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REPORT OF THE SECTION OF MINERALOGY

BY N. H. WINCHELL, CHAIRMAN.

[October, 1882.]

In the inception of any systematic and thorough work in the Mineralogy of Minnesota, it is obvious that the *first* thing is to find out what has been done already. It is the object of this paper to accomplish that for the Academy. In other words this paper begins with a reference to publications on the minerals of the State so far as they can now be ascertained—a kind of *Bibliography of the mineralogy of Minnesota*—and ends with an *enumeration of such minerals as are known to occur in the State*, and a statement of their localities, with notes on some of their characters or peculiarities.

BIBLIOGRAPHY OF THE MINERALOGY OF MINNESOTA.

The earliest mention of any minerals in Minnesota is to be found in the Relations of the Jesuit Missionaries. These pious and venturesome fathers occasionally mention metallic copper in possession of the Indians, and in some cases attempt to give some idea of the whereabouts of the mines from which it was obtained, but their statements are of little scientific value. LaHarpe's "History of Louisiana" maintains that LeSueur saw a large vein of native copper near the mouth of a small lake at a point four leagues above the mouth of the St. Croix River. One of the early maps locates a coal mine on the Minnesota river, some distance above its mouth. LeSueur's fanciful copper mining took place in 1700 and 1701 and was located at Fort

L'Huillier, near the mouth of the Blue Earth river. Carver, in his *Travels*, first alludes to the Red Marble, of which the Indians made their calumets, now known as *catlinite*, and to various black, white and blue clays found in the same part of Minnesota.

Prof. Wm. Keating, however, in 1828 seems to have been the first to have identified any minerals by recognized and accepted scientific terms within the limits of Minnesota. This was during his expedition with Major Stephen H Long to the "Source of the St. Peter's river, and to Lake Winnepeep" wherein he acted as geologist, mineralogist and general chronicler. It is true also that Major Long in 1817, in his narrative of a "Voyage in a six-oared skiff to the Falls of St. Anthony," had enumerated sundry brilliant pebbles which he had gathered on the summit of Gwinn's Bluff, in Winona county, saying they consisted of "crystals of iron ore, siliceous crystalizations, beautifully tinged with iron, some of them purple, others reddish, yellow, white, etc., crusts of sandstone strongly cemented with iron, and I think set with solid crystals of quartz;" and again at a point a few miles below the mouth of the St. Croix, he mentions a bluff which he ascended, on the slopes of which he "observed a variety of pebbles and stones, amongst which were the agate of various hues, chalcedony, flint, serpentine, ruby and rock crystal, etc., but as Major Long was not a mineralogist, while Keating was, it will do Long no injustice to accredit the first accurate mineralogical observations to Keating.

His first observations were on the sands that compose the banks of the Mississippi below St. Paul, (vol. I p. 304.) He remarks that in these sands sometimes are found carnelians, agates, jaspers, etc., which present characters analogous to those observed on the Rhine below Oberstein, and in Scotland where they are distinguished by the name of Scotch pebbles." *

* * * "In one or two instances, while examin-

ing the sand with the microscope a white transparent topaz was extracted from it. It is probable that had more time been taken on land many would have been found. Although much rubbed, still the form of the prism of the topaz with its dihedral summit, could be well made out."

At the mouth of the Redwood river Keating enumerates *quartz, feldspar, mica* and *amphibole*, and dwells on the great variety of combinations which they assume in the primitive rocks there *in situ*. At the Lake of the Woods he mentions *iron pyrites* and veins of *quartz*, and on the authority of Dr. Bigsby *staurolite* is said to occur in the slates of Rainy Lake river.

Mr. Featherstonhaugh mentions galena not far from Red Wing, salt springs "east of the Pembina Hills" and bituminous coal at Lake Taverse. Mr. George Catlin, whose work on Indian Costumes and Manners is well known, visited the famed red pipestone quarry in 1836, and was the first to procure and bring away for chemical examination, a piece of the pipestone. This he submitted to Prof. C. T. Jackson, of Boston, who named it with the mineral designation *Catlinite*, though Gen. H. H. Sibley insists that the Indian name, *E-yan-shah*, should be preserved (Journal of the Council of Minnesota, 1849, p. 30.) The paper of M. Catlin is published in the American Journal (1) xxxviii, though it was first read before the Boston Society of Natural History, September 4, 1839. Dr. Jackson's analysis is in the 35th volume of the American Journal, p. 388. Of this pipestone the following analyses have been published, Prof. Peckham's being in the *Sixth Annual Report of the Geological and Natural History Survey of Minnesota*, p. 101.

	Silica.	Alumina.	Iron.	Manganese.	Magnesia.	Lime.	Alkalies.	Water.
Thomson,	56.11	17.31	6.96		0.20	2.16	12.48	4.59
Jackson,	48.20	28.20	5.00	0.60	6.00	2.60		8.40
Peckham (lt. c'd)	58.25	35.90	trace					6.48
Peckham (red)	57.43	25.94	8.70		trace	trace		7.44

The Geological Survey of Wisconsin, Iowa and Minnesota by Dr. D. D. Owen, added largely to the accurate mineralogy of the State of Minnesota. This was carried on from 1847 to 1850. As we shall have occasion to refer considerably to this in the enumeration of the minerals of the state as well as to some of the following publications, it is sufficient here simply to name them.

In Schoolcraft's volume giving an account of the final discovery of the source of the Mississippi in 1831 and 1832, is a short list by Mr. Schoolcraft, of localities of minerals observed in the Northwest in 1831 and 1832. Among these localities are named the following in Minnesota.

Calcareous tufa, in the gorge below the Falls of St. Anthony.

Granular quartz, Falls of Peckagama, Upper Mississippi.

Agate, Imbedded in the Trap Rocks of Lake Superior.

Hornblende, as a constituent of the primitive rocks of the upper Mississippi.

Argillite, St. Louis River.

In Schoolcraft's volume, entitled "Summary Narrative of the Discovery of the Sources of the Mississippi," published in 1854, by Lippincott, of Philadelphia, may be found (pp. 356) a report by Mr. Schoolcraft to John C. Calhoun, Secretary of War, on the Geology and Mineralogy of the Upper Mississippi, bearing date 1822. This report seems to have been published first in 1854. In giving a description of the pipestone, now generally known as *catlinite*, he applies the true mineral name, *opwagonite*, saying it is the Algonquin word for Calumet-stone or pipestone. Realizing that this Algonquin word is more appropriate than that applied by Dr. Jackson, and supposing that Schoolcraft's references would bear out his implied earlier use of his designation, I took the trouble to consult his earlier reports, to which he refers, with a view to the adoption of Schoolcraft's name, should it prove to have antedated the word *catlinite*. But it was found that in his "View of the Lead Mines of Missouri," published

in 1819, to which he refers, he does not make use of that designation, and is so far ignorant of the origin of the substance as to assign it to the Falls of St. Anthony. Again, when in 1820 he visited the Falls of St. Anthony, he corrects, it is true, his statement that it is found here, and assigns it to the Coteau des Prairies, but still does not employ the term *apragonite* in the report of that expedition, published under the title "*Narrative journal of travels from Detroit northwest through the great chain of lakes to the sources of the Mississippi river, in 1820,*" as a member of the expedition under Governor Lewis Cass. It seems to be necessary, therefore, to conclude that Schoolcraft invented the word in 1854, and published it as if applied in 1822. If Mr. Schoolcraft made such a mineralogical report to Mr. Calhoun in 1822, it is remarkable that it was not published, nor referred to by him in his volume on the Discovery of Lake Itasca, published in 1834 by Harper & Brothers, prone as he was to reproduce his official and other papers.

Mr. Schoolcraft, in 1854, also enumerates the following minerals and mineral localities in Minnesota:

Iron sand, on the shores of Fond du Lac and Lake Superior.

Micaceous oxide of iron, among the debris of St. Louis river and of Fond du Lac.

Ochery red oxide of iron "is produced near the spot called Big Stone, on the head of St. Peter's river." It is employed as a pigment by the Indians.

Quartz is mentioned in various forms, viz:

(a) *Arenaceous*; the sandrock of many localities.

(b) *Pseudomorphous*, shores of Lake Pepin; having taken the crystalline impress and form of rhombohedral crystals of carbonate of lime.

(c) *Chalcedony*, shores of Lake Pepin.

(d) *Carnelian*, shores of the Upper Mississippi.

(e) *Agate*, shores of the Upper Mississippi.

(f) *Basanite (Touchstone)*, along the banks of the Upper Mississippi.

Mica, in minute folia in alluvial soil of the Upper Mississippi.
Hornblende, at the "Peace Rock," on the Upper Mississippi.
(This is supposed to be near Watab).

Granular Graphite, "in a small vein in the clay slate of the St. Louis river, at the head of the Nine Mile Portage. It is coarse grained and gritty."

Besides an occasional mention of native copper, gold, magnetic iron ore, coal and argentiferous galena, in the reports of the early so-called "surveys" of the state and territory of Minnesota, most of which are exaggerated from ambitious and speculative purposes, but little is added in those reports to the mineralogy of the state. Their authority, and much of their material, are taken from Owen's earlier *Report on the geology of Wisconsin, Iowa and Minnesota*.

They may be enumerated, however, in the bibliography of the state, viz:

Report on Geology. No. 12, of the Legislative Documents of 1861. Anderson and Clark. 26 pp., 8vo.

Report of Hanchett and Clark on the geology and physical geography of the northeastern district of Minnesota. 1865. 82 pp., 8vo.

Report of H. H. Eames on the metalliferous region bordering on Lake Superior. 1865. 23 pp., 8vo.

Geological reconnaissance of the northern, middle and other counties of Minnesota. By H. H. Eames. 1866. 58 pp., 8vo.

Geology and minerals. Report of explorations in the mineral regions of Minnesota in the years 1848, 1859 and 1864. By Col. Charles Whittlesey. 1866. 54 pp., 8vo. This pamphlet is more valuable for its geology than its mineralogy. Its errors are numerous, among which may be mentioned its identification of prehnite at French River with quartz, and of labradorite feldspar at Split Rock River with quartz. The summit of Carlton's Peak is said to consist of gray quartz.

The following statement is quoted from this pamphlet, p. 41:

"In the spring of 1858 a boulder was found on the north shore of the St. Louis river, at Rice's Point, below Oneota, having a metallic appearance, with a pale brass color, and which weighed about 100 pounds. Various accounts have been current as to the locality of this mass. Mr. R. B. Carlton said it was found by Joe Pose, soon after the spring freshet, in the sand at the place just named. In size it is about a foot long, with two faces nearly parallel, as though it came from a vein with regular walls, four or five inches wide. Some persons regard it as an artificial alloy of zinc and copper, which had been produced by melting a church bell. It is broken with difficulty, and in the interior has patches of a greenish tinge. The mass has a whitish-yellow color, a pyritous aspect, finely crystallized, with small blotches of spar, showing it not to be an artificial compound. As I was sending a box of minerals to my friend J. H. Boalt, Esq., of the School of Mines at Freyburg, in Germany, a piece of this boulder was forwarded, with the request that it should be analyzed. No arsenides of copper were then known on Lake Superior, but I have since seen a specimen from Portage Lake. Mr. Boalt reported that about the time of the arrival of my specimen another was received from Chili, in South America. All parties were interested to know what ore of copper they represented. The analysis gave eighty-three per cent. of metallic copper, and seventeen of arsenic, which approaches very near to the rare mineral *algodonite* of Dana. This boulder, no doubt, came with the drift materials from the north-east, and represents a vein somewhere in that direction, perhaps not far distant."

In the *Minnesota Teacher* for June and July, 1871, Mr. J. H. Kloos has papers on "Geological Rambles in Minnesota," in which are found some discriminating remarks on the minerals constituting the crystalline rocks near Duluth. He mentions: labradorite, diallage, or hypersthene, or augite, magnetite, epidote, calcite, laumontite, chlorite, quartz, copper.

At Taylor's Falls he enumerates: hornblende, (a transparent

mineral of the color of chrysolite), labradorite, copper, dolomite, quartz, calcite, copper glance, earthy malachite.

In the syenites of the St. Cloud region he also enumerates the minerals which he expects to find on making a careful chemical and mineralogical examination, viz: orthoclase, a triclinic feldspar, pyroxene, labradorite, anorthite, hyperite, hornblende, mica, protobarite, pyrite, quartz.

Mr. Kloos collected samples of some of the crystalline rocks of Minnesota which he took to Germany. These were the subject of a series of papers by Streng and Kloos in the *Neues Jahrbuch für Mineralogie (Geol. u. Pal.)* 1877. Mr. Kloos repeated his general observations and extended them in a paper published in 1871 in the *Zeitschrift d. d. Geol. Gesell.* p. 428*

It is not necessary to enumerate the publications of the present geological survey, as they are well known. They all contain some mineralogical material, particularly the seventh, eighth, ninth and tenth annual reports.

MINERALS AND MINERAL LOCALITIES IN MINNESOTA.

NATIVE ELEMENTS.

GOLD.

Gold has been washed from the drift in noticeable quantities in various places in the State, particularly at Rochester, Oronoco, Spring Valley, sec. 31, Jordan, Fillmore County, and at several points in Wabasha County. As an ingredient of the bedded rocks it has been extensively sought in the chloritic slates at Vermilion Lake, as reported by Mr. Eames in 1865, and somewhat in the same formation west of Moose Lake Station, in Carlton County. In these examinations, the former of which induced a general movement of miners and other hasty speculators to Vermilion lake, some gold may have been

*A translation of this paper will be found in the Tenth Annual Report of the Geological and Natural History Survey, 1881.

found, and certainly was, if the reported assays in Mr. Eames' report be true. Recent assays, however, do not give gold in any appreciable amounts from the Vermilion quartz rocks, nor from the slates containing the quartz rocks.

Gold has lately been taken from the gravel at Willmar, as reported. The pieces are angular, and appear to have been recently cut by some sharp instrument, indicating an artificial sprinkling in the naturally rounded gravel. It is 91 per cent. pure gold, the rest being copper. Gold is also found in the quartz veins of Rainy Lake, but the shafts sunk have all been on Canadian territory so far as I am informed.

SILVER.

Silver occurs native in the quartz veins of the slates in the northeastern part of the State, but no valuable deposits within Minnesota have yet been brought to light. This is the same formation that is wrought at Silver Islet and Thunder Bay, in Canada. Its most abundant occurrence is in the form of argentiferous galena. Several late enterprises have begun operations on the islands between Thunder Bay and Pigeon River, and one also is started on one of the islands south of Pigeon Point in Minnesota. Some of the float pieces of copper found in the central and southern part of the State also show small quantities of silver. The assays of the Vermilion gold ores, reported by Mr. Eames, show small percentages of silver.

COPPER.

Copper has been mined at French river, at Sucker river, on Snake river, at Fall river, at Taylor's Falls, and at several other points. At French river it occurs with prehnite, and is occasionally associated with small quantities of native silver. This metal is disseminated in nodules and thin vein fillings throughout much of the "trap-rock" of the region, but is at the same time principally aggregated in one or two metalliferous beds or belts a shaft that penetrated 43 feet, revealing two such beds.

Pieces weighing several pounds have been taken from this shaft. It is also being mined or sought by shafting near Chengwatana, in the trap and amygdaloids.

Pieces of native copper of considerable size are occasionally found distributed through the drift in the central and southern part of the State. Mr. T. Elwell, of Granite City, Morrison County, reports fifty-six pieces found in that vicinity, and transmitted them to St. Paul in 1861, by Hon. Levi Wheeler, Representative from the third district. Several pieces have been found at Minneapolis and others at St. Paul. Numerous pieces have been found in the valley of the St. Croix river; other localities are Rochester, Zumbrota, White Bear Lake, and along the Mississippi below St. Paul. LeSueur is reported by LaHarpe to have seen a large mass of native copper at a point four leagues above the mouth of the St. Croix river, near the mouth of a small lake. Several hundred pounds of float copper were found between the Northern Pacific Junction and Knife Falls during the construction of the Knife Falls railroad. These pieces lay usually among stones on the surface, and were probably derived from the general drift-sheet that may be supposed to have covered the region, the railroad following the ancient valley of the St. Louis all the way. Small pieces have been found in the mineral Thomsonite which fills amygdaloidal cavities in the trap at Good Harbor Bay.

IRON.

No well authenticated instance of native iron in Minnesota is known, though such has been reported from St. Paul. It is true that grains of metallic iron ore found in the drillings of the well near the Harvester works. These certainly are not natural. They have the form of iron cuttings and drillings artificially made, and on being allowed to remain among the rock drillings become rusted immediately, cementing the rock grains together in small rusty clusters. Their chemical composition also indicates that they are not natural.

GRAPHITE.

This is found in considerable quantities at Pigeon Point. It is disseminated in lumps through a metamorphic sand rock. The lumps vary from the size of a pin-head to flattened masses six or eight inches in diameter. The sand rock sometimes becomes gneissic, and is of the same formation as that which holds the silver mines of Thunder Bay and Silver Islet. Graphite also is found in a vein about a foot thick a short distance above Thomson, at the head of the "Nine-Mile Portage." Schoolcraft says it is coarse-grained and gritty.

SIMPLE SULPHIDES, &c.

ALGODONITE.

This arsenite of copper was found in a large transported mass in 1858 on the shore of the St. Louis river, near Rice's Point. The piece was about a foot long, with two faces nearly parallel, as though it came from a vein with regular walls four or five inches thick. It was reported to have been analyzed by J. H. Boalt, of the School of Mines, Freiburg, in Germany, and was found to afford 83 per cent. of metallic copper with 17 per cent. of arsenic.

WHITNEYITE.

On the authority of Mr. Dana the large mass of algodonite last mentioned was stated to be partly made up of whitneyite, which is a compound of copper and arsenic, but having less arsenic than algodonite.

GALENITE.

This sulphide of lead is common in the state. It has been found almost invariably in the trial shafts for silver in the Lake Superior region. It is associated with calcite, barite, pyrite and quartz. It is also found in limited quantities in the Galena limestone in the southern part of the state, and in the St. Lawrence and St. Croix formations at Dresbach in Winona county.

In the St. Croix sandstone at Dresbach it is found as a matrix which cements considerable masses of rock that is made up of sand grains and linguloid shells. In that form it has been taken out of a shaft about 20 feet below the level of the Mississippi river.

BORNITE.

This is probably the ore found by shafting about three miles west of the mouth of Cascade river, Lake Superior, and on the island south of Pigeon Point. It also occurs in a dark bed of metamorphic conglomerate about six feet thick, at London, near Duluth.

SPHALERITE.

This sulphide of zinc is common in the shafts sunk for silver in the slate and quartzite group at Pigeon Point and along the international boundary. It is also reported from Stillwater.

CHALCOCITE.

In a vein near the water level at St. Croix Falls, opposite Taylor's Falls.

PYRITE.

A common mineral. It occurs in all mines, and as nodules in most of the rocks of the state. It is found in the common building-stone (Trenton) at Minneapolis as little shining yellow specks, and in the cretaceous shales in the western part of the state. Sometimes it weathers out of the latter, and is found on the sloping bluffs where these shales outcrop. It is also common in the blue drift-clay, or hard-pan, of the western part of the state, derived originally from the cretaceous, and in that situation it retains its metallic lustre unchanged, affording frequently clusters of crystals that are quite beautiful.

CHALCOPYRITE.

Common in the shafts sunk in the cupriferous rocks in the northern part of the state, as well as in the slate and quartzite groups of Pigeon Point.

 MARCASITE.

Very common in the south-eastern part of the state, where it accompanies the St. Lawrence limestone. It is found in lumps, partly altered to *limonite* on the tops of the bluffs in that part of the state, along the river valleys. It is evidently the result of denudation from some higher strata.

 COMPOUNDS OF CHLORINE.

HALITE.

The only evidence of this mineral in Minnesota is the occurrence of saline springs and of artesian salt water in the north-western part of the state. The most noteworthy instance is the deep well at St. Vincent, where, however, the brine contains also some lime and some magnesia.

 COMPOUNDS OF FLUORINE.

FLUORITE.

This occurs in small quantities at Lester river, on the north shore of Lake Superior, and in much larger quantities in some of the veins that have been explored for silver in the north-eastern part of the state.

 COMPOUNDS OF OXYGEN.

CUPRITE.

This mineral was found, mingled with malachite, coating a piece of metallic copper which was found on the surface or among the drift materials, near Rochester. It, doubtless, also exists in varying quantities wherever metallic copper is found in the rocks of the state.

WATER.

Within the state there is a superficies of water of 4,714 square miles, and at Minneapolis the average flow of the Mississippi is

25,000 cubic feet per second. The average rain-fall at Minneapolis is about 29 inches per year.

HEMATITE.

In large quantities in the vicinity of Vermilion lake, and in the Mesabi Range. It also occurs as a red, ochreous deposit in numerous places. It has been employed as a pigment by the Indians, who obtained it at Big Stone lake and at Grand Portage.

MAGNETITE.

In large quantities in the north-eastern part of the state. It is apt to bear titanium. But when found in large strata in the Huronian formation, it is wholly or nearly free from it. It occurs also at Rainy Lake.

MENACCANITE.

This seems to be the principal magnetic mineral which enters into the gabbros and other igneous rocks of the cupriferous in Minnesota. It is so abundant in the region of Iron lake, north of Grand Marais, and at Herman, near Duluth, that it has attracted attention as an iron ore. The titanium present is frequently not enough to constitute this mineral, which requires from 30 to 40 per cent. It is sometimes as low as three per cent., the mineral then being rather *titaniferous magnetite*. As iron-sand it gathers on the Lake Superior shore at Black Beach, about 4 miles west of Beaver Bay, and can be extracted from the gravel with a magnet in nearly all parts of the state—particularly the eastern.

LIMONITE.

This ore of iron frequently is found pseudomorphous after pyrite and marcasite. This is particularly the case in the changed marcasite found in the south-eastern part of the state. As a bog-ore it is found frequently, and it often stains the earth and peat about lakes and stagnant pools, when it cannot, from its impurity, be styled correctly as limonite. It is found as a bog-ore in considerable quantities near Coon Creek in Anoka county.

OXIDES OF THE CARBON-SILICON GROUP.

QUARTZ.

This most common of all minerals exhibits itself in nearly all its forms in Minnesota. Its most remarkable and pure deposits are seen in the St. Peter and St. Croix sandstones, with which all geologists are familiar, in the bluffs of the Mississippi river and its tributaries, where it constitutes 98 per cent. of the rock. As agate, carnelian and chalcedony it exists in the trap rocks in the north-eastern part of the state, and is distributed in the gravel throughout the eastern half of the state. Agate Bay is so named from the great numbers of pebbles of agate that are found on its beach. But they are equally numerous in other places. Many may be found at Burlington Bay, and at the point next west of Knife Island. As chalcedony it weathers out of the trap at Gooseberry river, and in the drift of the western part of the state it is in that form from fossil wood derived from the cretaceous. It is less commonly found as amethyst in the cupriferous, the only locality known in Minnesota being on a small island a short distance east of the Gooseberry river. Amethyst also occurs sometimes in the siliceous geodes of the Shakopee and St. Lawrence dolomites. As heliotrope, or bloodstone, very fine specimens are sometimes found, but the prevailing color is rather brownish or black than green. Moss agate, which seems to come from agatized wood, is more common in the western part of the state, referable to the cretaceous debris. Flint, hornstone, basanite, touch-stone, red, brown and black jaspers, as well as jasperoid hæmatite with beautiful banding, are common as pebbles throughout the state, particularly the eastern half. Agates and carnelians are so abundant that they are largely represented in every amateur collection, and thousands of specimens have been carried from the state. The amethysts that are sold so abundantly at Duluth are from Thunder Bay, 150 miles further east, on the north shore. Quartz occurs in perfect crys-

tals in the quartz-porphyrines on the north shore of Lake Superior in Minnesota, and in the form of prase it is found on the beach among the pebbles.

ANHYDROUS SILICATES.

HYPERSTHENE.

As a constituent of the rock at Black Beach, about four miles west of Beaver Bay. Although this is the only point at which this silicate has been reported, though here still subject to correction by more careful examination, it is probable that it occurs largely in the rocks of the north shore of Lake Superior. It may be confounded with bronzite, since they show the same kind of metalloidal surface which glitters like mica in the sunlight. It has the same crystallization also.

BRONZITE (ENSTATITE).

The rock composing Encampment Island, on the north shore of Lake Superior, has a "metalloidal augite" as an important constituent, which is thought to be enstatite. It has, however, only been examined microscopically, and is subject for further analysis.

WOLLASTONITE.

A radiated white fibrous mineral from Scoville's Point, Isle Royale, weathering from the trap of the region, is believed to be wollastonite, but the samples gathered have not yet been examined carefully. The same may be looked for in Minnesota between Grand Portage and Grand Marais, judging from the strike of the strata.

PYROXENE.

The only form of pyroxene within the state that has been identified is the variety known as augite; and much of that belongs to the sub-variety diallage. It comprises a large constituent of the igneous rocks of the cupriferous, and is disseminated from Chingnatowa to Pigeon Point. The regular form of pyr-

oxene seems to pervade the rock known as "trap-rock" at Taylor's Falls, but that is also subject to further examination.

SPODUMENE.

May be doubtfully named as a Minnesota mineral, from the Mesabi Range.

AMPHIBOLE.

Under this name are included all the varieties of hornblende found in the syenites and crystalline schists of the state. This is a very common mineral. It is found in the St. Cloud and Sauk Rapids syenites, in the red syenite near Duluth, and in the same formation back of Grand Marais. It is abundant in a rock at W. Gull lake, near Saganaga lake, where it is associated with quartz and a little plagioclase, so as to constitute a rock styled amphibolyte. The same rock spreads widely west of that point. Actinolite appears as a microscopic mineral in many thin-sections from the rocks of Minnesota. Both actinolite and tremolite are reported from Rainy lake by Dr. Bigsby.

CHRYSOLITE.

This mineral, which is common in the igneous rocks of the cupriferos series, as one of their constituents, sometimes makes nearly alone the entire rock. Such is the case in a rock on the "iron trail" north from Grand Marais, about half way between Little Trout lake and Brule river. (Survey No. 677.)

GARNET.

Small garnets occur abundantly in the schists at Little Falls. Larger ones are in the same rock at Pike Rapids, associated with staurolite. These are of the usual dark cinnamon color. But at Duluth, in some of the metamorphic strata of the cupriferos, is a waxy, honey-yellow garnet, pierced with microscopic actinolite. This is in small quantities in laminations in a metamorphic shale. (18 A). Garnet occurs also at Rainy lake.

EPIDOTE.

A common mineral in the cupriferos rocks of Lake Superior.

It is known at Duluth, at Taylor's Falls, and abundantly on Isle Royale.

BIOTITE.

This is a common mineral in the syenites at St. Cloud, and as a microscopic mineral in the rocks of the cupriferous.

MUSCOVITE.

This is probably the mica that is mingled with the schists at Little Falls and Thompson, and forms a constituent of most of the granites of the state. It is disseminated also through some of the sandstones, particularly the lower portions of the St. Croix sandstone at Dresbach. Along the northern boundary, at Rainy Lake and at Lake of the Woods, it has been seen in large foliæ.

WERNERITE.

Found in the trap at the Island Mine, Isle Royale, and doubtfully identified on the north shore of Lake Superior at Lover's Bay, in Minnesota. The form Glaucolite is found also at the same place on Isle Royale.

ANORTHITE.

This accompanies orthoclase in the porphyries at Duluth and at Taylor's Falls.

LABRADORITE.

Is the chief constituent of the Rice Point gabbro, and of the range of hills that passes behind Duluth and reaches to the international boundary. It forms the rock of Carlton's Peak. It is embraced in basaltic trap at Split Rock Point as transported light-colored boulders, making a curious pudding-stone. It occurs beautifully in large masses near Beaver Bay, and constitutes low hills near the lake shore a few miles east of Beaver Bay. In some of these cases this mineral is nearly pure and makes up the whole rock. It does not, however, exhibit the internal opalescence, generally, which characterizes it in Labrador, and in Lewis county, New York. It is the chief feldspathic ingredient in the igneous rocks of the cupriferous series.

ANDESITE.

Occurs at Duluth in the porphyries of the cupriferous.

ORTHOCLASE.

Is found disseminated abundantly porphyritically in the rocks at Duluth, and in the porphyry at Taylor's Falls, and is an essential ingredient in the granites everywhere in the state—particularly those having a red color. It is perhaps as often found uniting with hornblende, forming syenite, as with mica, forming granite. It fills amygdaloidal cavities at Duluth, near Chester creek at the lake beach.

OLIGOCLASE.

This feldspar is found in an augitic quartz-diorite at Watab, and in the syenitic granites at Sauk Rapids.

ALBITE.

Is disseminated porphyritically in some schists of the Huronian in the region about Vermilion lake, and is found also in the granite at Watab. A large boulder of chloritic schist having crystals of albite $\frac{3}{4}$ inch across was found by Dr. Elliot near Lake Calhoun.

TOPAZ.

Occasionally occurs in the sand of the drift along the Mississippi river below St. Paul.

DATOLITE.

Occurs on Isle Royale, in the trap rocks, and is likely to be found in Minnesota, but has not yet been certainly identified.

STAUROLITE.

Is found in the mica schist at Pike Rapids, on the Mississippi, and at Lake of the Woods in a similar rock associated with garnet. At the former place the crystals are frequently twinned, at least crossed, so as to make symmetrical cruciform figures, and some are attached obliquely. The schist disintegrates easily, allowing the crystals to mix with the gravel, where they are found sometimes in most perfect form and preservation.

HYDROUS SILICATES.

PECTOLITE.

Fine specimens of pectolite occur on Isle Royale, but it has not yet been certainly identified in Minnesota.

LAUMONTITE.

This crumbling flesh-colored mineral is very abundant in the cupriferous rocks. It is not only found in the red amygdaloids (or pseudo-amygdaloids), in which it pervades the beds that reach a thickness of one to fifteen feet, but it is also found in the amygdules of the trap itself, more sparsely disseminated. Its rapid disintegration in the weather is the first and most efficient cause of the many purgatories and arched rocks that beautify the scenery of the north shore of Lake Superior. It is disseminated in these crumbling beds through a shaly rock of a red color, which often presents the characters of sedimentation, and even among the red conglomerates of the cupriferous, these sedimentary beds showing fucoidal fossils.

CHRYSOCOLLA.

This occurs occasionally on the north shore of Lake Superior and in the cupriferous rocks of Pine county. It is generally associated with chalcopyrite.

PREHNITE.

At French river, containing native copper. It is here abundantly scattered through certain beds in all their cavities and veins, comprising perhaps one-tenth of the rock. It is radiated and fibrous, of a light color, slightly greenish in larger masses, and appears like quartz, for which it has been mistaken. It is the gangue-rock of the native copper which has been somewhat mined at French river.

CHLORASTROLITE.

At Rock Harbor, Isle Royale.

ZEOLITES.

THOMSONITE.

Of this section of the silicates, probably the most noteworthy in Minnesota, is the *thomsonite*, which is found abundantly in the trap-rocks from Terrace Point to Poplar river and even further west, on the north shore of Lake Superior. It was brought to light by the Mayhew Brothers of Grand Marais, who have bought of the squaws many hundred dollars' worth, gathered from the beach of the lake, where they are smoothed by the waves among the other gravel and show their beautiful markings, and have sent them to eastern dealers in minerals and gems. Eclipse Beach and Terrace Point are the chief localities.

LINTONITE.

This is found associated with thomsonite, and seems to be a variety of thomsonite. It is green, generally amorphous, and although it encloses frequently the thomsonite amygdules, it also constitutes amygdules alone.

NATROLITE.

Is found at Beaver Bay on the north shore of Lake Superior. It is in seams in the labradorite rock at the west point of the bay, and is taken out in crusts about $\frac{1}{8}$ inch thick.

STILBITE.

Is a common zeolite along the north shore of Lake Superior, between Poplar river and Grand Marais. It occurs abundantly at Eclipse Beach and at Sugar Loaf Point, as far as to Two Island river. It is also abundant about two miles west of Little Marais.

HEULANDITE.

Occurs as coatings, very generally, along the shore of Lake Superior, in the joints of the trap-rocks.

MORDENITE.

Occurs as amygdules at Sec. 26, T. 57, 6, a few miles west of Little Marais, associated with stilbite and jasperoid agate.

MARGAROPHYLLITES.

TALC.

This is the basis of the talcose schist which plays a conspicuous part in the stratigraphy of the Huronian at Vermilion lake and on the International boundary, but no important deposits of the unmixed mineral have yet been discovered in Minnesota. It seems to be the chief ingredient in the greenish "pipestone" cut by the Indians from Pipestone Rapids and at Rainy lake.

GLAUCONITE.

Is said to occur in the sandstones of the St. Croix, as at Red Wing, and in the St. Lawrence limestone at St. Lawrence. But the characters of this Cambrian greensand do not agree with those of the cretaceous greensand, nor with that from igneous rocks.

SAPONITE.

Under the name *thalite* a mineral was described by Dr. Owen from the mouth of Knife river, as new to science. But Dana has placed it under the older term *saponite*. It is soft and nearly white, filling cavities in amygdaloidal rock at the very water's edge. It is also found in the same kind of rock on Kettle river, in Pine County.

HALLOYSITE.

Whether the decomposed granites of the Minnesota valley can be included under this term or not, they certainly should be placed in this section of the silicates. The most of this deposit, which occurs characteristically at Birch Cooley, is amorphous, earthy, soft, greenish, and ferruginous on analysis, but in some places it is more nearly white, approaching kaolinite in outward characters.

DELESSITE.

Common as a product of decay in the trap-rocks of the north shore of Lake Superior. It also fills amygdaloidal cavities and

cracks. It gives a soft and slippery feel to the green traps when undergoing incipient decay near the water-line. It has a velvety radiated crystallization.

PROCHLORITE.

This term is here employed for all the chlorites and chlorite-like minerals, except delessite, that occur in the cupriferous rocks. Very often a chlorite-like mineral results from the decay of hornblende or augite. This is often called *viridite*, which signifies the same thing, but is used to avoid the appearance of exact knowledge of its mineral nature. The chloritic schists can hardly be distinguished from the talcose, and they hardly from the hydro-mica schists, without minute chemical or microscopic examination. Hence, it must be understood that the term here is used without intending to apply closely to that class of crystalline rocks, although there can be no doubt but the chloritic schists form an important group of the so-called Huronian strata.

PHOSPHATES.

APATITE.

At present this is known only as an unimportant ingredient of the igneous rocks. It exists not only in the trappean beds of the cupriferous, where nearly every thin section reveals, under the microscope, numerous needle-shaped crystals, but also in the igneous dykes that cut the rocks of the Huronian at Thomson, and the syenites at Sauk Rapids. The well-known fertility of the soils derived directly from the decomposition of the igneous rocks seems to be due largely to the presence of this mineral.

SULPHATES.

BARITE.

Barite is common in the northern part of the State, as a gangue rock in the veins that have been explored for silver and for copper, but particularly for silver. It is associated with calcite, pyrite, amethystine quartz and galenite. On Pigeon Point is a conspicuous dyke, or vein, of white barite, which crosses from one side of the peninsula to the other, about four feet in width. This has long been known, having been described by Norwood, an assistant on Owen's survey.

GYPSUM.

This accompanies the Cretaceous rocks in the western part of the state, and is found on the slopes of some of the bluffs made of the cretaceous shales, as at Big Stone Lake. It is frequently found in perfect, transparent selenite crystals in the drift-clay, in sinking wells in the drifted western counties, where it seems to have been formed by segregation from the clay.

EPSOMITE.

On account of the easy solubility of this mineral it is not known to have been found in its crystalline condition in the state, but it is in solution in the alkaline waters of the western part of the state, in noticeable amounts, mingled with some common salt. It seems to have been the basis on which the so-called *salt springs* of the state were located. It is also found on the lower side of some projecting shelves of magnesian limestone as a delicate white efflorescence, the sulphur probably being derived from oxidation of pyrite. This is the case along the bluffs of the Galena limestone at Mantorville.

MELANTERITE.

This is also a product of the oxidation of pyrite or marcasite, and in limited quantities, exists in the same situations as epsom-

ite, as a coating on the under surface of projecting strata of dolomite, but its color is apt to be yellowish instead of white.

CHALCANTHITE.

This has not been identified in the state, but undoubtedly exists in the northern portion. It results from the oxidation of chalcopyrite, and is apt to be carried away in solution by waters that come in contact with it.

CARBONATES.

CALCITE.

As the essential and principal ingredient of all limestones, this is an abundant and very important mineral in Minnesota. The only pure limestones, however, are the Trenton (the Building-stone beds) as seen at Minneapolis and St. Paul, and the Niobrara limestone of the Cretaceous. So far as examined this contains also a small percentage of carbonate of magnesia, while all the others are highly magnesian or quite dolomitic. Calcite also occurs in veins in the crystalline rocks, where it sometimes exhibits perfect crystalline forms. At Pigeon Point some perfect specimens have been obtained in the shaft sunk by Kindred and Baker. At Crystal Bay, near Duluth, a modified red shale has numerous nests of perfect crystals enveloped in a recent red clay, loosely embraced in cavities in the rock. Nail-head and Cocks-comb forms of crystals occur in the Niobrara beds at Redstone, near New Ulm. At Chatfield some of the calcite in the Shakopee limestone embraces much quartz and in translucent grains, giving it the character of the Fontainebleau limestone of France. Near Caledonia, in Houston county is a large deposit of argentine or lamellar calcite, lying on the sloping bluff of the St. Peter sandstone. It has a grayish-yellow and brownish, undulating lamination, varying to nearly white. A large piece of the same once existed near St.

Charles, in a similar situation, but it has been exhausted for hand specimens. Calcareous tufa or travertine, is abundant in Minnesota, being the deposit of calcareous spring waters. It has been mentioned on the east bluff of the Mississippi just below the Falls of St. Anthony, whence thousands of specimens have been removed by visitors. At Osceola, (on the St. Croix Lake) calcareous tufa has been burnt for quick-lime for forty years at least. Marl is sometimes found in swamps and beneath peat beds. Sometimes it shows its origin by containing, still, fragments of fresh water shells, as at St. Cloud. In other cases it is an inpalpable, pulpy mud which passes gradually into a calcareous clay.

DOLOMITE.

This is the characteristic mineral of the dolomitic limestone of the state, and they include by far the greater number of our limestone strata. In its crystalline, pure form dolomite is rarely seen separated from the rock-mass. Sometimes as brown spar it is seen lining cavities or associated with calcite in geodic aggregations, as at St. Lawrence.

ANKERITE.

This is simply a ferruginous dolomite, and has been reported only from the St. Lawrence limestone, at Clear Grit, in Fillmore county, where it fills cavities in the limestone. It then has a slightly grayish color.

SIDERITE.

This is found in occasional loose boulders in the drift, more or less converted to limestone, in the condition of clay ironstone. In this form its origin is referable either to the cretaceous or to the Devonian strata. Such lumps occur abundantly at Austin, and are easily recognized by their weight. In a more pure state it has been found filling cavities in other boulders, somewhat in the manner of an amygdaloid, the outer surfaces becoming spotted with limonitic depressions due to the weather-

ing out of the siderite after its conversion to an oxide. The boulders that are thus marked are quartzitic. As a pure carbonate it is found in important quantities in the iron-strata of the Mesabi Range in northern Minnesota.

MALACHITE.

Occurs sparingly in numerous instances in connection with the cupriferous rocks of the state in the Lake Superior region. It is found also at Taylor's Falls and at Chengwatona as coatings on the protected surfaces of seams in the rock.

HYDRO-CARBON COMPOUNDS.

MINERAL COAL.

That which is popularly known as "coal" in Minnesota and in Dakota, is lignite or "brown coal" from the cretaceous, or from the tertiary. It not only embraces often impressions of woody fibre, but has frequently a considerable undecayed wood, as well as charcoal which shows the grain and cellular structure of the original wood. The best of it, however, is clean, black, amorphous and hard. On drying, this cracks in innumerable places and slowly crumbles to finer pieces and these again to finer, a quality which renders it difficult and wasteful to transport it on the cars, or to handle it for fuel. It occurs in the cretaceous strata at Redwood Falls on Crow Creek, at Fort Ridgley, on the Cottonwood river southwest of New Ulm, at Richmond in the Sauk river valley and has been found in the drift in nearly every county in the state. It also occurs at Namekan lake, on the northern boundary. These strata are frequently penetrated in sinking deep wells in western Minnesota and Dakota.