Reviews

SUMMARIES OF CURRENT NORTH AMERICAN PRE-CAMBRIAN LITERATURE.[1]

WALCOTT[2] reports on the results of an examination of Cambrian and pre-Cambrian formations on Smith's Sound, Newfoundland, during the summer of 1899. At Smith point he found the Olenellus fauna 369 feet below the summit of the Etcheminian, and one of its types, Coleoloides typicalis, in the basal bed of the Cambrian, on the south side of Random Island. This retains the Etcheminian of Newfoundland in the Lower Cambrian.

The Random terrane, so-called from a typical section on Random Sound, is a series of sandstones, quartzitic sandstones, and sandy shales, resting conformably upon the Signal Hill conglomerate (which was formerly supposed to represent the top of the Avalon or Algonkian series) and extending up to the base of the Cambrian. The Random terrane is thus the upper member of the Avalon series and fills a portion, if not all, of the gap between the Signal Hill conglomerate and the Cambrian. The Cambrian rests on the Random terrane with a thin belt of conglomerate. The thickness of the terrane is probably 1000 feet. In one horizon in the terrane were found several varieties of annelid trails, including a variety about 5 millimeters broad, a slender form ½ millimeter broad, and an annulated trail 2 to 3 millimeters in width.

An examination of the form known as Aspidella terranovica found in the Momable terrane of the Avalon series proved the supposed fossil to be a spherulitic concretion, and this removes it from among the possible pre-Cambrian forms of life.

Cushing[3] describes and maps the pre-Cambrian rocks of Franklin

[1]Continued from p. 87, Vol. IX, this JOURNAL.

[2]Random, A Pre-Cambrian Upper Algonkian Terrane, by CHARLES D. WALCOTT: Bulletin of the Geological Society of America, Vol. XI, 1900, pp. 3–5.

[3]Preliminary Report on the geology of Franklin county, Pt. III, by H. P. CUSHING: Eighteenth Annual Report of the State Geologist of the State of New York, 1900, pp. 75–128. With geological map.

county, New York. These are classified as Grenville (Algonkian) rocks, igneous rocks intrusive in the Grenville, and other igneous rocks of doubtful age, possibly in part older than the Grenville rocks.

The Grenville rocks occur in small disconnected patches surrounded by intrusive igneous rocks. Some of them have such position with reference to one another that they seem to represent remnants of what were originally two continuous parallel N. E. to S. W. belts. The characteristic rock of the series is the crystalline marble. This is intricately infolded with quartzose and hornblendic gneisses, and with fine-grained granitic, syenitic, and gabbroic gneisses precisely like gneisses which occur in other areas where no member of the Grenville series is to be found.

The gneisses of undetermined age include granite, syenite, diorite, and gabbro gneisses, together with intermediate varieties. They occupy a very large area. If all these gneisses are igneous (as is thought probable) there are three possibilities in regard to their age.

1. They may represent in whole or part a more ancient series than the Grenville.

2. They may represent a somewhat later series intrusive in the Grenville, but older than the great gabbro, syenite, and granite intrusions.

3. They may represent thoroughly foliated phases of these later intrusions.

In Dr. Cushing's present judgment they will be found to belong partly under 2 and partly under 3, but more especially the former.

No rocks have been found in the northern Adirondacks which can be shown to be older than the Grenville series, but in every case in which the relations have been made out, the adjacent rocks show intrusive contacts with the Grenville rocks. On the other hand, the Grenville is a sedimentary series and must have been laid down on some floor.

Younger than the Grenville rocks and for the most part younger than the doubtful gneisses are a considerable quantity of igneous rocks comprising gabbros (anorthosites) syenites, and granites. These again occupy large areas.

In the northern portion of the county, Upper Cambrian rocks overlie the pre-Cambrian rocks with unconformity.

Smyth[1] discusses certain features of recent work in the western

[1] The Crystalline Rocks of Western Adirondack Region, by C. H. SMYTH: Rept. of the New York State Geologist for 1897, published in Fifty-first Ann. Rept. of New York State Museum, Vol. II, 1899, pp. 469–467.

Adirondack region. He concludes that the rock previously called gabbro by Nason, Van Hise, Williams, and himself, south of the belt of limestone in the Diana-Pitcairn area in Lewis and St. Lawrence counties, is an augite syenite of igneous origin, although it passes into a hornblende-gneiss which is unquestionably a result of dynamic action. The origin of other gneisses has been inferred to be igneous from their similarity to this gneiss which has been particularly studied, and it is evidence of this kind which serves as a basis for Smyth's conclusions, previously published,[1] that some of the gneisses on the western Adirondacks are certainly, and most of them probably, of igneous origin.

With the view of exploring the central and little known portion of the Adirondacks, a reconnaissance was made through the area contiguous to the Fulton chain of lakes and Raquette Lake in the counties of Hamilton and Herkimer. It was found that the heart of the Adirondacks is made up essentially of gneiss, with minor quantities of crystalline limestone and its associated sedimentary gneisses and schists. This is precisely analogous to what was found by the writer in St. Lawrence, Jefferson, Northern Lewis, and southwestern Hamilton counties, and by Kemp and Cushing in the eastern Adirondacks. These facts lead to the conclusion that the Adirondack region, instead of consisting of a great central mass of gabbro, surrounded by a narrow fringe of gneisses and limestones with quaquaversal dip, is essentially composed of gneisses, with numerous limestone belts, having northeast strike, and northward dip, and cut through on the east by immense intrusions of gabbro. It is still possible, of course, that some areas of gabbro may be found in the unexplored portions of the western half, but even should this be so, it would not materially modify the above conclusion, as such masses must necessarily be isolated intrusions of no great extent, rather than parts of a large area.

Kemp,[2] in connection with the description of the magnetite deposits of the Adirondacks, briefly describes the general features of the geology of the gabbro and gneiss of Westport, Elizabethtown, and Newcomb townships in Essex county, New York, and presents a geological map of the former two townships.

[1] See Summary JOUR. GEOL., Vol. VII, p. 406.

[2] The Titaniferous Iron Ores of the Adirondacks, by J. F. KEMP: Nineteenth Ann. Rept. U. S. Geol. Surv., 1897–8, Pt. III, 1899, pp. 397–399.

Kemp and Newland[1] make a preliminary report on the geology of Washington, Warren, and parts of Essex and Hamilton counties, New York. Some of the points particularly noted are:

The excessive mashing and granulation of the gneisses, giving them in places semblance to quartzite. The greenish gneisses, consisting in largest part of microperthite, were originally eruptive rocks. The discovery is reported of quartzose gneisses or foliated quartzites which are certainly metamorphosed sediments. They form notable areas along the head of South Bay, Whitehall township. Their presence indicates the probable presence of a considerable series of clastic sediments. The crystalline limestones themselves have been found in small exposures over almost all of Warren county, and generally in the crystalline belt of Washington. They are most extensive in Newcomb and Minerva townships of Essex, and to the south become thinner and more scattered. So far as we have observed they are less common in eastern Hamilton county. There is evidence to show that stratigraphical relations can be proven and that anticlines and synclines can be demonstrated.

Dikes of basic gabbro usually of moderate width, but lithologically like the larger masses in Essex county, have been met over a wide area — in fact almost every township in Warren, but the basaltic traps almost disappear.

Kemp[2] summarizes the present knowledge of the pre Cambrian rocks of the Adirondacks. Most of the features have been covered in previous articles. Attention is called to the distribution of the sedimentary crystalline rocks, the Oswegatchie series (equivalent to the Grenville series of Adams and perhaps the Huronian). These consist of limestones, sedimentary gneisses, and quartzites. They occupy greater area than has been supposed. The limestones are found chiefly in the northwest, and the southeast or eastern portions of the Adirondack area of crystalline rocks. They are in small quantity, or altogether absent in the northern portion, in the broad belt running from

[1] Preliminary Rept. on the Geology of Washington, Warren, parts of Essex and Hamilton counties, by J. F. KEMP and D. H. NEWLAND: Rept. of the New York State Geologist for 1897, published in Fifty-first Ann. Rept., New York State Museum, Vol. II, 1899, pp. 499–553.

[2] Pre-Cambrian Sediments in the Adirondacks, by J. F. KEMP: Vice Presidential address published in the Proceedings of the A. A. A. S., Vol. XLIX, 1900, pp. 157–184.

northeast to southwest across the area, and along the southern and southwestern border. On the northwest they are in extended and comparatively broad belts, but in the eastern portion they appear in many small and separated exposures, associated with some quartzites and much greater amounts of characteristic gniesses, but greatly broken up by igneous intrusions. The quartzites thus far known are in small quantity, but such as they are, they are found principally in the eastern portions of the area, where the limestones are thinnest and most scattered. From the presence of the quartzites it is inferred that clastic sediments must have been present in larger amounts than has heretofore been realized. On the east it has not been proven that sediments form synclines pinched into the underlying gneissoid rocks. On the contrary they seem to constitute low, dipping, flat monoclines.

Comment.—The complex geology of the Adirondack crystalline rocks is being rapidly worked out by Kemp, Smyth, Cushing, and others. The frequent brief papers issued by these geologists in nearly all cases report some important advance in the solution of their problem. The precise relations of these advances to the general problem may not be clear to the average geological reader, too busily engaged to follow the subject closely, and for such the general summary of Adirondack geology given by Kemp [1] will be of value.

In a previous comment [2] on Adirondack geology the state of geological knowledge, as indicated by the literature on the subject then available, was briefly summarized by the writer, and here attention will be called only to later developments. One of the most interesting of these is the extension of the areas of pre-Cambrian sedimentary and associated rocks, and the corresponding contraction in the area of the great Adirondack gabbro. This was formerly supposed to occupy the great central area of the Adirondacks with the pre-Cambrian sediments and the associated gneisses around its periphery. Recent work seems to show that the area is occupied by gneisses, with narrow limestone belts, cut through on the east by a number of immense intrusions of gabbro. Another advance is the discovery of greater quantities of clastic sediment than have before

[1] Pre-Cambrian Sediments in the Adirondacks, by J. F. KEMP: Vice Presidential address published in Proceedings of the A. A. A. S., Vol. XLIX, 1900, pp. 157–184.

[2] JOUR. GEOL., Vol. VII, pp. 410–411.

been realized in the eastern portion of the Adirondack area, where the limestone is thinnest. The main problem of the region, the origin of the gneisses, is as yet far from settlement. The tendency is, however, to ascribe to them an igneous origin, and to place them later than the Oswegatchie series, in the areas where they have been most closely studied.

Jones,[1] in connection with a description of Tallulah Gorge of northeastern Georgia, describes the crystalline rocks there occurring, and gives a little sketch map showing their relations. They are called pre-Cambrian.

Watson[2] describes the granitic rocks of the Piedmont plateau of Georgia. Field and laboratory studies indicate that they are not all contemporaneous in origin. Some of them are pre-Cambrian, while others may possibly be later in age.

Adams[3] describes the Laurentian granitoid gneiss and granite of the Admiralty group of the Thousand Islands, Ontario. The granitoid gneiss is presumably derived by metamorphism from the granite. A large exposure of crystalline limestone on Island No. 18 resembles in all respects that of the Grenville series of the mainland adjacent.

Parks[4] describes the geology of the Moose River Basin in Canada, including the Moose and Abitibi Rivers, tributary to James Bay. This is an immense triangular area of which the apex is at James Bay, and the base stretches from above Lake Abitibi to a point west of Kabinakagami. The southern and major portion of this triangular area consists of Laurentian gneisses and granites crossed, by bands of Huronian rocks. Along the Abitibi River, Huronian rocks, consisting of altered diorites, pyrites, gray quartz schists, and some soft decomposed schists occupy the country to the south, extending as far north as the head of the first long rapid on the Frederick House River. The line of contact of this belt crosses the Abitibi below the Iroquois

[1] The Geology of the Tallulah Gorge, by S. P. JONES: American Geologist, Vol. XXVII, 1901, pp. 67–75.

[2] The Granitic Rocks of Georgia and Their Relationships, by T. L. WATSON: American Geologist, Vol. XXVII, 1901, pp. 223–225.

[3] Notes on the Geology of the Admiralty Group of the Thousand Islands, by FRANK D. ADAMS: Can. Rec. of Sci., Vol. VII, 1897, pp. 267–272.

[4] PARKS, WILLIAM A.: The Nipissing-Algoma boundary, Eighth Rept. Ont. Bur. Mines, 1899, pp. 175–204, with geological map; Niven's base line, Ninth Rept. Ont. Bur. Mines, 1900, pp. 125–142; The Huronian of the Moose River Basin, University of Toronto Studies, Geol. Series No. 1, 1900, pp. 35, with sketch map.

Falls. From this point to the Lobstick portage, Laurentian gneisses and mica schists crop out occasionally. The narrow Huronian belt from the Lobstick to the foot of the canyon or Long Portage, consists mainly of augite-syenite, passing into gabbro to the north. Beyond this portage Laurentian gneiss extends to the Devonian contact above the Sextant rapids.

Coleman[1] gives a general account of a visit to all the iron and copper regions of the Lake Superior country. For the ranges on the United States side of the boundary no facts are given not found in the published reports. On the Canadian side of the boundary the Michipicoten Range, the iron formation near Dog River, and the siliceous iron ores of Batchawana Bay are described. In the Michipicoten range the Helen mine in particular is referred to. In general, the rocks, including the ore at this mine, have all the appearance of Lower Huronian or Keewatin rocks, as in the Vermilion district, and not those of the Upper Huronian or Animikie, as in the Mesaba.

Near Dog River are iron formation rocks similar to those extending northeast from Michipicoten bay. It is thought probable that the two may connect.

The occurrence and relations of iron formation material northeast from Michipicoten Bay and near Dog River are indicated on a sketch map.

Coleman,[2] as a result of an examination of the new Michipicoten iron district, and the consideration of other iron formation areas in Ontario, has collected facts which seem to throw some light on the relative ages of the different areas mapped as Huronian on the north shore. In the Michipicoten district iron-formation material, consisting of banded ferruginous sandstones, cherts, and jaspers, standing nearly vertical, extends from Little Gros Cap northeastward for twenty miles; then bending to the north and west it takes a westerly direction for more than thirty miles. The width of the belt is but a few hundred yards.

Sandstones of the same peculiar type occur at Little Turtle Lake, east of Rainy Lake and near Fort Frances, on Rainy River, as well as at the Scramble gold mine, near Rat Portage, on Lake of the Woods.

[1] COLEMAN, DR. A. P.: Copper and Iron Regions of Ontario, by A. P. COLEMAN. Report of the Ontario Bureau of Mines for 1900, pp. 143–191.

[2] Upper and Lower Huronian in Ontario, by ARTHUR P. COLEMAN: Bull. Geol. Soc. Am., Vol. II, 1900, pp. 107–114.

Thin sections of these rocks show the same polygonal shapes of the grains of quartz, and more or less iron ore is associated with specimens from each locality. It is very probable, then, that the same horizon exists at points far to the west of Lake Superior.

Turning toward the east, specimens very like the jaspery varieties of the Michipicoten iron range are found interbedded with iron ores near Lakes Wahnapitae and Temagami, between Sudbury and the Ottawa River.

At Batchawana Bay at the southeast end of Lake Superior, a siliceous rock with narrow bands of magnetite occurs, which is probably the equivalent of the Michipicoten rock.

If, as seems probable, these jaspers are the equivalents of the western Huronian sandstones, there is a definite horizon traceable from point to point across the whole northern end of the province, a distance of more than six hundred miles.

At a number of places over this area conglomerates, containing jasper, ferruginous sandstone or chert pebbles, probably derived from the source above described, are known. Beginning at the west, some of these conglomerates occur as follows : on Shoal Lake, east of Rainy Lake ; west end of Schist Lake ; near Mosher Bay, at the east end of Upper Manitou Lake ; a mile east of Fort Frances on the Rainy River ; near Rat Portage ; near the mouth of Dorè River ; in the original Huronian area, north of Lake Huron, particularly the Thessalon area ; on Lake Temiscaming.

It is assumed that the iron-formation material cannot be other than Lower Huronian, and that the conglomerates must represent a basal horizon of the Upper Huronian. The break between the Upper and Lower Huronian thus represented is a most profound one, and affords a good basis for the correlation of the Huronian formations. It is further suggested that this great unconformity may be the same as that between the Upper and Lower Huronian formations on the south shore of Lake Superior and in Minnesota.

Comment.—As stated by Dr. Coleman a number of the conglomerates above mentioned have been regarded by Pumpelly, Irving, Van Hise, and other United States geologists, as basal to the Lower Huronian — on structural evidence. Dr. Coleman places them in the Upper Huronian because they contain fragments of iron formation material which are assumed to be Lower Huronian. According to the generally accepted ideas of the number and relations of the pre-Cambrian iron bearing formations, this assumption is perfectly justified and the conclusion follows as to the Upper Huronian age of the typical conglomerates mentioned.

But, lately evidence has been accumulated pointing to a conclusion of a rather radical nature. This evidence has been such that Van Hise[1] in a general article on the iron bearing formations of the Lake Superior country just published, describes *three* iron bearing formations, the Upper Huronian, Lower Huronian, and *Archean*. The most important of the Archean iron bearing formations are the Vermilion and the Michipicoten.

Van Hise himself in his published articles on the pre-Cambrian has persistently maintained the essentially non-clastic nature of the Archean, and the post-Archean age of all the iron bearing formations of the Lake Superior country. But new evidence on the subject, secured principally during the past year, has been so decisive that he has not hesitated to announce as proven the existence of an Archean or Basement Complex iron-bearing formation.

If there is an Archean iron formation, to which the Michipicoten and Vermilion iron formations belong, then Dr. Coleman's argument as to the Upper Huronian age of conglomerates containing iron formation fragments is rendered ineffective, and the conclusions indicated by the structural evidence that the great conglomerates and accompanying rocks above described are Lower Huronian must stand, until decisive evidence to the contrary is found.

Grant[2] describes and maps the Upper and Lower Keweenawan copper-bearing rocks of Douglas county, Wisconsin. The Lower Keweenawan appears in a broad belt running from northeast to southwest across the county, widening toward the southwest, and in a small belt cutting through the southeastern corner of the county. It consists mainly of basic lava flows, associated with which, in the area in the southeast corner of the county, are a few beds of conglomerate composed of débris of the closely adjacent underlying rocks. The Upper Keweenawan appears in a broad belt in the southeastern part of the county between the two belts of Lower Keweenawan rocks. It

[1] The iron-ore deposits of the Lake Superior region, by C. R. VAN HISE: Twenty-first Ann. Rept. U. S. Geol. Surv., Pt. III, 1901, p. 322.

[2] Preliminary Report on Copper Bearing Rocks in Douglas county, Wisconsin, by U. S. GRANT: Wisconsin Geological and Natural History Survey, Vol. VI, 1900, pp. 55.

is a series of conglomerates, sandstones and shales. In a belt north of the northern belt of Lower Keweenawan rocks, extending from these rocks to the shore of Lake Superior, is the Lake Superior sandstone (Cambrian). This is either flat-lying or dips slightly toward Lake Superior. The junction of the sandstone with the Lower Keweenawan is marked by a fault, along which the Lake Superior sandstone has been depressed, in some places probably as much as several hundred feet.

The Upper and Lower Keweenawan belts form a syncline, the axis of which runs northeast and southwest through the center of the tract underlain by Upper Keweenawan rocks.

While the Keweenawan rocks of this area are the same in kind and age as are the productive copper-bearing rocks of Keweenaw Point, the probable unproductive character of the Douglas county rocks is intimated.

Alexander Winchell[1] prefaces a detailed petrographical description of certain phases of the gabbroid rocks of Minnesota with a brief account of the general succession in structure of formations in northeastern Minnesota. This is essentially the same as given by N. H. Winchell[2] in Volumes IV and V of the Minnesota State Survey. The correlation of this succession with the succession determined by the United States Geological Survey is discussed.

Comment.— Mr. Winchell's ideas as to succession and structure determined by the United States Geological Survey are naturally derived mainly from Bulletin 86 of the Survey and from the "Principles of Pre-Cambrian Geology" published in the Sixteenth Annual Report of the Survey. However, since these reports have been issued, the United States Geological Survey has done somewhat detailed field work in northeastern Minnesota as a result of which the ideas of the United States geologists on the succession and correlation have been considerably changed. The new conclusions of the Survey are briefly outlined by Van Hise in the Twenty-first Annual Report. This paper should be referred to by anyone reading Mr. Winchell's discussion of the correlation.

[1] Mineralogical and Petrographic study of the gabbroid rocks of Minnesota, and more particularly of the plagioclastites, by ALEXANDER N. WINCHELL: American Geologist, Volume XXVI, 1900, General part, pp. 153–162, with geological sketch map of Northeastern Minnesota.

[2] See summaries, JOUR. GEOL., Vol. IX, pp. 79–86.

Van Hise and Bayley[1] describe and map the geology of a portion of the Menominee iron district of Michigan.

The pre-Cambrian succession is as follows:

Algonkian	Upper Menominee	Hanbury slate. Vulcan formation, subdivided into the Curry ore-bearing member, Brier slate, and Traders ore-bearing member.
	Unconformity	
	Lower Menominee	Negaunee formation. Randville dolomite. Sturgeon quartzite.
	Unconformity	
Archean	- - - -	Granites and gneisses, cut by granite and diabase dikes. Quinnesec schists, cut by acid and basic dikes and veins.

In general the Algonkian rocks constitute a trough bounded on the north by the Archean rocks.

The Archean.—The Quinnesec schists are dark green or black basic schists and spheroidal greenstones, cut by large dikes of gabbro, diabase, and granite, and by smaller dikes of a schistose quartz porphyry. These occur in two areas, one along the Menominee River to the south of the Huronian rocks, and another in the west-central end of the district.

Bordering the Algonkian trough on the north is a complex of granites, gneisses, hornblende schists, and a few greenstone schists, all cut by dikes of diabase and granite. This complex is called the "Northern Complex." Most of the Archean rocks are igneous. Although there is no evidence of this, some of the fragmental tuffs may have been water-deposited. The Quinnesec schists and the Northern Complex are called Archean because they resemble lithologically other areas of Archean rocks in the Lake Superior country, and they both underlie the Algonkian series. The Northern Complex underlies the series with unconformity. The Quinnesec schists have

[1] The Menominee special folio, by CHARLES R. VAN HISE and S. W. BAYLEY: Geological Atlas of United States, Folio No. 62, U. S. Geol. Surv., 1900.

not been observed in contact, and hence the presence or absence of a normal erosion unconformity cannot be inferred.

The Lower Menominee series.—The formations of the Lower Menominee series are observed only in the center and on the northern side of the Menominee trough. The Sturgeon formation is composed mainly of a hard white vitreous quartzite forming a continuous border of bare hills bordering the Archean complex. At its base is a coarse conglomerate made up of débris from the underlying Archean complex. The belt is in general a southward dipping monocline with dips varying from 25° to perpendicularity, although there are many reverse dips to the north. Its thickness is placed at from 1000 to 1250 feet.

Above, the Sturgeon quartzite grades into the Randville formation which is mainly a homogeneous dolomite interstratified with siliceous or argillaceous layers. This formation appears in three belts. The northern one is just south of the belt of the Sturgeon quartzite. The central belt is on the north side of Lake Antoine for a portion of its length, passes eastward between the Cuff and the Indiana mines, and ends at the bluff known as Iron Hill in the east half of Sec. 32, T. 40 N., R. 29 W. The southern belt of dolomite extends all the way from the western side of the sandstone bluff west of Iron Mountain to the village of Waucedah, at the eastern end of the mapped area. Structurally the northern belt of dolomite is a southward dipping monocline, while the two southern belts are anticlines. The thickness is not determined on satisfactory evidence, but is probably 1000 feet or more. The Randville formation is found, in a number of mines. in contact with the basal formation of the Upper Menominee series Here there is a coarse conglomerate in the basal part of the overlying formation indicating unconformity.

The Negaunee formation, overlying the Randville dolomite, is represented in the district by so few and so small outcrops that it is mapped with the Vulcan formation. Its presence is inferred mainly from the occurrence of abundant iron formation débris in the basal conglomerate of the Upper Menominee formation, showing that the Lower Menominee iron-bearing series must have been present. In the Marquette district an iron-bearing formation (the Negaunee) occupies an exactly similar stratigraphical position.

The Upper Menominee series.—The formations between the unconformity at the top of the Lower Menominee and the unconformity at the base of the Lake Superior sandstone, are placed in the Upper Menominee series. These occur in two great series, the Vulcan and the Hanbury.

The Vulcan formation is unconformable above the upper part of the Lower Huronian, which for most of the district is the Randville formation, and unconformable below the Hanbury slate. For parts of the district the Vulcan iron-bearing formation does not appear at all between the dolomite and the slate and its absence is explained by the unconformity between the Vulcan formation and the Hanbury slate. The Vulcan formation embraces three members. These are, from the base up, the Traders iron-bearing member, the Brier slate, and the Curry iron-bearing member. They are mapped as a single formation. The principal area of the Vulcan iron formation is in the belt 900 to 1300 feet wide, following the sinuosities of the southern border of the southern belt of Randville dolomite. It is generally absent north of the southern belt except at the east end where it appears at the Loretto mine and eastward. The second important area of Vulcan iron formation stretches off about five miles along the south side of the central dolomite belt running north of Lakes Antoine and Fumee, and ending somewhere about the east line of Range 30 West. At the east end of the dolomite area the iron-bearing formation appears in the lean slates at Iron Hill. The third stretch of country in which the iron-bearing beds are to be expected is that which borders the northern dolomite belt, but while pits have shown the existence of the formation here its distribution is unknown. The other areas in which the Vulcan formation may occur are those bordering the Quinnesec schists, but this has not yet been determined.

The Traders member consists of ferruginous conglomerate, ferruginous quartzite, heavily ferruginous quartzose slates and iron ore deposits. The Brier member consists of heavy black ferruginous and quartzose slates. The Curry member consists of interbedded japsilite, ferruginous quartzose slates and iron ore deposits. The relations of the Traders and Brier Hill members where there has been no disturbance of the strata is that of gradation. Where there has been disturbance, as in the vicinity of Norway, there has been a zone of differential movement between the two, resulting in slickensides and brecciated zones. Between the Brier slates and the Curry member there is gradation.

The Vulcan formation is bent into folds of several orders of magnitude, the greater ones corresponding approximately to the folds in the underlying Randville dolomite. The total thickness of the formation is probably 600 to 700 feet.

The iron ore deposits of large size rest upon relatively impervious formations, which are in such positions as to constitute pitching troughs. A pitching trough may be made (*a*) by the dolomite formation underlying the Traders member of the Vulcan formations, (*b*) by a slate constituting the lower part of the Traders member, and (*c*) by the Brier slate between the Traders and Curry members of the Vulcan formation. The dolomite formation is especially likely to furnish an impervious basement where its upper horizon has been transformed into a talc-schist, as a consequence of folding and shearing between the formations.

Unconformably above the Vulcan iron formation is the Hanbury formation, which forms three large belts in the syncline of the older rocks, and occupies a very large proportion of the district. The formation comprises clay slates, calcareous slates, graphite slates, graywackes, quartzite, ferruginous dolomite, and rare bodies of ferruginous chert and iron oxide. The formation is much thicker than any of the other formations of the district, but it is probably not thicker than 2000 or 3000 feet.

Wilder[1] describes and maps the Sioux quartzites and quartz porphyries of Lyon county, Iowa. No points concerning the stratigraphy or age have been added to those already given by other writers.

Bain[2] describes the geology of the Wichita Mountains. Gabbros and porphyries of pre-Cambrian and probably of Archean age are present. The gabbro is more prominent in the western portion of the mountains, being especially well developed in the Raggedy Mountains, and the porphyry is more common in the eastern part of the mountains, being typically developed at Carrollton Mountain.

Matthews[3] gives a detailed petrographical description of the granites of the Pike's Peak quadrangle of Colorado. They are referred to the late Algonkian period.

[1] Geology of Lyon county, by FRANK A. WILDER: Iowa Geol. Surv., Vol. X, 1899, pp. 96–108.

[2] Geology of Wichita Mountains, by H. FOSTER BAIN: Bull. Geol. Soc. Am., Vol. XI, 1900, pp. 127–144, Pls. XV–XVII.

[3] The Granite Rocks of the Pike's Peak Quadrangle, by A. B. MATTHEWS: JOUR. GEOL., Vol. VIII, 1900, pp. 214–240.

Cross[1] maps and describes the geology of the Telluride quadrangle, Colorado, and briefly sketches the geology of the San Juan region, of which the Telluride quadrangle is a part.

In the Telluride quadrangle, along Canyon Creek north of Stony Mountain, is a small body of upturned quartzites, with an intercalated rhyolite sheet, which have been referred to the Algonkian. The quartzites are coarse and grade into fine conglomerate.

Ancient granites, gneisses, and schists are known in the Animas Valley and in the Uncompahgre plateau. These rocks have usually been considered as belonging to the Archean, but some of them are probably younger than the great series of quartzites exhibited in the Needle Mountains to the south, and younger than the quartzites beneath the volcanics in the canyons of the Uncompahgre, above Ouray, which have been referred to the Algonkian. These quartzites stand on edge or have been greatly disturbed. The relations of these isolated exposures to contemporaneous formations elsewhere are unknown.

Spurr[2] maps and briefly describes the Archean[3] granite of the Aspen district of Colorado. This is unconformably below and in direct contact with sediments of upper Cambrian age.

Davis[4] in a general account of a trip through the Colorado Canyon district briefly describes certain features of the pre-Cambrian geology. He calls attention to the extraordinary evenness of the floor of schists with granite dikes (Archean) upon which the Chuar and Unkar terranes (Algonkian) rest. The floor for the Paleozoic strata is somewhat less regular than the floor for the Unkar. In two places the pre-Cambrian rocks rise higher than the basal Tonto (Cambrian) sandstone. The Archean schists beneath the Unkar have a steep and regular slope, indicating uniform resistance to erosion. Where, beneath the Tonto, they show a bench, it is taken to indicate a softer character at this point, probably due to a longer period of pre-Tonto weathering.

[1] Telluride Folio, Colorado, by WHITMAN CROSS: Geol. Atlas of the U. S., No. 57, 1899.

[2] Geology of the Aspen Mining District, Colorado, with Atlas, by J. E. SPURR: Mon. U. S. Geol. Surv., No. 31, 1898, pp. 1–4.

[3] The term Archean is evidently used in the sense of pre-Cambrian.

[4] Notes on the Colorado Canyon District, by W. M. DAVIS: Am. Jour. Sci., 4th ser., Vol. X, 1900, pp. 251–259.

Blake[1] refers to the Archean the thick layers of gneiss forming the southern flank of the Santa Catalina Mountains, Arizona. The gneiss is in flat layers representing beds. A part of it is augen gneiss; other layers are quartzose and seemingly quartzites.

Knight[2] in connection with the discussion of the artesian basins of Wyoming gives a brief description, accompanied by a map, of the geology of the state. Algonkian and Archean rocks are present. The Archean rocks consist mainly of granite, in places cut by dikes of porphyry containing mineral ores, which can be seen in typical exposure at Sherman, Laramie Peak, east of Whalen Canyon, along the Big Horn, Wind River, Gros Ventre, Medicine Bow, Ferris, Seminoe, and Owl Creek ranges, along the Sweetwater River, a few miles northwest of Rawlins, and north of Clark's Fork, in Big Horn county.

The Algonkian rocks are for the first time separated from the Archean. They consist of schists in great profusion, marbles, and quartzites, all cut with dikes of eruptive rocks. They occur in granite basins in unconformity with the Archean, and form important bands in numerous localities. The strike of the series varies from north to northeast and the dip of the strata is seldom less than 65–75°. The thickness of the entire series has not been absolutely measured, but including the eruptive band, which does not form an important part, the maximum thickness in Wyoming is about 20,000 feet. Typical areas have been found in the Black Hills in Wyoming, and occasional outcrops from that place to the Hartville hills—one exposure being east of Lusk, another at Rawhide Butte, and a large one in Whalen Canyon. They also occur at Halleck Canyon, Plumbago Canyon, in the Medicine Bow Mountains, nearly all of the Sierra Madre Mountains, in the Seminoe Mountains and in the Sweetwater mining district of the Wind River range. None of these localities have been examined in detail; but sufficient work has been done to prove that these rocks were at one time sedimentary, and that they have been changed by metamorphism to schists. In the Sweetwater districts the rocks are chiefly schists; but there are many bands of erruptive rock that form dikes which follow the strike of the formation.

[1] Mining in Arizona, by WM. P. BLAKE: published in report of the Governor of Arizona to the Secretary of the Interior, Washington, 1899, p. 142.

[2] A preliminary Report on the Artesian Basins of Wyoming, by WILBUR C. KNIGHT: Wyoming Experiment Station, Bulletin No. 45, 1900. Part on pre-Cambrian, pp. 111–116. With geological map. This is the first geological map of Wyoming that has appeared.

Weed[1] maps and describes the pre-Cambrian rocks in the Fort Benton and Little Belt Mountains quadrangles of Montana.

The Archean rocks are found only in the Little Belt range in the southwestern part of the Fort Benton quadrangle and in the northwestern part of the Little Belt Mountains quadrangle. They are gneisses and schists of various kinds, and of somewhat uncertain origin. They are, in part at least, of igneous origin, and none of them show any traces of sedimentary origin. Their relations to the Algonkian rocks are those of unconformity. The Algonkian rocks are found in the mountain tracts of the Little Belt range, in Castle Mountain, and in the low range crossed by Sixteenmile Creek in the southwest corner of the Little Belt Mountain quadrangle. They are divided into the Neihart quartzite and the Belt formation,[2] both of which are parts of what Mr. Walcott has called the Belt Terrane.

The Neihart quartzite is a hard pink and gray quartzite forming the base of the Belt Terrane for this area. It is found in the vicinity of Neihart in the Little Belt Mountains. Its thickness is about six hundred feet. The Belt formation consists mainly of slaty, siliceous shales, but also contains interbedded limestone and quartzite. Fossils found in this series (in the shales above the formation which Mr. Walcott has named the Newland limestone member of the Belt Terrane), represent the earliest forms of life yet known. Near Neihart the Algonkian period is represented by 4000 feet of beds, while further south and west the thickness is much greater.

Overlying the Algonkian rocks conformably are rocks containing Middle Cambrian fossils. North of Neihart they rest directly on the Archean.

Reconnaissance geological surveys in Alaska and adjacent portions of British Columbia, by United States and Canadian government parties, have shown the basal rock over considerable areas to be a granite, which is provisionally assigned to the Archean.[3] Such granite

[1] Fort Benton and Little Belt Mountains Folios, by WALTER HARVEY WEED: Geol. Atlas of the U. S., Nos. 55 and 56, 1899.

See also Geology of the Little Belt Mountains, Montana: Twentieth Ann. Rept. U. S. Geol Surv., 1898–9, Pt. III, 1900, pp. 278–284.

[2] The Belt formation includes the various lithological members of the Belt Terrane which Mr. Walcott has named the Chamberlin shale, the Newland limestone, the Greyson shale, the Spokane shale, and the Empire shale.

[3] Usually in the sense of pre-Cambrian.

is reported as occurring along the Pelly and Dease Rivers (Dawson[1] and Hayes;[2]) to the west, between the northern base of the St. Elias Mountains on the Yukon River (Hayes[3]); along the Upper Tanana River (Allen[4] and Brooks[5]), which is correlated by Spurr with the granite along the Pelly River; along Fortymile Creek, a tributary of the Yukon near the Canadian-Alaskan boundary (Spurr[6]); forming the core of the Kaiyuh Mountains (described by Dall,[7] referred to Archean by Spurr[8]); possibly forming the core of the Alaska Peninsula and the Aleutian Islands (noted by Dall[9] and Purington,[10] referred to Archean by Spurr[11]).

C. K. LEITH.

On Rival Theories of Cosmogony. By the REV. O. FISHER. *American Journal of Science*, June 1901, Pp. 414–422.

In this article the author has brought the current gaseo-molten hypothesis of the origin of the earth into comparison with the hypothesis of gradual accretion without a molten state recently advanced by Chamberlin, and has endeavored to test the tenability of the newer hypothesis by subjecting some of its fundamental postulates to mathematical and physical inquiries. The author disclaims holding a brief for either hypothesis and well sustains his claim to an impartial attitude.

[1] GEORGE M. DAWSON: Geological Natural History Survey of Canada, Vol. III, Pt. I, 1887–8, p. 34B.

[2] C. WILLARD HAYES: Geographic Magazine, Vol. IV, 1892, p. 139.

[3] Loc. cit., p. 139.

[4] LIEUTENANT H. D. ALLEN: Expedition to the Copper, Tanana, and Koyukuk Rivers, Senate Documents, Washington, 1897, p. 159.

[5] A. H. BROOKS: Twentieth Ann. Rept. U. S. Geol. Surv., Pt. VII, 1900, pp. 460–465.

[6] J. E. SPURR: Eighteenth Ann. Rept. U. S. Geol. Surv., Pt. III, 1898, pp. 134–140.

[7] W. H. DALL: Seventeenth Ann. Rept. U. S. Geol. Surv., Pt. I, 1896, pp. 862, 863.

[8] J. E. SPURR: Twentieth Ann. Rept. U. S. Geol. Surv. Pt. VII, 1900, pp. 235 and 241.

[9] W. H. DALL: Seventeenth Ann. Rept. U. S. Geol. Surv., Pt. I, 1896, p. 135.

[10] C. W. PURINGTON: Manuscript map referred to by Spurr.

[11] J. E. SPURR: Twentieth Ann. Rept. U. S. Geol. Surv. Pt. VII, 1900, pp. 233–235.