My design is then merely to inquire if there can be carved off of the upper portion of the great complex which has been called Archæan, a series of *Huronian* rocks; a series entitled—by structural and genetic separateness, by clastic origin, by largeness of volume, and by the being made up of subordinate divisions of the formation rank—to the rank of a group, i. e., to a rank equal in classificatory value to the Cambrian, Silurian, etc.

II. The term *Huronian* seems first to have been used in a publication prepared for the Paris Exposition of 1855, by Sir Wm. Logan and Dr. T. S. Hunt, on part of the Geological Survey of Canada, and entitled "Esquisse Géologique du Canada." As used in this volume, however, the term has but a very vague and unsatisfactory signification. To begin with, it is used only as a synonym of *Cambrian*, and is not made to apply especially to any one individual or typical area, but to embrace vaguely defined series of rocks occurring in various wholly separated areas on Lakes Superior and Huron, which series may or may not be geologically equivalents of one another so far as any evidence presented goes to show. Moreover, the term is made to cover also the great and wholly distinct succession afterwards separated out as the Copper-Bearing or Keweenaw Series.

The term Huronian was afterwards used in various reports of the Canada Survey, with a somewhat changing signification, until, in 1863, Sir William Logan gave, in the Geology of Canada, a thoroughly definite account of the series, including

all information to date. With this description he gives also a detailed map and sections of "The Huronian Rocks" on the north shore of Lake Huron, between the St. Mary's and Mississagui rivers. This particular series Murray had described as early as 1848, as "a set of regularly stratified masses, consisting of quartz rocks or altered sandstones, conglomerates, slates and limestones, interstratified with beds of greenstone." Although both Logan and Murray extended the name Huronian to other rocks in the Lake Superior region this series was the only one so covered that was ever studied and mapped in any thorough manner, while the correlation of the other so-called Huronian areas with this one rested always on a pretty slender foundation. If then we seek—as we must do—for a type series with which to start a study of the so-called Huronian, we can find it only in this Lake Huron Series. This seems indeed to have done duty more or less definitely as such a type in the writings of European and American geologists for five and twenty years; although, most unfortunately, of the many who have made use of the name Huronian, only a very few have studied these rocks on the ground, in any such manner as to warrant the opinions they have so freely expressed.

Evidently our inquiry should begin with a study of this type series of rocks. Is this series, in its nature, volume and subordinate divisions, entitled to the rank of a clastic group? Do its structural relations and lithological contrasts with the great mass of the Archæan, with which it is in direct contact, indicate a chronological separateness? In attempting an answer to these questions, I make use not only of the facts summarized in Logan's descriptions and upon his map, but also of the results of my own observations extended during two seasons, not only in the area especially mapped as Huronian on the plate to which I have already referred, but also over a large contiguous area further to the eastward, which has been mapped as Huronian on the recent general maps of the Canadian Survey.

III. Briefly, then, that series of rocks, which is especially mapped by Logan on the plate above referred to, and which we may properly designate as the type or original Huronian, may be described as a great succession of quartzite layers, including a subordinate quantity of greywackes, a much smaller proportion of "limestone and chert" and numerous eruptive diabasic greenstones; the latter occurring both in dyke and sheet form. In the main the series is but very gently bowed. Only rarely the inclinations of the strata reach twenty degrees, while large areas occur, particularly in the interior and away from the lake shore, where the strata are not visibly removed from horizontality, the whole appearance of the topography in

such cases recalling strongly many regions of later horizontal strata, for instance that of the upper Mississippi valley.

According to Murray and Logan*—for whose painstaking accuracy and general geological insight I acquired the greatest respect while passing over the region, with their map and descriptions in hand—the series is made up of the following succession of strata, in ascending order, viz:†

Fig. 1. Section of the original or type Huronian, showing its relation to the pre-Huronian crystallines, Lake Huron. Scale, 10 miles to the inch. Reduced from Logan's section. *a–b*, Laurentian; *b–c*, Huronian; *d*, Cambrian and Lower Silurian.

	Thickness in feet.
1. Gray quartzite	500
2. "Chloritic and epidotic slates interstratified with trap-like beds"	2000
3. White quartzite, often conglomeratic	1000
4. "Slate-conglomerate, composed of pebbles of gneiss and syenite, held in an argillaceous cement of a gray to greenish color"	1280
5. Limestone, thin-banded, often argillaceous	300
6. "Slate-conglomerate," like No. 4	3000
7. Red quartzite	2300
8. "Red jasper-conglomerate;" a quartzite with frequent red jasper pebbles	2150
9. White quartzite	2970
10. Yellow chert and limestone	400
11. White quartzite	1500
12. Yellow chert and impure limestone	200
13. White quartzite	400
Total	18,000

* In the discussion which followed the reading of this paper, the point was made that I gave too much credit to Logan and too little to Murray, in the matter of the working out of the original or type Huronian series. My wish, of course, is to do exactly right in such a matter; but it is very difficult for one not familiar with the inside history of the Canadian Survey, particularly after the lapse of so many years, to adjust the credits correctly. In the Geology of Canada of 1863, which must serve as the source of information, the description of the series is all in Logan's own words, plainly. He also speaks distinctly of having examined this region in person (Preface, p. v); while Mr. Murray's examinations are said, in a general way only, to have extended over "Western Canada." In the atlas accompanying the Geology of Canada, however, it is said that the detailed map of the Huronian (Plate III. of the Atlas), to which reference is made above, is "chiefly from the surveys of Mr. Alex. Murray." The sections accompanying this map were drawn by Logan himself. (See Preface to Atlas, p. iv.) It would seem that Logan, after examining the ground himself to some extent, made use of Murray's more detailed studies also, from which to construct the map and sections himself, and to prepare the general description.

† Abbreviated from Logan's detailed section given in the Geology of Canada, 1863, pp. 56–58.

The thicknesses of the interbedded eruptives are not separately given, but their subtraction would not seriously affect these figures, except in the case of division No. 2, which, as subsequently shown, is very largely composed of diabase sheets. Placing together the several kinds of material composing Logan's section, without reference to stratigraphical order and without making any correction for included eruptives, the series is seen to be composed as follows: quartzite, 10,820 feet; "slate conglomerate," 4280 feet; "chloritic and epidotic slates and trap" 2000 feet: limestone and chert, 900 feet=18,000 feet. But a much more accurate conception of the relative proportions of the different kinds of rocks which constitute this series may be reached by making several important modifications of this statement. In the first place my own examinations of the ground, while they have served to convince me of the general correctness of Logan's section, have shown me that considerable portions of his "slate conglomerate" members are made up of quartzites, the remainder of these members being composed of dark-colored fragmental rocks, to which the name of greywacke more nearly applies than any other given in the books. Moreover, that portion of the series designated by Logan as "chloritic slates and traps" (No. 2), I have found by a study on the ground, and of a number of thin sections, to be mainly composed of a succession of diabase-sheets, along with which is a little interleaved fragmental material, perhaps partly of the nature of volcanic ash, but with which there is also some true sedimentary material. Taking these facts into account, and remembering also the interleaving of greenstone sheets at different horizons in the series, I estimate the whole succession to be about two-thirds quartzite, one-sixth greywacke, and one-twentieth "lime-stone and chert," the remainder being chiefly composed of eruptive material.

Of these rocks the *quartzites* are all no more nor less than indurated sandstones, without prominent schistose structure. The induration—which varies so greatly in degree that some of these rocks are almost loose sandstones, while others are completely vitrified quartzites, the two extremes occurring at times in close association with one another—is always due to the presence of an infiltrated silica. This infiltrated material occurs partly in the shape of a minute mosaic between the plainly recognizable rolled fragments of quartz, of which the rock is mainly composed; but is for the most part in the shape of enlargements or secondary growths to these fragments. This process of enlargement, which I have described and illustrated freely elsewhere, is one which, as I have been able to show, has affected fragmental quartzose rocks of all ages, from the most recent to the most ancient. Every stage in the development

of the process is recognizable among these ancient quartzites, as well as in the similar rocks of more recent formations. Even in the extent to which this indurating process has been carried on, the Huronian quartzites do not differ so remarkably from many sandstones of much later periods, like which they show also the ripple and other markings so characteristic of water-deposited sand.

The dark-colored fragmental rocks of this series, which I have embraced under the general head of *greywacke*, and which vary in coarseness of grain from aphanitic, slaty kinds to rather coarse grits, and are often dotted with pebbles and bowlders of granite and gneiss, are, equally with the quartzites, genuine clastic rocks, often differing in no respect from similar rocks found in various portions of the world, and at various horizons in the Palæozoic series, where they are found to be frequently highly fossiliferous. Indeed, these Lake Huron greywackes have on the whole undergone much less alteration than many fossiliferous rocks of a similar nature. Those of the north shore of Lake Huron are very regularly stratified, gray to black, often ripple-marked, compact aggregates of rounded to subangular mineral fragments, which include, besides pieces of quartz, particles of various other minerals, particularly of feldspars. Often the fragments are recognizable as particles of rocks, the disintegration having left the different mineral ingredients attached to one another. The thin sections of all of these greywackes show that their indurated condition is due partly, perhaps mainly, to a secondary deposition of interstitial quartz, entirely analogous to that just described as characteristic of the quartzites of the series; but that it is also due in part to a very general development of chloritic material from the feldspar fragments, to the presence of which chloritic ingredient the dark color of the rock is mainly due.

Limestone is made by Logan to constitute more or less of three numbers of his succession (Nos. 5, 10 and 12: respectively, 300, 400 and 200 feet in thickness). The lowest one of these three bands, which occurs in the lower half of the series, and is finely exposed along the shore of Lake Huron about two miles west of Bruce Mine Bay, is a thin-bedded, dark gray, often brown-weathering, compact and earthy-looking limestone. The very striking and regular thin lamination, which is brought out with the greatest prominence on weathered surfaces, the more impure laminæ being left projecting in little ridges above the more purely calcareous ones, seems to place the sedimentary origin of this rock beyond a question. This conclusion is borne out very emphatically by the appearance of the thin sections, which show distinctly a fragmental material mingled with the felted mass of minutely crystalline car-

bonate, the whole appearance of the section differing in no respect from sections I have examined of Palæozoic limestones. Not that it seems to me necessary to believe in a direct organic origin for the carbonate of lime contained. The whole process may have been a combination of the mechanical and chemical kinds of sedimentation such as we find exemplified in the clayey beds of the Coal Measures carrying carbonate of iron, and at various other geological horizons. The two other lime-bearing members of the series as marked by Logan are spoken of by him as very largely cherty, and as including here and there sandstone layers. In our own examination of these beds, made chiefly in the back country between Echo Lake and Garden River, it appeared to us that the cherty material predominated very largely over the calcareous. In this region the cherty layers are almost entirely horizontal, the whole appearance of the bluff sides of the exposures being that ordinarily presented by the horizontal formations, as, for instance, in the upper Mississippi valley. This horizontality, taken along with the very thin lamination of these rocks, and the presence of more or less distinctly detrital material, as is observable on the larger scale as well as microscopically, serves to place beyond question the sedimentary origin of these layers. Often these cherty beds are quite ferruginous, and at the same time brecciated, in which case they parallel very closely occurrences in the Marquette and Penokee iron regions on the south side of Lake Superior, and are not unlike occurrences among some of the later fossiliferous formations. Whatever may be true, then, of the origin of those great masses of coarsely crystalline limestone which are associated with the ancient gneisses, no doubt can be entertained of the sedimentary origin of these limestones of the original Huronian. Moreover, they have undergone since their first deposition changes no greater than are attributable to the action of infiltrating waters, or than those often found among the Palæozoic limestones.

Of the four principal kinds of rocks which constitute the series according to the estimate I have given above, there remain to be mentioned only those crystalline rocks which I have spoken of collectively under the convenient term of *greenstone*. Of these I need now say only that they are mainly diabases in no important respect different from eruptive diabases at various other horizons, that they are mainly non-schistose, and that they present no sign whatever of gradation into the adjoining sedimentary strata.

Thus the first part of our inquiry, with regard to the original or type Huronian is answered in the affirmative. Intrinsically, it is fully entitled to the group rank. Its detrital or clastic origin; its largeness of volume; its inclusion of a number of

subordinate strata—each entitled by its thickness and petrographical distinctness to be classed with any of the "formational" subdivisions of any of the Palæozoic groups—combine to give it this position. But it remains to be considered whether there is equally strong warrant for believing this series to be structurally, and consequently chronologically, separable from the adjoining portions of the so-called Archæan. Is it not possible that we are merely setting off arbitrarily a set of rocks which is really only part and parcel of the whole great Archæan complex, and is not separable by any genuine line of demarkation?

Before attempting to reply to this part of the problem it will be well to understand what sort of evidence that must be whose production will establish a degree of chronological separateness sufficient to warrant the ranking of this original Huronian as a Group. Such a degree of separateness, then, can only be established when we have in hand good reason for a belief in the subjection of the underlying rocks, as a land surface, to a long-continued atmospheric erosion, before the deposition upon them of the detrital series whose group rank it is desired to establish. In the cases of discordances between groups higher in the geological scale than that we are now considering, the rocks *below* as well as those *above* the discordance are of unquestioned sedimentary origin; so that in such cases we have indicated two periods of submergence, separated from one another by one of disturbance, emergence and erosion. But this accepted aqueous origin for the lower rocks is not essential. We may have equally good reason for a belief in a lengthy intervening period when the lower rocks are crystalline schists, as to whose origin there may be question, or sometimes even when they are eruptives. In the former case the foliation, schistose structure, and general crystalline character of the lower rocks, when contrasted with the absence of such characteristics in the higher, indicate the subjection of the former to long continued and deep-seated processes of alteration, whatever the first origin, and consequently to profound erosion, before the deposition upon them of the overlying detritals. Fragments of the lower crystalline rocks occurring in the higher detritals, particularly at the contacts of the two, serve greatly to strengthen such a conclusion; since these must be taken as a final demonstration of the production of the schistosity and foliation prior to the long-continued period of denudation which in turn must have been accomplished before the detrital deposition began. Somewhat similar reasoning will serve even if the lower rocks are of non-schistose, plutonic kinds ("tiefen Gesteine" of Rosenbusch), since these must have cooled at great depths, and must have been deeply denuded before the

masses of the different kinds of eruptives could be truncated or yield fragments to detrital deposits. In case the basement rocks are a combination of plutonic eruptives with crystalline schists, additional proof may be found in the fact that the eruptives intersect the schists, while they are truncated by the overlying fragmental rocks, to which also they have yielded fragments.

Now all of this evidence is forthcoming in the original Huronian region, and in the clearest and most unequivocal manner. The Huronian series is detrital and non-schistose; the underlying rocks are crystalline schists (mainly mica-schist), gneiss and granite; the mica-schists being without remaining fragmental texture, though at times banded in such a manner as to render an original fragmental condition very probable. The upper rocks are not intersected by the granite where the two come in contact; the lower schists and gneiss are deeply invaded by it in great bosses, in irregular masses of smaller size, and in an intricate net-work of veins; as may be seen most beautifully eastward from Algoma Mills, on the Lake Huron coast, and along the line of that branch of the Canadian Pacific Railway which extends from Algoma Mills to Sudbury on the main line.

Fragments of the older rocks occur in the detrital series at various horizons, but in most especial beauty at the contacts of the two series. These latter conglomerates are true *basal* conglomerates, whose asserted absence certain geologists* have urged with much emphasis as an argument against the existence of any separate Huronian series; i. e., separate from the remainder of the great Archæan complex. I may therefore not improperly enlarge somewhat on their actual occurrence. Probably the handsomest instance is that at the contact of Logan's basal member of the series, on the Lake Huron coast, about three miles east of the mouth of Thessalon River. From this point

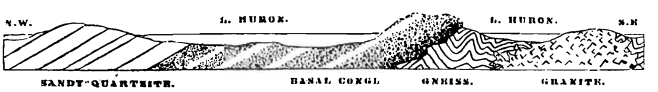

FIG. 2. Section about three miles east of the mouth of Thessalon River, Lake Huron, showing conglomerate at the base of the Huronian. Scale, 400 feet to the inch.

eastward the older gneiss, granite, etc., spread along the coast to Algoma Mills, and beyond. The contact is best seen in a group of small islands lying close to the mainland. These islands are moutonnéed to a very high degree, and are largely bare, so that the rocks are finely displayed. The figure is a section through three of these islands, the middle one of which shows the granite and gneiss at one end, and, resting

* J. D. Whitney and M. E. Wadsworth, in the "Azoic System," pp. 556, 557.

upon these and filling the irregularities of the original surface, the conglomerate rock, which dips some thirty degrees toward the northwest. The stratiform arrangement of the conglomerate is finely brought out by the interleaving of sandy layers, in which the pebbles are wanting, or nearly so. The sub-angular to angular fragments of the conglomerate, ranging in size from a fine detritus to bowlders two feet in length, are confusedly heaped together in the vicinity of the immediate contact; but further away show a tendency to arrangement in bands. They are mainly composed, in order of relative abundance, of a gray biotite gneiss or gneissoid granite, of red granite (including several varieties) and of dark-colored schists. The matrix, which is at times almost or wholly excluded by the bowlders, is mainly a fine detritus of the same nature as the fragments, the constituent minerals of the original rocks becoming more thoroughly separated from one another as the particles are finer. This finer detritus becomes more quartzose and arenaceous in the interleaved, non-conglomeratic layers, particularly as one passes away from the immediate contact. In these portions also there is present more or less of a kaolinic or sericitic ingredient resulting from the decay of the feldspathic constituents. Finally, invading the matrix very irregularly, at times giving it the appearance of a completely vitreous quartzite, and again leaving it very arenaceous in texture, is a siliceous cement, which has partly separated out as a finely interlocking quartz but often has divided itself off more or less thoroughly as enlargements of the quartz fragments. Upwards the conglomerate graduates into an arenaceous quartzite.

Closely analogous phenomena are to be seen at the contacts of these two sets of rocks displayed at three points on the line of that branch of the Canadian Pacific which runs from Algoma Mills to Sudbury on the main line, and particularly in the vicinity of the mouth of Serpent River. The pebbles and bowlders at these contacts are of all sizes up to two or three feet in diameter, and include granite, gneiss and mica-schist. It should be added that fragments of gneiss and granite are met with at various horizons through the Huronian series, often in considerable abundance in one place, while large parts of the series are composed of a little assorted granitic and gneissic detritus. These pebbles, and the finer gneissic detritus, though not at the base of the series, furnish strong evidence of the relatively great antiquity of the rocks which yielded them.

Thus the structural relations of the original or typical Huronian series to the older schists are such as to render abundantly evident its entire chronological separateness from them; and the second part also of our inquiry is answered in the affirmative.

Returning now to the classification of rocks and the characterization of the Group, quoted at the beginning of this paper, it will be seen that under this classification the Huronian can only be a group, since—(1) *it is essentially non-crystalline*, and therefore not to be placed with the non-eruptive crystallines, from which, moreover, it is structurally wholly separate; (2) *it is truly clastic and sedimentary*, and therefore must be included with the clastic groups, because these "comprise all the formations of known clastic origin;" and (3) *it has an immense volume*—a volume not only comparable with those of the ordinarily recognized fossiliferous groups, but in excess of the volumes of many of them. It cannot be a formation, being made up of formations. The classification then leaves us no choice but to call it a group.

The definition quoted demands, it is true, some other characters for the group in addition to those just mentioned, but since the latter are restricted by it to the true group, it is evident that in the original Huronian we are dealing with one of these groups, or that the definition is defective. This point I return to in the closing section of my paper, and may therefore pass it over for the present, merely remarking by the way that the question which has been raised by some, as to whether the Lake Huron Huronian may not be the equivalent of some group elsewhere recognized as fossiliferous, say the Cambrian or the Silurian, is hardly worthy of discussion. Here, in the typical region itself, the Upper Cambrian sandstone (Potsdam) may be seen crossing the immensely denuded surface and decapitated folds of the Huronian; so that to include the Huronian even in the Cambrian would require us to stretch that term over one of the greatest, if not *the* greatest, of the structural gaps in the whole geological column. Moreover, there is every reason to believe that the great Keweenaw Series of Keweenaw Point belongs to this interval, though by no means filling it. This series, on the south shore of Lake Superior, lies unconformably beneath the same Cambrian sandstone which traverses the edges of the Lake Huron Huronian, while at the same time unconformable to rocks beneath it whose equivalence with the original Huronian there is every reason to accept, as is subsequently maintained in this paper.

[To be continued.]