

THE MINERALS OF FRANKLIN AND STERLING HILL NEW JERSEY

BULLETIN 65

NEW JERSEY GEOLOGICAL SURVEY

DEPARTMENT OF CONSERVATION AND ECONOMIC DEVELOPMENT

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THE MINERALS OF FRANKLIN AND STERLING HILL,
NEW JERSEY

by

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TRENTON, NEW JERSEY

— 1962 —

ERRATA

- p. 12 Omit all references to zinc-mangan-
 & ese cummingtonite. This mineral is
p. 20 not an accepted specie.
- p. 14 There are 42 mineral species first
 found at Franklin and 211 mineral
 species and varieties at Franklin and
 Sterling Hill.
- p. 50 H_2O+ analysis B 0.70%, not 0.75%
- p. 54 MnO 34.94%, not 39.94%
- p. 61 Wherever appropriate spelling should
 be corrected, it is "polyadelphite".

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INTRODUCTION

This paper was written at the request of Dr. Kemble Widmer, State Geologist. In a letter dated December 16, 1959 he suggested that the writer discuss in some detail the minerals of Franklin and Sterling Hill, including 1) the history and significance of the discovery of the zinc ore minerals, 2) the chemical formulae, physical properties, and associations of all minerals first found at Franklin and Sterling Hill, 3) the names of the persons who first described these minerals, as well as the origin of the mineral names, 4) a list of all other minerals ever found at these localities, and 5) a short statement pertaining to the theories of origin of these world-famous ore deposits. These subjects comprise the major part of the paper, and the writer thanks Dr. Widmer for his suggestions. Constructive criticism of the manuscript by Professors Clifford Frondel and J. H. C. Martens, and by John L. Baum, Resident Geologist, The New Jersey Zinc Company, is gratefully acknowledged. Mr. Baum graciously gave the author considerable valuable information pertaining to the subjects at hand, about which the author was unaware, for which the author is greatly appreciative.

In the preparation of this paper the author has necessarily availed himself of important data contained in many papers and books listed in the bibliography. Specific acknowledgment for each fact is, naturally, not stated; such acknowledgment as is appropriate is given, however.

It might logically be expected that the list of minerals first found at Franklin and Sterling Hill in this paper would be the same as that in Report No. 1 of The Geological Society of New Jersey, "Minerals of New Jersey," December, 1959, written by the same author. Such is not the case, however. The discrepancy is the result of several factors, the most important of which was inadvertent omission of some minerals.

Errores feci quos confiteri volo.

It might also logically be expected of anyone writing about the minerals of Franklin and Sterling Hill to list, as does Palache in his masterpiece—"The Minerals of Franklin and Sterling Hill, Sussex County, New Jersey" in U. S. Geological Survey Professional Paper No. 180, 1937—the minerals that characterize his five zones. To list the minerals in these zones, however, requires the acceptance of these zones. Such acceptance demands strong belief in the origin of the

zinc deposits as presented by some geologists, including Palache. The latter's views are being challenged to such a degree that one should not repeat these zones because they possibly do not exist. So the 42 minerals in Palache's Pegmatite Contact Zone, the 19 minerals in his Scarn Zone, the 6 Recrystallized Products, the 55 minerals of his Hydrothermal Vein Minerals, and the 21 minerals of the Surface Oxidation Products are not listed as such in this paper.

The large number of mineral species and varieties first found at Franklin and Sterling Hill can be accounted for by the well-trained, keen-eyed chemists, geologists, and ordinary mineral-loving miners who as individuals and as a group must have at all times been on the lookout for that great thrill of recognizing that which is new. If it had not been for these men present on the scene day after day, the number of new species and varieties would be much smaller than it is now known to be. The activity and keen insight of local collectors of minerals also had much to do with the discovery of new minerals. Some of the famous collections of these minerals are associated with the well-known names of Canfield, Fowler, Gage, Hancock, Kemble, Losey, Rowe, Woodruff and others. These men recognized a new mineral when they saw it. For the whole world scientists are adding new mineral names at the rate of about 20 each year, and less than half of these appear to be valid. Any large collection of Franklin and Sterling Hill minerals may contain specimens not yet identified with certainty, and there seems to be no end to the number of species and varieties that might in the future be found.

Between 1,200 and 1,500 valid mineral species are recognized, but the exact number is not known, in part due to the difference of opinion as to what a species or a variety is. If a list of all minerals that have been suggested were to be counted there would be between 10,000 and 12,000 entries.

Although the ores of Franklin and Sterling Hill have been valuable chiefly as a source of zinc, they have also been valuable for their content of manganese and iron. High-grade spelter or commercial zinc, zinc oxide used in white paint and in the arts, and spiegeleisen (an alloy of iron and manganese) used in the manufacture of steel have been made from these ores. Mineralogists and mineral lovers at times seem to forget that minerals on occasion are used by man, and that all minerals are not to be found in collections and museums. The general area under discussion is, one must admit, one of the most interesting mineral districts in the world, and the number of different mineral varieties and species found here is greater than that of any other known deposit with the probable exception of the famous mines at Langban, Sweden. An up-to-date comparison of the two places has not been made; the two totals are nearly the same.

The opportunity for finding rare minerals or even good specimens of the more common minerals at the mines is not considered to be good, nor was it ever really good. Few waste piles ever accumulated because most waste material was used to fill older underground workings. Crystals are not abundant on the surface dump at Franklin, but here careful search by the knowledgeable collector is rewarded. The casual "quickie" visitor may be disappointed. The Buckwheat dump is controlled by the town which charges a nominal fee for collecting. The Parker dump is free but requires effort. Good specimens are easily obtainable at Sterling Hill, if one visits underground. Several abandoned limestone quarries in the immediate neighborhood still are accessible to the mineral collector, and good specimens characteristic of the limestone are to be obtained.

HISTORY OF AREA

Persons who have studied the history of New Jersey believe that the ore deposits at the Franklin-Sterling Hill area were discovered about 1640 by prospectors and miners, probably Dutch, who traveled from some location near Port Jervis to points along the Hudson River. Copper was mined at that time near Port Jervis and the ore was taken to Kingston (then Esopus), New York. It is evident that these men mistook zincite for cuprite. When the heirs of Anthony Rutgers owned a portion of this land in 1730 it was known as "the copper tract." An original land survey made in 1749 mentions "the old mine holes" in the area. Many years later the nature of the red mineral was still not known for we are told that Lord Sterling, the landed proprietor of the area now known as "the Sterling tract," in 1774 sent several tons of the ore to England for smelting. A few specimens of this zincite found their way into English collections and years later, their origin having been forgotten, were labeled as having come from localities where zincite did not occur. Lord Sterling also believed, as did all others acquainted with the mineral, that the very abundant black mineral, later called franklinite, was a valuable ore of iron. Endeavors to smelt this highly refractory ore in the Franklin iron furnace as well as in England proved unsuccessful. The iron furnace erected about 1770 was in ruin by 1820.

Knowledge of the true nature and economic value of the deposits was gained in 1810 when Dr. Archibald Bruce of New York City discovered the chemical nature of the red mineral he named zincite. Berthier in France obtained specimens of the black mineral that were sent to Europe by William Maclure. Berthier named the mineral "franklinite" in 1819 and declared it to be an ore mineral of both zinc and manganese.

In 1816, Lord Sterling's holdings were in the ownership of the Fowlers; first, Dr. Samuel Fowler and later his son, Colonel Samuel Fowler. Lardner Vanuxem and W. H. Keating, probably while guests of the Fowlers in 1824, discovered the true nature of willemite. Ballou, who is said to have been an associate of the Fowlers, first prepared white oxide of zinc from the ores so as to make paint for the Fowler's house. The white oxide of zinc was a substitute for white lead and the occasion was the first time that zinc oxide was used to paint a house in the United States.

A few years later, in 1835-36, the first metallic zinc made in the United States was reduced from zincite from this district. Henry D. Rogers, first official geologist of New Jersey, in 1840, writing in the "Final Report of the Geology of the State of New Jersey" stated, in reference to Sterling Hill, "Zinc of an admirably pure quality has been prepared from this ore by Mr. Hitz, under the direction of Mr. Hasler, for the manufacture of the brass for the standard weights and measures now making by the latter scientific gentlemen for the several custom-houses of the United States, by order of Congress. An economical method for the separation of zinc from the franklinite in this ore still remains, however, a desideratum in practical metallurgy."

The New Jersey Zinc Company started its first successful exploitation of the ores at Franklin in 1850. The famous Trotter shaft was sunk in 1880. George H. Cook, in 1868, stated in the New Jersey Geological Survey publication, "Geology of New Jersey," that "Sterling Hill is owned by three different companies. The New Jersey Zinc Company have about 550 feet on the northeast end of the vein. The Passaic Zinc Company, whose property adjoins that of the New Jersey Zinc Company, owns nearly as much more both on the south-east or front vein and the northwest or back vein; and Mr. Noble owns the bend or cross vein at the southwest end of this long outcrop."

About 1870, when the Sterling Hill property was first worked commercially, secondary ore and not primary ore was mined in shallow pits in the limestone. Specimens of hemimorphite (calamine) taken from these old pits are found today in many collections.

Since about 1870 the ownership of some of the properties has changed hands several times. For years much litigation was carried on. In 1897 the New Jersey Zinc Company obtained full possession of what ultimately proved to be exceptionally large, valuable, and scientifically interesting zinc properties. The prospects were turned into mines, and these were successfully operated until the end of September, 1954, when the zinc ores at Franklin were depleted. The

Sterling Hill or Franklinite mine at Sterling Hill was opened in 1877; while occasionally shut down for one reason or another, it is now expected to continue production for many more years.

GENERAL GEOLOGY

Franklin and Sterling Hill are in Sussex County in the north-central part of New Jersey. They are in the physiographic province known as the Highlands. The district exhibits the northeast-southwest trends in topography and areal geology which characterize the whole province.

Gneisses of various origins and crystalline limestone, all of Precambrian age, are cut by minor masses of granitic pegmatites and a few basic dikes. Enclosed in the limestone are the ore bodies which are in the shape of pitching troughs or inclined canoes, the pitch being toward the northeast. Both ore bodies are essentially alike in form and composition; they are warped, tabular bodies with hook-shaped outcrops. The ore bodies are, in general, from 10 to 100 feet thick. Granular franklinite, willemite, and zincite, stated in their order of abundance and probable importance, occur in a calcite gangue or matrix. At Sterling Hill, tephroite is said to have been an ore mineral. Normally one or more of these zinc-bearing minerals is noticeably concentrated in bands which are roughly parallel to the sides of the trough. In some places the ore consists entirely of franklinite with calcite; in other places it consists of willemite with franklinite and calcite; at still other localities one sees the pleasing-to-the-eye brilliant green or brown willemite sprinkled with blood-red zincite, and black franklinite in a matrix of white calcite. Where else is ordinary ore so beautiful?

Well-defined walls do not always sharply separate the ore and country rock. In many places there is a gradual transition from workable ore through leaner material into absolutely barren rock without a trace of a physical break.

Almost all of the great variety of rare zinc- and manganese-bearing minerals, which are so characteristic of this area and of no other place in the world, have come from the pegmatite contacts.

Various authors write of the "irregular dikelike masses of pegmatite"; "the minor masses of granitic pegmatite"; that the pegmatites "consist essentially of microcline, oligoclase, and quartz with accessory minerals which include apatite, muscovite, epidote, allanite, thorite, and zircon"; that they are "coarse-grained granites"; and that "the dike of pegmatite inside the ore trough at Sterling Hill does not cross the laminations of the limestone but follows the curve of the ore layer. The concave side of the dike in contact with the mass

of barren limestone that fills the southeast end of the trough shows no development of contact minerals, but along the convex side, which faces the ore layer, garnet and zinc-bearing pyroxenes and biotite occur in several places." (1).

The average mineral content of the ore at Franklin is as follows: franklinite 43%, willemite 26%, zincite 1%, gangue 30%.

In contrast to this very simple mineral composition of these ore bodies taken as a whole is the large number and great complexity of rare minerals in the Franklin and Sterling Hill mines.

This steady producer of zinc since the middle of the past century is very different from all other zinc-producing areas in the world in that the ore is practically devoid of sulphides, has only a small lead content, has a very peculiar combination of ore minerals that is strikingly unique, and that little is known concerning its origin. The main ore of zinc throughout the world is the sulphide, sphalerite.

This region has been the most important zinc-producer east of the Mississippi River.

ORIGIN

The perplexing question concerning the origin of the world-famous and unique Franklin-Sterling Hill zinc deposits has been frequently, but certainly unsatisfactorily, discussed. This paper will not fully discuss the pros and cons of the various theories. Too much has already been published on this subject by persons who did not fully know the necessary details of the local geology. There is no universal agreement among geologists concerning the origin of these ores.

Numerous theories have been advanced since 1840, when Henry D. Rogers proposed his igneous injection theory. This was upheld by A. C. Spencer in 1908, and by J. E. Spurr and J. Volney Lewis, with modifications, in 1925.

In 1855, W. Kitchell proposed his sedimentary deposition theory, a theory that was more or less upheld by the geologists of the New Jersey Geological Survey up to about 1900.

F. L. Nason in 1890, and J. F. Kemp in 1893, advocated a theory based on contact metamorphism.

H. Ries and W. C. Bowen, in 1922, said that the ores were due to deposition by rising hydrothermal solutions of magmatic origin by a process of replacement of the limestone which preceded the folding of the rocks.

Charles Palache stated his beliefs by writing, (2)—"It is believed that the ore bodies were metasomatic replacements formed in

the limestone in pre-Cambrian time before its regional metamorphism; that they were deposited near the surface under oxidizing conditions and probably consisted largely of the hydrous zinc silicate, calamine (hemimorphite), together with hydrated oxides of iron and manganese and perhaps carbonates of zinc and manganese. The depositing solutions are believed to have derived their metallic contents from the products of oxidation of a previously existent mass of mixed sulphides.

"It is believed that these oxidized minerals were laid down in more or less well-banded masses whose form may well have been determined by a preceding folding of the limestone which initiated structures and controlled the flow of the depositing solutions. The present minerals constituting the deposits are, on this theory, the result of dehydration and recrystallization effected during the profound and long continued metamorphism of the whole pre-Cambrian system of rocks. Thus were impressed upon the minerals of the ore deposits the identical texture and structures of the enclosing limestone, so marked a characteristic. The established sequence in the age of the minerals, oxides following the silicates, seems entirely consonant with the suggested mode of origin.

"This metasomatic hypothesis of ore emplacement seems to account for the observed facts without essential conflicts. The localization in the limestone is necessary, the duplication not remarkable. The form of the ore bodies may be quite independent of sedimentary structure. The pitching synclines are conformable in attitude to the general structures of the gneiss but how much of the folding may have been effected during metamorphism we have no means of determining. The hypothesis is indifferent in this matter since the original form of the deposits may have been anything from a simple layer to a mass whose form was not unlike what we now see. The identical texture of ore and country rock; the banding of the ore; the sudden transition from ore to barren limestone; the dying out of the ore along the strike, northwards at Mine Hill; the occasional occurrence of disseminated ore in the limestone within the fold at Sterling Hill; all these characters are satisfactorily accounted for by the suggested process.

"The only clear evidence of direct introduction of magmatic materials is to be found in the contact zones about the pegmatites which were certainly far later than the ore deposits themselves."

THE ROWE COLLECTION

In 1941 the Department of Geology of Rutgers, The State University of New Jersey, was the recipient of a locally well-known

collection of minerals. The donor was Mr. George Rowe of Franklin. This collection is of interest because of its many rare minerals and the large number of Franklin mineral species. Most of the specimens were found by Rowe although many were given to him by his mining associates, and a few were purchased from mineral collectors.

Of the more than 2,400 specimens in this collection, 931 are from Franklin and Sterling Hill; they include 129 mineral species from these areas. One of the three existing specimens of roweite (named in honor of Mine-Captain Rowe) is the latest addition to the collection. Palache acknowledged the Rowe Collection as one of several that furnished valuable specimens for his outstanding study of Franklin minerals.

More than one hundred specimens fluoresce, very many phosphoresce. Many crystals show rare crystal forms. The beauty of many specimens is outstanding.

Following is a list of the minerals first found at Franklin and Sterling Hill that are in this collection, along with the number of such specimens of each.

Cahnite	3	Larsenite	3
Calcinu-Larsenite	2	Leucophoenicite	3
Chalcophanite	10	Margarosanite	2
Chlorophoenicite	4	McGovernite	3
Chondrodite	11	Nasonite	1
Fowlerite	6	Roebbingite	8
Franklinite	210	Roepperite	2
Gageite	1	Roweite	1
Glaucochroite	3	Schallerite	1
Hancockite	18	Sussexite	14
Hardystonite	3	Tephroite	26
Hetaerolite	11	Troostite	7
Hodgkinsonite	24	Willemite	170
Holednite	1	Zincite	51
Jeffersonite	12		

The minerals missing are bementite, clinohedrite, desautlesite, dysluite, hydrohetaerolite, loseyite, magnesium chlorophoenicite, manganpyrosomalite, mooreite, polyadelphite, torreyite, woodruffite, yeatmanite, and zinc-manganese-cummingtonite.

Although geology and mineralogy have been taught for exactly 132 years at Rutgers, and mineral collections have been added from time to time (Beck Collection of 3,000 specimens, year 1853; Cook Collection of 4,000 specimens, year about 1870; Chester Collection

of 4,800 specimens, year 1903; Rowe Collection of 2,400 specimens, year 1941; Labaw Collection of 1,112 specimens, year 1959) few persons have or had the opportunity to study or even view the minerals—not even the professors. Due to lack of space many specimens have been housed at various times in portions of Van Nest Hall, Old Queens, the Geology building, and in a library annex at University Heights. This lack of space at Rutgers is mentioned so that anyone desiring to see all of these collections will understand when he is informed that his request cannot be granted. It is to be hoped that at sometime in the near future there will be ample space for more mineral displays so that the mineral-lover can view or study the minerals in all of the above-mentioned collections.

Forty-two Mineral Species and Varieties First Found at Franklin or Sterling Hill

F = Franklin		SH = Sterling Hill	
Bementite	F	Loseyite	F
Cahnite	F	Magnesium chlorophoeni-	
Calcium-larsenite	F	cite	F
Chalcophanite	SH	Manganpyrosmalite	SH
Chlorophoenicite	F	Margarosanite	F
Chondrodite	F	McGovernite	SH
Clinohedrite	F	Mooreite	SH
Desaulesite	F	Nasonite	F
Dysluite	F	Polyadelphite	F
Fowlerite	F	Roebbingite	F
Franklinite	F	Roepperite	SH
Gageite	F	Roweite	F
Glaucochroite	F	Schallerite	F
Hancockite	F	Sussexite	F
Hardystonite	F	Tephroite	SH
Hetaerolite	SH	Torreyite	SH
Hodgkinsonite	F	Troostite	SH
Holdenite	F	Willemite	F
Hydrohetaerolite	SH	Woodruffite	SH
Jeffersonite	SH	Yeatmanite	F
Larsenite	F	Zincite	F
Leucophoenicite	F		

OTHER MINERAL SPECIES AND VARIETIES FOUND AT FRANKLIN OR STERLING HILL

In addition to 42 mineral species and varieties first found at Franklin or Sterling Hill, the following list of 169 species and varieties includes those that are found in association with the 43 minerals, but which occur and have been first described from other localities. There are thus 212 mineral species and varieties at Franklin and Sterling Hill.

Actinolite	Azurite
Albite	Barite
Allactite	Barylite
Allanite	Barysilite
Almandite	Biotite
Amphibole group (see actinolite, crocidolite(?), cummingtonite, edenite, gamsigradite, hastingsite, hornblende, pargasite, tremolite)	Birnessite
Analcite	Blende (see sphalerite)
Andradite	Bornite
Anglesite	Brandtite
Anhydrite	Brookite
Anorthoclase	Brucite
Anorthite	Bustamite
Anthophyllite	Calciotomsonite
Antigorite	Calcite
Apatite	Celestite
Apophyllite	Cerussite
Aragonite (see flos ferri)	Ceylonite
Argentite	Chabazite
Arsenic, native	Chalcocite
Arsenopyrite	Chalcodite
Asbestos (see chrysotile, crocidolite(?))	Chalcopyrite
Augite	Chlorite
Aurichalcite	Chrysotile
Axinite	Cleophane (see sphalerite)
	Copper, native
	Corundum (see sapphire and ruby)
	Crocidolite(?)

Cumingtonite	Heulandite
Cuprite	Hexahydrite
Cuspidine	Hornblende
Cyprine	Hortonolite
Datolite	Humite group (see norbergite)
Descloizite	Hyalophane
Diopside	Hydrohausmannite
Dolomite	Hydromagnesite
Edenite	Hydrozincite
Epidote	Ilmenite
Erythrite	Jasper
Ettringite	Johannsenite
Feldspars (see albite, anorthite, hyalophane, microcline, oligo- clase)	Kaolinite
Ferroan friedelite (formerly fer- roschallerite)	Kentrolite
Ferroaxinite	Kutnahorite
Ferroschallerite (see friedelite)	Kyanite
Flos ferri	Lead, native
Fluoborite	Leucaugite
Fluorite	Limonite
Forsterite	Lollingite
Friedelite	Magnetite
Gahnite	Magnetite
Galena	Magnussonite
Ganophyllite	Malachite
Garnet (see almandite, andradite, grossularite, spessartite, mela- nite)	Manganaxinite
Goethite	Manganberzeliite
Gold, native	Manganbrucite
Graphite	Manganite
Greenockite	Manganocalcite
Grossularite	Manganophyllite
Gypsum	Manganosite
Hastingsite	Manganserpentine
Hedyphane	Marcasite
Hemimorphite (calamine)	Mica (see anomite, biotite, mus- covite, phlogopite)
Hematite	Microcline
	Millerite
	Molybdenite
	Muscovite
	Neotocite

Niccolite	Serpentine
Norbergite	Siderite
Oligoclase	Sillimanite
Orthoclase	Silver, native
Pararammelsbergite	Skutterudite
Pargasite	Smithsonite
Pectolite	Spessartite
Phlogopite	Sphalerite
Powellite	Sphene
Prehnite	Spinel
Pyrite	Stilbite
Pyrochroite	Stilpnomelane (see chalcodite)
Pyrolusite	Svabite
Pyrosmalite	Szaibeylite
Pyroxene group (see diopside, leucaugite, schefferite, johannsenite)	Talc
Pyrrhotite	Tennantite
Quartz (see "rock crystal" and jasper)	Thomsonite
Rammelsbergite	Thorite
Realgar	Todorokite
Rhodochrosite	Tourmaline
Rhodonite	Tremolite
Riebeckite	Vesuvianite (see cyprine)
"Rock Crystal" (see quartz)	Wernerite
Ruby	Wollastonite
Rutile	Xenotlite
Sapphire	Zeolites (see calcliothomsonite, heulandite, stilbite, thomsonite)
Sarkinite	Zinalsite
Scapolite (see wernerite)	Zircon
Schefferite	Zoisite

TABULAR SUMMARY OF MINERAL DISCOVERIES

<i>Year described or discussed</i>	<i>Mineral</i>	<i>Origin of name</i>	<i>Reference</i>
1810	Zincite	From its composition	Dr. Bruce; American Mineralogy Journal, vol. 1, pp. 96-100, 1914.
1817	Chondrodite	Greek—granular structure	Count D'Ohsson; Memoirs Stockholm Academy, p. 206, 1817.
1819	Franklinite	Franklin, the town	P. Berthier; Annales des Mines, 1st ser., vol. 4, pp. 483-494, 1819.
1822	Dysluite	Greek for "hard" and "to loosen"	L. Vanuxem and W. H. Keating; Jour. Academy Natural Sciences, Philadelphia, vol. 2, pp. 277-288, 1822.
	Fowlerite	Honor of Dr. Samuel Fowler	Thomas Nuttall; American Journal of Science, 1st ser., vol. 5, pp. 239-248, 1822.
	Jeffersonite	President Thomas Jefferson	L. Vanuxem and W. H. Keating; Jour. Academy Natural Sciences, Philadelphia, vol. 2, pp. 194-204, 1822.
1823	Tephroite	Greek—ash-gray	August Breithaupt; Charakeristik des Mineral-Systems, p. 278, 1923.
1824	Willemite	William The First, King of The Netherlands	L. Vanuxem and W. H. Keating; Jour. Academy Natural Sciences, Philadelphia, vol. 4, pp. 3-11, 1824.
1829	Polyadelphite	Greek for "many" and "brothers"	Thomas Thomson; Lyceum Natural History, New York Annals, vol. 3, p. 9, 1829.

TABULAR SUMMARY OF MINERAL DISCOVERIES—Continued

<i>Year described or discussed</i>	<i>Mineral</i>	<i>Origin of name</i>	<i>Reference</i>
1832	Troostite	Honor of Prof. Gerard Troost	C. U. Shepard; Treatise on Mineralogy, 1st Ed., vol. 1, pt. 1, p. 154, 1832.
1868	Sussexite	County of Sussex	G. F. Brush; American Jour. Science, 2nd ser., vol. 46, pp. 240-243, 1868.
1870	Roepperite	Honor of W. T. Roepper	G. F. Brush; American Jour. Science, 2nd ser., vol. 50, pp. 35-38, 1870.
1875	Chalcophanite	Greek for "copper" and "to appear"	G. E. Moore; American Chemist, vol. 6, pp. 1-2, 1875.
1877	Hetaerolite	Greek for "a companion"	G. E. Moore; American Journal of Science, 3rd ser., vol. 14, p. 433, 1877.
1887	Bementite	In honor of C. S. Bement	G. A. Koenig; Acad. Nat. Sci., p. 311, 1887.
1889	Desaulesite	Honor of Maj. A. B. deSauler	G. A. Koenig; Acad. Nat. Sci. Proc., p. 184, 1889.
1897	Roebbingite	Honor of Col. W. A. Roebbing	S. L. Penfield and H. W. Foote; American Jour. Science, 4th ser., vol. 3, pp. 413-415, 1897.
1898	Clinohedrite	Greek for "to incline" and "face"	Penfield and Foote; American Jour. Science, 4th ser., vol. 5, pp. 289-293, 1898.
1899	Glaucochroite	Greek for "blue-green" and "color"	S. L. Penfield and E. H. Warren; American Jour. Science, 4th ser., vol. 8, pp. 339-353, 1899.

TABULAR SUMMARY OF MINERAL DISCOVERIES—Continued

<i>Year described or discussed</i>	<i>Mineral</i>	<i>Origin of name</i>	<i>Reference</i>
1899	Hancockite	Honor of E. P. Hancock	S. L. Penfield and E. H. Warren; American Jour. Science, 4th ser., vol. 8, pp. 339-353, 1899.
	Leucophoenicite	Greek for "pale or light" and "purple-red"	S. L. Penfield and E. H. Warren; American Jour. Science, 4th ser., vol. 8, pp. 339-353, 1899.
	Nasonite	Honor of F. L. Nason	S. L. Penfield and E. H. Warren; American Jour. Science, 4th ser., vol. 8, pp. 339-353, 1899.
1900	Hardystonite	Hardyston, the town (formerly Hardistonville)	J. E. Wolfe; Proc. American Academy of Arts & Sciences, vol. 34, pp. 111-115, 1900.
1910	Gageite	Honor of R. B. Gage	A. H. Phillips; American Jour. Science, 4th ser., vol. 30, pp. 283-284, 1910.
	Hydrohetaerolite	Greek for "companion"	Charles Palache, American Jour. Science, 4th ser., vol. 29, pp. 177-187, 1910.
1913	Hodgkinsonite	Honor of H. H. Hodgkinson	Charles Palache and W. T. Schaller; Jour. Washington Academy of Science, vol. 3, pp. 474-478, 1913.
1916	Margarosanite	Greek—platy or tablet form	W. E. Ford and W. M. Bradley; American Jour. Science, 4th ser., vol. 12, pp. 159-162, 1916.
1924	Chlorophoenicite	Green in natural light and pink to red in artificial light.	R. B. Gage, W. F. Foshag, H. Berman; Jour. Washington Academy Science, vol. 14, pp. 362-363, 1924.
1925	Schallerite	Honor of W. T. Schaller	E. S. Larsen and H. E. Vassar; American Mineralogist, vol. 10, pp. 9-11, 1925.

TABULAR SUMMARY OF MINERAL DISCOVERIES—Continued

<i>Year described or discussed</i>	<i>Mineral</i>	<i>Origin of name</i>	<i>Reference</i>
1927	Cahnite	Honor of Lazard Cahn	Charles Palache and L. H. Bauer; American Mineralogist, vol. 12, pp. 149-153, 1927.
	Holdenite	Honor of A. F. Holden	Charles Palache and E. V. Schannon; American Mineralogist, vol. 12, pp. 144-148, 1927.
	McGovernite	Honor of J. J. McGovern	Charles Palache and L. H. Bauer; American Mineralogist, vol. 12, pp. 373-374, 1927.
1928	Larsenite	Honor of E. S. Larsen	Charles Palache, L. H. Bauer, H. Berman; American Mineralogist, vol. 13, pp. 142-144, 1928.
	Calcium-Larsenite	Honor of E. S. Larsen	Charles Palache, L. H. Bauer, H. Berman; American Mineralogist, vol. 13, pp. 142-144, 1928.
1929	Loseyite	Honor of S. R. Losey	L. H. Bauer and H. Berman; American Mineralogist, vol. 14, pp. 150-153, 1929.
	Mooreite	Honor of Gideon H. Moore	L. H. Bauer and H. Berman; American Mineralogist, vol. 14, pp. 165-172, 1929.
1930	Magnesium Chlorophoenicite	See Chlorophoenicite	George Stanton; Mineralogical Magazine, vol. 24, No. 158, p. 616, 1930.
	Zinc-manganese-Cummingtonite	Cummingtonite named from Cummington, Mass.	L. H. Bauer and H. Berman; American Mineralogist, vol. 15, p. 340, 1930.

TABULAR SUMMARY OF MINERAL DISCOVERIES—Continued

<i>Year described or discussed</i>	<i>Mineral</i>	<i>Origin of name</i>	<i>Reference</i>
1937	Roweite	Honor of Mine Captain George Rowe	H. Berman and F. A. Gonyer ; American Mineralogist, vol. 22, p. 301, 1937.
	Yeatmanite	Honor of Pope Yeatman	C. Palache, L. H. Bauer, H. Berman ; American Mineralogist, vol. 23, pp. 527-530, 1937.
1949	Torreyite	Honor of John Torrey	Joan Prewitt-Hopkins ; American Mineralogist, vol. 34, pp. 593-595, 1949.
1953	Manganpyrosmalite	Pyrosmalite from Greek meaning "fire" and "odor"	C. Frondel and L. H. Bauer ; American Mineralogist, vol. 38, pp. 755-760, 1953.
	Woodruffite	Honor of Samuel Woodruff	C. Frondel ; American Mineralogist, vol. 38, pp. 761-769, 1953.

THE LUMINESCENT MINERALS

F. E. Mutschler, (3), recently compiled a list of luminescent minerals from the area under discussion, recording 27, of which two are in doubt. Most of these were studied under "shortwaves" (2537 Å) and "long waves" (3650 Å) as well as the iron-arc. Following is listed these minerals with the color of their fluorescence seen on some specimens.

Anorthite	pale blue
Apatite	pale green
Aragonite	yellowish cream
Barite	delicate blue to grayish cream
Barylite	pale to light blue
Bustamite	pink to deep red
Calcite	intense red
Calciiothomsonite	pale blue
Calcium larsenite	lemon yellow
Clinohedrite	orange
Corundum	bright red
Diopside	pale bluish cream
Fluorite	green
Hardystonite	dull, deep purple
Hedyphane	indistinct bluish grey (?). Doubtful
Hydrozincite	pale blue
Larsenite	pale violet (?). Doubtful
Manganaxinite	red
Margarosanite	vivid pale blue-violet
Norbergite	drab yellow
Pectolite	yellow
Smithsonite	yellowish cream
Sphalerite	salmon orange
Svabite	yellowish orange
Tremolite	faint green
Wollastonite	brilliant orange to orange pink
Willemite	green to yellow-green

CORRECTIONS TO FRANKLIN - STERLING HILL
MINERAL LIST OF DISCREDITED SPECIES
AND INCORRECT NAMES, USAGES,
SPELLING AND IDENTIFICATION.

From time to time in the various publications dealing with the minerals of Franklin, Sterling Hill, or from other nearby localities in Sussex County, mineral names appear which are no longer accepted; names over the years have been changed; minerals have been mistakenly identified; and spelling has changed. This section has been compiled in order to provide a check list of mineral names which do not appear in the other listings in this paper or which fall into one or more of the above-mentioned categories.

Anatase was mistaken for rutile.

Annabergite is not known as a definite mineral at Franklin.

Anomalite was a local term for a dark brown jeffersonite.

Automalite was the first name given to dysluite.

Beryl probably was green microcline.

Bustamite is not recognized as a variety of rhodonite by some authors.

Brucite is the first name given to chondrodite; term used in the United States but not in Europe. Brucite today is not the brucite of yesterday.

Calamine is now known as hemimorphite; also smithsonite.

Calcimangite has not been an accepted species for about 100 years.

Calcotephroite is but an impure glaucochroite.

Calcozincite is a naturally occurring mixture of zincite and calcite.

Caswellite is said to be grossularite after biotite.

Chloanthite has been incorrectly identified as smaltite and remmelsbergite at Franklin. Is probably a mixture of several minerals.

Chrysocolla reported but not verified.

Clinozoisite is not accepted by Palache, who states that reported occurrence was chlorophoenicite.

Crocidolite (at least some) at Franklin reported to be riebeckite.
Cyanite is incorrect spelling of kyanite.
Delta-moorecite is now torreyite.
Diallage reported but not verified.
Dyssonite was a local term for some oxidized rhodonites.
Epistilbite was mistaken for stilbite.
Ferroschallerite now is ferroan friedelite.
Hercynite is reported by Valiant as having been found in a pegmatite at Franklin. It is believed that this is an identification made from a thin section since it is not reported elsewhere.
Hydrofranklinite is chalcophanite.
Hydrohodonite was a local term for a manganiferous serpentine from fowlerite.
Leucite reported from a basic dike at Franklin is believed to have been found only in thin sections.
Maclurite was the second name (first was brucite) given to chondrodite; term used in the United States but not in Europe.
Mariposite reported from Sterling Hill now proved (?) to be kyanite.
Spartaite or spartite was the original name of calcimangite. See calcimangite.
Spartalite, no longer accepted, local term for zincite in glacial boulders near Sparta.
Sterlingite name first proposed for zincite; also first name proposed for roepperite.
Tephro-willemite today is a synonym for troostite.
Vanuxemite is known to be a mixture of accepted minerals.
Vivianite reported but not supporting evidence.
Wad probably was psilomelane.
Yttrocerite reported from Franklin, but the occurrence has never been confirmed.

DESCRIPTION OF MINERALS

Crystallography, Physical Properties, Optical Properties,
Composition, Remarks.

BEMENTITE

Crystallography

Orthorhombic.

Crystals unknown.

Physical Properties

Color pale yellow, yellowish brown, gray. Darkens on exposure to air for a considerable length of time.

Occurs in fibers, lamellae, and radiate masses with minute foliate structure. Also found in compact or even hornlike masses.

A massive granular form characteristically breaks into somewhat rectangular blocks.

Cleavage pinacoidal; three directions at right angles. Pearly luster on cleavage faces.

H = 4.5 (Palache); 6 (Winchell).

Sp. Gr. = 2.981 (Palache); 3.1 (Winchell).

Optical Properties

Biaxial, negative.

2V = almost zero, therefore almost uniaxial.

Alpha = 1.624 (Palache); 1.602 - 1.624 (Winchell).

beta = gamma = 1.650 (Palache); 1.632 - 1.650 (Winchell).

Absorption weak with X less than Y = Z.

Composition

H₁₀ Mn₈ Si₇ O₂₇ (Palache).

Mn₅ (OH)₆ Si₄O₁₀ (?) (Winchell).

SiO ₂	39.00%
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MnO	42.12
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FeO	3.75
-----	------

ZnO	2.86
-----	------

MgO	3.83
-----	------

CaO	tr.
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H ₂ O+	8.44
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G. A. Koenig, analyst.

100.00%

Closely related to serpentine (?)

Remarks

Bementite was first studied by G. A. Koenig in 1887, (4). Koenig honored C. S. Bement of Philadelphia by naming the new mineral "bementite." Although at first it was thought to be a rare mineral, even in the Trotter mine, where first found, and in the Parker shaft, a considerable amount of it has been found since its discovery. It has also been found in western Washington. It apparently is difficult or even impossible to differentiate by physical appearance alone between some bementite and some serpentine, so there may be even more specimens in existence than is known.

An unusual occurrence of the mineral is in minute wormlike "stalactites" on some crystals of tephroite and willemite where these minerals occur in small open veins.

It has been shown that caryopilite and ectropite of Langban, Sweden, are identical with bementite from Franklin and western Washington.

CAHNITE

Crystallography

Tetragonal bisphenoidal.

$a : c = 1 : 0.615$

Usual forms (100), (110), (111), ($\bar{1}\bar{1}1$).

Single crystals are extremely rare. Crystals are usually twinned.

Physical Properties

Perfect cleavage parallel to the prism.

$H = 3$ sp. gr. = 3.156

Crystals are white and transparent and possess a vitreous luster.

Optical Properties

Uniaxial, positive

$\Omega = 1.662$ $E = 1.663$

Strong dispersion and abnormal interference colors.

Composition

$Ca_4 B_2 As_2 O_{12} \cdot 4H_2O$ (Palache).

$Ca B_2 O_4 \cdot Ca_3 As_2 O_8 \cdot 4H_2O$ (Winchell).

CaO 37.62%

B₂O₃ 11.86

As₂O₅ 38.05

H₂O 12.42

99.95%

Very pure sample, weight 0.5 grams.
L. H. Bauer, analyst.

Remarks

Cahnite has been found only at Franklin. Although Palache and Bauer were the first to describe the mineral in 1927, (5). Lazard Cahn in 1911 was the first to sketch several of the crystals that doubtlessly came from the Parker shaft. Chemical analyses were not made from these crystals because of the small amount found, the few crystals available being sent to Harvard University. Palache regarded them as perhaps being calcium edingtonite since they were twinned, white and transparent. This undescribed mineral was named for Lazard Cahn. The name cahnite first appeared in the title of a paper in the American Mineralogist in 1921—a paper that was never published, however.

Five years after the mineral was named, i.e., in 1926, George Stanton found a small amount of poorly crystallized cahnite in the northern part of the mine. Two years later a small amount of the mineral was taken from the south end of the mine at a depth of about 800 feet.

Cahnite, with a general resemblance to clear barite, was found in association with calcite, or growing on or with pyrochroite, axinite, garnet or willemite.

Cahnite is a very rare mineral, there being little chance of specimens of it being found today by the average mineral collector.

CALCIUM-LARSENITE

Crystallography

Orthorhombic.

Crystals unknown. Occurs in coarse granular massive form.

Physical Properties

Indistinct cleavage.

H = Not recorded. Close to 3 (?). sp. gr. = 4.42

Greasy luster.

Colorless, white, opaque.

Outstanding lemon-yellow fluorescence under iron-arc, this fluorescence being even more vivid than that of willemite.

Optical Properties

Biaxial, negative.

$2V = 5^\circ$

$\alpha = 1.760$

$\beta = \gamma = 1.769$

Composition

(Pb, Ca, Zn)₂ SiO₄

Nesosilicate.

A variety of larsenite with approximately 50% Pb replaced by Ca.

SiO ₂	24.10%
FeO	.48
MnO	.57
CaO	16.36
ZnO	30.61
PbO	27.63
MgO	.23
H ₂ O	.12
<hr/>	
	100.10%

L. H. Bauer, analyst.

Remarks

Calcium-larsenite, found only at Franklin, was originally described by Charles Palache, L. H. Bauer, and Harry Berman, (6). Larsenite itself was named in honor of Esper S. Larsen.

The greasy luster, the white color, and the opaqueness of this coarse granular mineral that has a vivid lemon-yellow fluorescence under the iron-arc make it, theoretically, not too difficult to recognize. But the mineral seldom is found unaltered. It darkens very fast due, some persons believe, to separation of pure metallic lead. Native lead has been reported to be associated with some specimens of calcium-larsenite.

Calcium-larsenite is found closely associated with larsenite and also, in the 1,100 foot level, apparently replaces glaucochroite and hardystonite. A specimen of hardystonite collected from the Parker shaft about 1898 was later shown to contain calcium-larsenite, this mineral being unknown as a mineral species at that time.

The mineral collector of today has little chance of finding specimens of this rare mineral at Franklin.

CHALCOPHANITE

Crystallography

Hexagonal - rhombohedral.

a : c = 1 : 3.527

Usual forms (0001) and (10 $\bar{1}$ 1). Results in a pseudo-octahedral habit because the basal pinacoid and rhombohedron are equally developed.

Physical Properties

Perfect cleavage parallel to the basal pinacoid.

H = 2.5 sp. gr. = 3.903

Color is iron-black to bluish black, and possesses a shiny metallic luster when freshly broken.

Usually is found as drusy crusts.

Optical Properties

Uniaxial, negative

Omega much greater than 2.72, epsilon approximately 2.72.

Pleochroism strong with epsilon being deep red and omega being almost opaque.

Composition

(Mn, Zn, Fe) O · 2MnO₂ · 2H₂O (Palache).

(Mn, Zn, Fe) Mn₂O₅ · 2H₂O (?) (Winchell).

MnO ₂	59.94%
MnO	6.58
ZnO	21.70
H ₂ O	11.58
Fe ₂ O ₃	.25
	<hr/>
	100.05%

G. E. Moore, analyst.

Remarks

Chalcophanite has been found only at Sterling Hill, having been first found and described by G. E. Moore, (7), in 1875. Its name is derived from the Greek words for "copper" and "to appear" in reference to its change in color when it is heated. Moore stated that the mineral was in small openings or cavities and as small veins in a mass of fragments of waterworm rocks and minerals which was locally called "strippings" and which was used as a minor ore of manganese.

It is believed by some mineralogists that chalcophanite is an alteration product of franklinite, first passing through the hydrohetaerolite stage.

It is not too difficult a mineral to recognize, once one has seen it. This mineral with its bluish black color and quite brilliant metallic luster, best seen on freshly broken surfaces, is frequently deposited on botryoidal surfaces of hydrohetaerolite or even limonite. Chalcophanite is a rare mineral and not one that can be expected to be found by the seeker of rare minerals at Sterling Hill.

It might here be added that one looking for a description of the mineral, using original sources, can read Penfield and Kreider's work in the American Journal of Science, 3rd. ser., vol. 48, pp. 141-143, 1894. The authors here describe hydrofranklinite (later proved to be chalcophanite) and chalcophanite.

CHLOROPHOENICITE

Crystallography

Monoclinic.

$a : b : c = 2.357 : 1 : 2.153$

Forms (001), (100), (106), (102), ($\bar{1}04$), ($\bar{2}03$), (111).

Crystals are thin prismatic.

Physical Properties

Distinct cleavage parallel to 100 (Winchell);

parallel to 100 and 001 (Palache).

H = 3 - 3.5 sp. gr. = 3.46 - 3.6

Color is grayish green, but in artificial light is pink or even light purplish red.

Luster is glassy to pearly.

Optical Properties

Biaxial, negative

Alpha = 1.682 beta = 1.690 gamma = 1.697

$2V = 83^\circ \pm 2^\circ$

Dispersion is strong with red greater than violet.

Composition

$(\text{Mn}, \text{Zn})_3 \text{As}_2\text{O}_8 \cdot 7 (\text{Mn}, \text{Zn}) (\text{OH})_2$ (Palache).

$(\text{Mn}, \text{Zn}, \text{Mg})_5 (\text{OH})_7 \text{AsO}_4$ (Winchell).

MnO 34.46%

ZnO 29.72

FeO .48

MgO 1.34

CaO 3.36

As₂O₅ 19.24

H₂O 11.60

100.20%

W. F. Foshag, analyst.

Remarks

In pillars of ore between the 500- and 600-foot levels at Franklin, R. B. Gage discovered the arsenate which he named chlorophoenicite.

He, with W. F. Foshag and H. Berman, first described this mineral in 1923, (8). In the 1923 find, most of the glassy to pearly, grayish green mineral was in association with leucophoenicite and calcite, some of it was with tephroite, the slender deeply striated crystals of chlorophoenicite themselves being implanted in cracks in the franklinite-willemite zinc ore. The arsenate was easily confused with crystals of transparent willemite.

Gage named the mineral chlorophoenicite because of its pink to red color in artificial light and its grayish green color in natural light, getting its name from the Greek for these colors.

Although chlorophoenicite has also been found in aggregates of needle-like crystals on the 900-foot level at Sterling Hill, here associated with calcite and barite, it is one of the really rare minerals even in the Franklin area, and mineral collectors have little chance of enhancing their collections with this mineral.

CHONDRODITE

Crystallography

Monoclinic.

$a : b : c = 2.170 : 1 : 1.663$ angle beta = 109°

Physical Properties

At Franklin, chondrodite crystals are unknown. It is found as centers of cores of grains of norbergite. Elsewhere in the world—as at Brewster, N. Y., Vesuvius, Finland, Sweden—the crystals, yellow or brown or red in color, occur as 010 tablets with poor 001 cleavage.

Vitreous to resinous luster.

H = 6 - 6.5 sp. gr. 3.1 - 3.2

Optical Properties

Biaxial, apparently both positive and negative.

Alpha = 1.594 beta = 1.607 gamma = 1.619

2V = large.

Thin sections show 001 multiple twinning.

Thin sections show it to be colorless to brown with X = pale golden yellow, brownish yellow or reddish brown; Y = very pale yellow, yellowish green, or reddish brown; Z = colorless, pale yellow, pale green or pale brown.

Absorption X greater than Y greater than Z.

Palache tells us that Franklin chondrodite, under the microscope, is colorless and possesses a greater index of refraction than the adjacent norbergite, possesses slight pleochroism, and reveals polysynthetic twinning which ends abruptly against the norbergite.

Composition

$\text{Mg}(\text{OH}, \text{F})_2 \cdot 2\text{Mg SiO}_4$ (Palache).
 $\text{Mg}(\text{OH}, \text{F})_2 \cdot 2\text{Mg}_2 \text{SiO}_4$ (Winchell).
Nesosilicate.

Remarks

Chondrodite was first analyzed and described by Count D'Ohsson in 1817, (9). The writer, not having access to this publication, was unaware of the locality of the specimen from which the analysis was made, but somewhat naturally assumed it to be a European locality. This work is referred to by James Dwight Dana in his *System of Mineralogy*, 1837, p. 349, but the locality of the original specimen is not mentioned.

In Dana's *System of Mineralogy*, 5th Ed., 1868, p. 365, it is stated that brucite (chondrodite) was first found in New Jersey, the name brucite being given by a Colonel Gibbs in honor of Dr. Bruce. It thus appeared to the writer that the first chondrodite was recognized as a new species by D'Ohsson in 1817 and that it was some unrecorded years later that the New Jersey discovery was made. But this assumption was short lived because Dana then continued his remarks, stating that fluorine was first detected in this then undescribed mineral species in 1811 by a Dr. Langstaff of New York. Cleavland gives a brief description of this undescribed species in the first or 1816 edition of his "*Mineralogy*," but spoke of it as a fluato of magnesia. It was a specimen of this undescribed fluato of magnesia from New Jersey that D'Ohsson analyzed and described in the *Memoirs of the Stockholm Academy* in 1817, thus making Franklin the locality from which the first specimen came. In the specimen, however, D'Ohsson found no fluorine.

In the United States chondrodite was first known as brucite, as previously mentioned, and then was known as maclurite, so named by Seybert.

The word chondrodite is derived from the Greek, alluding to the usual granular structure of the mineral.

CLINOHEDRITE

Crystallography

Monoclinic domatic.

$a : b : c = 0.6826 : 1 : 0.3226$

Angle beta = $103^\circ 56'$

Forms (010), (320), (110), ($\bar{1}10$), (120), (130), (101), ($\bar{1}01$), (111), ($\bar{1}\bar{1}\bar{1}$), ($\bar{1}\bar{1}1$), ($\bar{1}1\bar{1}$), ($\bar{3}31$), ($\bar{5}51$), ($\bar{7}71$), ($\bar{5}31$), ($\bar{1}31$), ($13\bar{1}$), ($1\bar{3}1$), ($12\bar{1}$).

Physical Properties

Color is amethystine, nearly white, or colorless.
Often transparent.
Perfect 010 cleavage, at times showing pearly luster.
Generally prismatic habit but frequently wedge-shaped.
Also in granular or lamellar aggregates.
H = 5.5 sp. gr. = 3.33
Strongly pyroelectric.
Under the iron-arc strongly fluoresces orange-color.

Optical Properties

Biaxial, negative.
Alpha = 1.662 beta = 1.667 gamma = 1.669
2V = large.
Z = b Y to c = 28°

Composition

Ca₂ Zn₂ (OH)₂ Si₂O₇ · H₂O

SiO ₂	26.73%
ZnO	37.13
CaO	26.25
MnO	1.11
H ₂ O	8.09
(Fe, Al) ₂ O ₃	0.37

L. H. Bauer, analyst.

99.68%

Sorosilicate.

Remarks

It was in 1898 that Penfield and Foote, (10), first described the new mineral species, clinohedrite, that two years previous had been sent to them by Frank L. Nason and then more recently by E. P. Hancock and W. F. Ferrier. All the specimens reportedly came from a dump of the new shafts at the Trotter mine. It is believed that the specimens came from about the 1,000-foot level. The crystals occurred with transparent prisms of green willemite, a massive variety of brown garnet (polyadelphite ?), phlogopite, beautiful yellow axinite, dull crystals of datolite, and a then-unknown reddish brown mineral (hancockite) which was described a year later in 1899.

The type specimen was in the Hancock collection and was a group of beautiful amethystine crystals which lined a small cavity in massive franklinite, willemite, and hancockite. Some crystals found at

a more recent date were first mistaken for gypsum because of the habit of the crystals and their pearly luster on the clinopinacoid.

Some crystals are strongly fluorescent in an orange tint that is difficult to distinguish from the yellow fluorescence of some pectolites.

It is difficult to understand why Penfield and Foote named the new mineral species clinohedrite (Greek for "to incline" and "face") because in 1866, thirty-two years previously, Breithaupt had used the same name "clinohedrite" and for the same reason, "face inclined," for a kind of tetrahedrite.

DESAULESITE

Crystallography

Amorphous, therefore never occurs in crystals.

Physical Properties

Yellowish green, apple-green, emerald-green.

Crusts and aggregates as well as in earthy forms.

Optical Properties

$N = 1.59$

Composition

$4 (\text{Ni, Zn, Fe})\text{O} \cdot 3\text{SiO}_2 \cdot 6\text{H}_2\text{O}$ (Palache).

SiO ₂	27.33%
NiO	43.78%
ZnO	1.92%
FeO	0.19%
MnO	0.11%
CaO	tr
MgO	tr
As ₂ O ₃	7.99%
H ₂ O+	10.59%
H ₂ O—	6.57%

L. H. Bauer, analyst.

98.48%

A variety of genthite. Same as genthite except magnesia is lacking.

Remarks

The new mineral of various shades of green that was found as crusts on or as filling in fluorite, and also as aggregates that were

spongelike porous masses associated with and probably altering from niccolite and chloanthite, was found in the Trotter mine by Koenig, (11), in 1889. Koenig named the new mineral in honor of Mine Manager, Major A. B. de Sauler.

DYSLUITE

Crystallography

Isometric or cubic.

Forms (100), (111), (110), (331), (211).

Found only in crystals, usually with octahedron dominant.

Physical Properties

H = 7.5 sp. gr. = 4.5 - 4.9

Color clear dark green, brown, greenish black, greenish yellow, yellow or even blue.

Optical Properties

Isotropic.

N = 1.808 ± .005

Composition

(Zn, Fe, Mn)O · (Al, Fe)₂O₃

A variety of gahnite.

Al ₂ O ₃	47.27%
Fe ₂ O ₃	9.90%
ZnO	37.10%
MnO	.93%
MgO	1.09%
CaO	1.01%
CO ₂	.38%
SiO ₂	1.47%
H ₂ O	1.21%

W. T. Schaller, analyst.

100.36%

Remarks

In 1822 Lardner Vanuxem and W. H. Keating, (12), first described dysulite from the Franklin area. Later Palache told us that at Franklin greenish yellow and blue crystals were not uncommon in the limestone at the Trotter mine but that these greenish crystals of dysluite were known as "automolite" by all the early investigators. It is now known that the crystals at the Trotter mine are the same

as those from Sterling Hill, this fact coming to light in 1846 when Francis Alger, (13), wrote on this subject.

Dysluite is most easily recognized by its physical properties of hardness equal to 7.5, its colors, and its habit of occurring only in crystals with octahedral habit, modified at times by the dodecahedron. In exceptional crystals the cube is the dominant form. It has been found in the Franklin limestone with biotite, apatite, roepperite, and lollingite.

While dysluite was for years not uncommon in the limestone at the Trotter mine and at Sterling Hill, it never was a mineral of great abundance. It is even less so today.

Dysluite (Greek for "hard" and "to loosen").

FOWLERITE—A variety, not a species.

Crystallography

Triclinic.

Crystals often with many forms.

Usual forms (100), (010), (001), (110), ($\bar{1}10$), (130), (401), ($\bar{4}03$), (201), ($\bar{4}01$), ($0\bar{4}1$), ($\bar{1}11$), (222), (441), ($\bar{1}10$), ($\bar{2}21$), ($\bar{4}41$), ($\bar{1}11$), (443), ($\bar{2}21$), ($\bar{2}21$).

Complete individual crystals are rare.

Physical Properties

Perfect prismatic cleavage at angle of 68° , also good basal cleavage. Very good paring parallel to the brachypinacoid, traces of parting at times seen parallel to the macropinacoid.

Some crystals are very brittle.

In color ranges from bright to pale rose-pink to gray to brownish-red.

H = 5.5 - 6 sp. gr. = 3.4 - 3.68

Luster frequently dull but some are glassy or vitreous or shiny, generally somewhat translucent in thin pieces, some rare small crystals are even transparent.

Optical Properties

Biaxial, positive.

2V = moderate to large.

Alpha = 1.687 - 1.726 beta = 1.692 - 1.730

gamma = 1.709 - 1.737

Strong crossed dispersion.

Composition

(Mn, Zn, Ca) SiO₃

Fowlerite is a zinciferous rhodonite.

SiO ₂	44.76%	
MnO	40.83%	
FeO	.99%	
ZnO	3.26%	
CaO	10.12%	
MgO	.76%	Larsen and Shannon, analysts.
H ₂ O	.06%	
<hr/>		
100.78%		

Cyclosilicate

Various published chemical analyses show a considerable range in the extent to which manganese is replaced by other elements.

Remarks

C. U. Shepard, (14), is said to have been the first to publish the named fowlerite for the newly discovered zinciferous rhodonite. This was in 1832, when he described the mineral. The name was given, however, in 1822 by Thomas Nuttall in honor of Dr. Samuel Fowler of Franklin. It was not until 1849 that fowlerite was shown to be a variety of rhodonite, however.

Most fowlerite crystals are prismatic in habit but some are tabular, as every mineral collector knows. As previously stated, complete crystals are very rare because they so frequently occur in parallel groups, individuals of these groups attaining lengths greater than 8 inches and being 2 or more inches in cross-section. Fowlerite is also found in coarse granular masses, at times foliated, or as isolated somewhat rounded grains. Fowlerite normally is embedded in a calcite matrix near the boundary of the ore body and is found associated with the zinc ore minerals—franklinite, willemite, and zincite. Many isolated grains have been found in pegmatite of the Parker shaft, Trotter and Buckwheat mines. Occurrences as above mentioned reveal the fowlerite faces to be somewhat dull in luster. In more rare occurrences in open cavities the luster is brilliant or vitreous, and here fowlerite is associated with garnet, calcite, and barite.

Early names for fowlerite were (1) ferrosilicate of manganese, (2) siliceous oxide of manganese, and (3) manganesian feldspar.

It is of interest to note that Palache described a mangani ferous serpentine as an alteration product of fowlerite, this serpentine locally

being known as hydrorhodonite. The name "dyssnite" has been locally applied to an oxidized rhodonite.

Fowlerite always has been a fairly abundant mineral at Franklin and doubtlessly some good crystals will still be discovered in the dumps of the area. It never was really abundant at Sterling Hill. Every Franklin collection probably has specimens of fowlerite in it.

FRANKLINITE

Crystallography

Cubic or isometric, hexoctahedral class.

Usual forms (100), (111), (110), (311), (211), (310), (510), (531).

Usually in octahedrons modified by the dodecahedrons and frequently passing into grains somewhat rounded.

Physical Properties

Cleavage absent, but very rarely observed is an octahedral parting. Color is iron-black, usually with a shiny metallic luster, but some specimens have a dull metallic luster.

Streak is reddish brown.

Magnetism practically missing in some specimens but most show moderate to strong magnetism.

H = 5.5 - 6.5

Sp. gr. 5.07 - 5.22 (Palache), 5.32 (Winchell).

Composition

(Fe, Mn, Zn)O · (Fe, Mn)₂O₃ (Palache).

Zn Fe₂O₄ (Winchell).

Fe ₂ O ₃	66%	
ZnO	17	
Mn ₂ O ₃	16	
	99.0%	

P. Berthier, analyst for
original crystal analysis.

Remarks

Is there anyone who has not seen the large crystals of franklinite, up to 7 inches on an edge, in the famous Canfield collection of the U. S. National Museum or the plaster duplicate of such crystals in the collection at Harvard? All mineral-lovers should visit the National Museum.

All New Jersey mineral collectors know franklinite and doubtlessly have several specimens in their collections. Specimens can still

be found in the general Franklin district. The only mineral with which it can be confused is magnetite, which is more strongly magnetic and possesses a streak of slightly different color. But many collectors do not realize that this opaque mineral with its shiny to dull metallic luster has been found in the Hamburg mine as very small crystals with an adamantine luster and which are a translucent deep-red color when seen in thin splinters. Small crystals occurring as cubes have also been reported. These more rare crystals apparently have been found only in small cavities and are associated with small talc-rosettes and willemite.

Franklinite commonly occurs in both isolated grains and in granular form. Some individual crystals are quite large, as those found at the surface during the early days of exploration at Sterling Hill. These crystals were about 7 inches on an edge. Franklinite forms quite pure thick deposits locally but usually it is associated with various quantities of calcite, willemite, and zincite. Franklinite occurs in the old Parker shaft and in the Trotter, Buckwheat, and Taylor mines, and in the Noble mine at Sterling Hill.

Franklinite has been the dominant zinc ore-mineral at Franklin and at Sterling Hill. It was P. Berthier, (15), in 1819 who, in a French publication, described and named franklinite, naming it "in order to remind us that it was first found in a place to which the Americans have given the name of a great man."

It should be mentioned that for years franklinite was believed to be magnetite and the operators were perplexed by their unsuccessful attempts to make this highly refractory mineral an ore of iron. Thus for years it was overlooked and even ignored as an ore of zinc. This belief that franklinite was an iron ore and the knowledge that zincite was a zinc ore led to the division of the mineral rights into those of zinc and those of iron. Law suits were common, and the development of the area into a real zinc district was held up for years.

The zinc in franklinite is converted into zinc white and a residue and is smelted to form spiegeleisen which is used by steel manufacturers. Spiegeleisen is an alloy of iron and manganese.

Franklinite has also been found at several other places. This is mentioned because it is the belief of many persons that the mineral occurs solely in New Jersey.

GAGEITE

Crystallography

Orthorhombic.

Physical Properties

Minute prisms or needles or laths frequently as a matted mass, more frequently in bundles or as radial arrangements. The small prisms are either colorless or pink with a glassy or vitreous luster.

Sp. gr. = 3.584

Optical Properties

Biaxial, negative.

2V = moderate.

Alpha = 1.723 beta = 1.734 gamma = 1.736
all plus or minus 0.003

Positive elongation.

Dispersion extreme with violet greater than red.

Composition

4(Mn, Mg, Zn) (OH)₂ · 6(Mn, Mg, Zn)₂ SiO₄ · 3H₂O
(Palache).

(Mn, Zn, Mg)₁₆ (OH)₈ Si₆O₂₄ · 3H₂O (?) (Winchell).

SiO ₂	24.71%	23.58%	
MnO	50.19	53.74	
MgO	11.91	9.95	
ZnO	8.86	3.96	(1) R. R. Gage, analyst
FeO	....	0.03	(2) L. H. Bauer, "
Al ₂ O ₃	....	0.15	
H ₂ O	4.43	8.24	
	<hr/> 100.00%	<hr/> 99.65%	

Nesosilicate.

Dissolves immediately in warm dilute nitric acid.

Remarks

In 1910 A. H. Phillips, (16), first called our attention to another new mineral from Franklin. The mineral was named in honor of R. B. Gage of Trenton. This new mineral from the Parker shaft was found associated with calcite, leucophoenicite, willemite, and zincite. A number of years later gageite was found somewhat abundantly at Franklin. Some people believe the pale pink aggregates of this delicate fibrous mineral to be pseudomorphs, but no one seems to know after what mineral, if any, they are pseudomorphous.

GLAUCOCHROITE

Crystallography

Orthorhombic bipyramidal.

$a : b : c = 0.4409 : 1 : 0.5808$

Forms (100), (010), (110), (120), (103), (111), (121), (021).

Physical Properties

Long prismatic habit. Crystals single or in columnar aggregates; rarely massive. Crystals seldom are terminated by faces.

Basal cleavage, poor.

H = 6 sp. gr. 3.407 (Palache), 3.48 (Winchell).

Color bluish green, bluish, pinkish, white.

Luster is vitreous.

Very brittle.

Optical Properties

Biaxial, negative.

$2V = 60^\circ 51'$

$\alpha = 1.686$ $\beta = 1.722$ $\gamma = 1.735$

Dispersion strong with red greater than violet.

Colorless in thin section.

Composition

Ca Mn SiO₄

SiO₂ 31.48%

MnO 38.00

CaO 28.95

PbO 1.74

C. H. Warren, analyst.

100.1%

Nesosilicate.

Remarks

The first crystals of glaucochroite, embedded in nasonite or willemitite and found with garnet and axinite, came from the 1,000 foot level in the Parker shaft. They were described by S. L. Penfield and C. H. Warren, (17), in 1899. The name is derived from the Greek words meaning "blue-green" and "color."

Later discoveries of glaucochroite, bluish in color and mixed with hardystonite and tephroite and franklinite, came from some unrecorded deep level of the Parker shaft.

Due to the fact that the mineral is extremely brittle, very few specimens of glaucochroite are to be found. If any glaucochroite is found in the dumps by present-day collectors the mineral probably will be in fragments.

HANCOCKITE

Crystallography

Monoclinic.

Forms (001), (100), (101), ($\bar{1}01$), ($\bar{1}11$).

Lath-shaped crystals striated parallel to length.

Physical Properties

Found in minute lath-shaped crystals, in aggregates or compact masses.

Color of individual crystals yellowish brown; in compact masses the color is a dull brick-red or reddish brown or even maroon.

H = 6.5 - 7 sp. gr. = 4.03

Luster is glassy or vitreous.

Optical Properties

Biaxial, negative.

$2V = 50^\circ$

Alpha = 1.788 beta = 1.810 gamma = 1.830

In thick plates X = Z = rose or greenish yellow,

Y = yellow brown.

Dispersion red greater than violet.

Composition

(Pb, Ca)₂ (Al, OH) (Al, Fe, Mn)₂ (SiO₄)₃ (Palache).

Ca (Pb, Sr) (Al, Fe)₃ (OH) Si₃O₁₂ (Winchell).

A member of the epidote group of minerals, containing notable amounts of Pb and Sr.

SiO ₂	30.99%
Al ₂ O ₃	17.89
Fe ₂ O ₃	12.33
Mn ₂ O ₃	1.38
PbO	18.53
MnO	2.12
MgO	0.52
CaO	11.50
SrO	3.89
H ₂ O	1.62

C. W. Warren, analyst.

100.77%

Inosilicate.

Remarks

J. A. Van Mater first called our attention to the mineral that later was recognized as a new mineral species and which was first described

in 1899 by S. L. Penfield and C. H. Warren, (17). They named it in honor of that well-known collector of Franklin minerals, E. P. Hancock of Burlington, N. J.

The small crystals and masses of crystals, usually brownish-red in color, were found in some abundance at the 1,000-foot level in the Parker shaft. As far as it is known to the writer, Hancockite has been found only in the Parker shaft. Hancockite had as associates garnet, axinite, datolite, and willemite. In fact, small crystals of Hancockite were inclusions in the three last-named minerals, giving these minerals a reddish brown tinge.

HARDYSTONITE

Crystallography

Tetragonal.

Crystals unknown.

Physical Properties

Good basal cleavage, poor prismatic cleavage.

Color white to faint pink.

Rarely semitransparent; vitreous luster.

H = 3 - 4 sp. gr. = 3.39

Some specimens fluoresce under the iron-arc with a faint violet to a dull, deep purple color.

Optical Properties

Uniaxial, negative.

Omega = 1.6691 epsilon = 1.6568

Composition

Ca₂ Zn Si₂O₇

SiO ₂	38.10%
Fe ₂ O ₃	.57
ZnO	24.30
MnO	1.50
CaO	33.85
MgO	1.62
Ignition	.52
	<hr/>
	100.46%

J. E. Wolff, analyst.

Sorosilicate.

Remarks

White to light pink hardystonite, occurring in granular masses and as single grains in limestone but seldom as individual crystals, was discovered in the Parker shaft at a depth of approximately 900 feet. With it was associated a mixture of franklinite, willemite, and rhodonite. J. E. Wolff, (18), described this new mineral in 1900. Albanese, (19), tells us that in 1899 "Mr. Van Mater wrote Prof. Wolfe about a new white mineral. In his letter he stated, 'We found this white mineral and had taken it for a willemite. When we first opened the mine, we crossed a layer about six feet wide, containing a large amount of this mineral—having shipped it to the works received a letter from them complaining we were shipping limestone. I advised them to analyze first before they made a complaint; which they did and were very much surprised to find it running well up in zinc.'

"A few days after this correspondence, Mr. A. Heckscher, of the New York office of the New Jersey Zinc Company wrote Prof. Wolff, 'With reference to the name of the mineral: would it not seem much more just that it be called wolfeite to indicate the name of the discoverer?'"

Professor Wolff, however, named the mineral after Hardyston township in which the Franklin mine was then located in the settlement of Franklin Furnace.

In later years considerable quantities of the mineral were taken from the Parker shaft. These later finds were associated with brown vesuvianite and apatite as well as willemite and franklinite, and the masses of hardystonite had a coarse columnar texture probably due to the basal and prismatic cleavages.

It is of interest to note that all hardystonite apparently contains a small amount of lead; and all minerals that contained lead had to be carefully checked in the assay offices because lead is injurious to zinc.

HETAEROLITE

Crystallography

Ditetragonal, bipyramidal.

Forms are (001) and (111).

$a : c = 1 : 1.595$ (Winchell), $a : c = 1 : 1.128$ (Palache).

Physical Properties

Color is shining black to dark brown.

Streak is dark brown.

Fibrous.

Basal cleavage.

$H = 6$ sp. gr. = 5.18 (Winchell; 4.85 (Palache).

Optical Properties

Uniaxial, negative.

$\Omega = 2.35$ $\epsilon = 2.10$

Reddish brown in thin section E greater than O absorption.

Composition

ZnO · Mn₂O₃ (Palache).

Zn Mn₂O₄ (Winchell).

Mn₂O₃ 64.21 %

Fe₂O₃ .24

ZnO 32.46

MnO 1.86

MgO .49

SiO₂ .18

H₂O .19

L. H. Bauer, analyst.

99.63 %

Remarks

It was in 1877 that G. E. Moore, (20), first described hetaerolite. Named from the Greek for "a companion," because it was found with chalcophanite. It was found "in abundance" at Sterling Hill. Many years later, in 1910, Palache concluded from new analyses that the mineral was really a zinc hausmannite. In this analysis much water was ignored, however. In 1913 W. E. Ford and W. M. Bradley described hetaerolite from Leadville, Colorado. Hetaerolite is really an anhydrous oxide, the hydrous variety being known as hydrohetaerolite. In 1910, Palache probably described hydrohetaerolite.

At Franklin a few minute pseudo-octahedral crystals were found. None of these exceeded a tenth of an inch in diameter. Other dark brown to shining black crystals occurred as druses with brilliant wine-colored hodgekinsonite, willemite, and calcite. Hetaerolite from Sterling Hill occurred on massive franklinite.

Crystallography

HODGKINSONITE

Monoclinic.

$a : b : c = 1.538 : 1 : 1.108$

Angle $\beta = 95^\circ 25'$

Complex crystals with reported forms (001), (100), ($\bar{1}10$), (320), (210), (012), (023), (011), ($\bar{0}21$), ($\bar{4}01$), ($\bar{4}03$), ($\bar{2}01$), ($\bar{4}01$), (111), (223), (441), ($\bar{1}11$), ($\bar{2}23$), (423), (623), ($\bar{4}23$), (211), ($\bar{2}11$), (311), (421), ($\bar{4}21$), (625), ($\bar{3}12$), ($\bar{2}61$), ($\bar{5}32$), (243), (131), ($\bar{6}21$), (176), ($\bar{1}12.6$), (456), (11.5.1).

Physical Properties

Color usually clear bright pink but some crystals are clear reddish brown; infrequently clear red or yellow.

Habit of crystals is acute pyramidal; granular masses also.

Perfect basal cleavage.

H = 4 - 4.5 sp. gr. = 3.91

Optical Properties

Biaxial, negative.

2V = 50°-60°

Alpha = 1.724 beta = 1.742 gamma = 1.746

Z to c = 38°

Pleochroism Y = almost colorless, X = Z = lavender.

Composition

Mn Zn₂ (OH)₂ SiO₄

SiO₂ 19.14%

ZnO 50.45

FeO 0.77

MnO 22.70

CaO 0.60

MgO 0.52

H₂O at 110°C 5.40

Jenkins and Bauer, analysts.

99.58%

Nesosilicate.

Remarks

H. H. Hodgkinson discovered, in 1913, the mineral named in his honor. The original specimens were discovered between the 850-foot and 900-foot levels of the old Hamburg mine in the northern part of the Franklin ore body. The new mineral species was first described by Charles Palache and W. T. Schaller, (21), in 1913.

Since the first few clear bright pink crystals were found, there has been enough of the crystals collected to say, at one time, that they were common or quite abundant. Probably these descriptions of the quantity found were slightly exaggerated.

Although hodgkinsonite crystals have been found with black pyrochroite and colorless calcite as incrustations on franklinite and willemite or, infrequently, garnet, and other somewhat stout crystals of clear yellow hodgkinsonite have been found with hetaterlite and willemite lining cavities, most crystals occur as thin seams or veinlets in granular willemite-franklinite ore in association with barite or,

infrequently, native copper. It has been these clear pink somewhat crystallographically complex crystals of hodgekinsonite in close association with almost pure white barite that have been most attractive to the collector of Franklin minerals. Specimens of one of the thicker vein-fillings, that had crystals yielding cleavage surfaces an inch across, found their way into the famous Stanton Collection.

Hodgekinsonite was somewhat common only in the northern part of the mining area.

HOLDENITE

Crystallography

Orthorhombic.

$a : b : c = 0.3802 : 1 : 0.2755$

Crystals tabular, parallel to macropinacoid.

Forms (001), (010), (100), (110), (120), (130), (011), (031), (102), (111), (211), (311), (131), (151), (251), (182), (7.16.2).

Physical Properties

Color clear pink, deep red, yellowish red.

Crystals are macropinacoidal tablets in habit.

Indistinct brachypinacoidal or (010) cleavage.

H = 4 sp. gr. = 4.07

Optical Properties

Biaxial, positive.

$2V = 30^{\circ}20'$

Alpha = 1.769 beta = 1.770 gamma = 1.785

Red greater than violet, dispersion easily discernible.

Composition

$8 \text{ MnO} \cdot 4 \text{ ZnO} \cdot \text{As}_2\text{O}_5 \cdot 5 \text{ H}_2\text{O}$ (Palache).

$(\text{Mn}, \text{Zn})_8 (\text{OH})_5 \text{O}_2 \text{AsO}_4$ (Winchell).

SiO₂ 2.01%

As₂O₅ 17.40

MnO 37.75

FeO 1.80

ZnO 28.08

CaO 3.80

MgO 1.45

H₂O 6.62

Slightly impure sample.

E. V. Shannon, Analyst.

98.91%

Remarks

Holdenite was named for A. F. Holden of Cleveland. It was in Holden's mineral collection, now at Harvard, that the one and only specimen of the mineral was discovered in 1913. Up to that time it was believed to be leucophoenicite, and was so labeled. Charles Palache and E. V. Shannon, (22), described the mineral for the first time in 1927. In reference to this extremely rare and thus valuable specimen, scientifically speaking, it should be stated that Palache said "It is a slab of massive franklinite ore with a slickensided surface 4 by 3 inches, clearly one wall of a veinlet. The crystals of holdenite were attached for the most part directly to the vein wall or to a thin coating of manganiferous calcite. With them there were minute amounts of barite, galena, pyrochroite, and fibrous willemite. Crystals were measured by the author in 1914, and practical certainty was reached that they were a new arsenate of manganese. After years of search for more of the mineral had proved fruitless, a part of the only specimen was sacrificed for analysis, the results of which confirmed the previous conclusion that the mineral is a hitherto unknown arsenate."

HYDROHETAEROLITE

Crystallography

Tetragonal (?)

Physical Properties

Dark brown to black in color.

Submetallic luster.

Dark brown streak.

H = 5 sp. gr. = 4.93 (Moore); 4.85 (Schaller).

Fibers in radiating masses; botryoidal or mammillary surfaces; massive granular; bladed forms.

Optical Properties

Uniaxial, negative.

Omega = 2.34 epsilon = 2.14

Pleochroism in red-brown; weak.

Composition

$2\text{ZnO} \cdot 2\text{Mn}_2\text{O}_3 \cdot \text{H}_2\text{O}$ (Palache).

Mn ₂ O ₃	60.44%
Fe ₂ O ₃	0.77
ZnO	33.43
H ₂ O—	2.47
H ₂ O+	1.42
SiO ₂	1.71
	<hr/>
	100.24%

Charles Palache, analyst.

Remarks

Charles Palache, (23), in 1910, was the first to analyze and describe hydrohetaerolite. The type specimen came from the Passaic Mine, Sterling Hill. Palache states that invariably it has been found with chalcophanite.

It must here be called to the attention of the reader that hydrohetaerolite was first recognized as a new mineral by G. E. Moore, (24), in 1877. Moore, however, gave no chemical analyses and his description was very incomplete. His conclusion that the mineral was a zinc hausmannite was not accepted by mineralogists.

The word "hetaerolite" comes from the Greek word meaning "companion."

JEFFERSONITE

Crystallography

Monoclinic.

Physical Properties

Color dark olive-green to brown; on some weathering surfaces gray to chocolate-brown to black.

Translucent.

Vitreous to greasy luster.

Poor prismatic cleavage and basal parting.

Contact twins on 100 are uncommon.

H = 5.5 sp. gr. = 3.55 - 3.63

Occurs in large crystals of ordinary pyroxene habit and in granular masses.

Optical Properties

Biaxial, positive.

$2V = 74^\circ$

Z to c = 55°

Alpha = 1.713 beta = 1.722 gamma = 1.745

Violet greater than red; easily seen.

Pleochroism with X = Y = olive-green and Z = brownish green.

Composition

Ca (Mg, Fe, Mn, Zn) Si₂O₆

	A	B	
SiO ₂	45.95%	49.03%	
CaO	21.55	19.88	
MgO	3.61	5.81	
MnO	10.20	7.91	
ZnO	10.15	7.14	
FeO	8.91	3.95	
Al ₂ O ₃	0.85	0.86	A) F. Pisani, analyst.
Fe ₂ O ₃	....	4.22	
H ₂ O+	0.35	0.75	B) G. Steiger, analyst.
H ₂ O	....	0.60	
	<hr/> 101.57%	<hr/> 100.10%	

Inosilicate.

Its variable but ever-present content of zinc makes it a new variety of pyroxene.

Remarks

From Sterling Hill, as a typical mineral of the contact deposits near pegmatites, came the abundant crystals that were called jeffersonite by L. Vanuxem and W. H. Keating, (25), in 1822. They named the new mineral in honor of President Thomas Jefferson.

Although jeffersonite was first described by Vanuxem and Keating in 1822, it was not until the following year that G. Troost, (26), determined it to be a pyroxene.

Most of the Sterling Hill crystals of jeffersonite are deeply pitted, have rounded edges, and have dull coatings of alteration products. These were discovered in pockets in limestone and in the residual clay of limestone, with them being dysluite, garnet, and apatite. Some dark brown crystals of jeffersonite possessed a very porous structure, these crystals being known as "anomalite" during the early days of the camp.

Jeffersonite has been found in crystals more than a foot long, many of these being doubly terminated. Some jeffersonite, however, is in granular masses. In the granular form it was the main dark mineral of the pegmatite dikes of the Trotter mine and in the Parker shaft. At these localities it was abundant in the limestone as single isolated crystals associated with garnet, rhodonite, microcline, franklinite, and gahnite.

LARSENITE

Crystallography

Orthorhombic.

$a : b : c = 0.4339 : 1 : 0.5324$

Forms (100), (010), (110), (210), (120), (150), (101), (012), (111), (122), (132), (142), (131), (252).

Physical Properties

Color, white, transparent.

Adamantine luster.

Slender crystals are needles, length 10 to 20 times thickness.

Good prismatic cleavage.

$H = 3$ sp. gr. = 5.90

Under the iron-arc shows pale-violet fluorescence, according to some writers.

Optical Properties

Biaxial, negative.

2V is about 80° .

$\alpha = 1.92$ $\beta = 1.95$ $\gamma = 1.96$

Red greater than violet dispersion, easily seen.

Composition

Pb Zn SiO₄

SiO ₂	16.87%	
PbO	56.66	
ZnO	22.74	
FeO	0.10	
MnO	0.14	
CaO	2.42	L. H. Bauer, analyst.
MgO	0.20	
H ₂ O	0.76	(contaminated with clinohedrite.)
	<hr/> 99.89%	

Nesosilicate.

Remarks

Larsenite, a species of the olivine group of minerals, was first described by Charles Palache, L. H. Bauer, and H. Berman in 1928, (27). The name is in honor of Esper S. Larsen, Jr. The first specimens came from the picking tables but later specimens came from a mine at the north end at a depth of about the 400-foot level. Most crystals are needle-like but rarely they have the form of thin plates. Many of these needles extended from wall to wall and without terminal faces. Part of the early specimens were found in veins

that cut the ore, others were from replacements in coarse willemite-franklinite ore. Associated minerals were massive pink garnet, pink to colorless hodgkinsonite, zincite, smithsonite, and clinohedrite.

LEUCOPHOENICITE

Crystallography

Monoclinic.

$a : b : c = 1.105 : 1 : 2.314$

Angle $\beta = 103^\circ 16'$

Forms (001), (010), (100), (120), (101), (102), (103),
($\bar{1}01$), ($\bar{1}02$), ($\bar{1}03$), ($\bar{1}04$), (011), (012), ($\bar{1}11$), (121),
($\bar{1}21$), ($\bar{1}22$), (122), ($\bar{2}11$), (123), ($\bar{1}23$), ($\bar{1}24$).

Physical Properties

Color pale purplish red to raspberry-red to brown.

Cleavage fair parallel to base.

$H = 5.5 - 6$ sp. gr. $= 3.848$

In isolated grains and in granular masses. Crystals uncommon, often elongated parallel to b-axis. The crystals are minute and some are twinned with 001 being the twinning plane.

Optical Properties

Biaxial, negative.

$2V = 74^\circ \pm 5^\circ$

$\alpha = 1.751 - 1.760$ $\beta = 1.771 - 1.788$

$\gamma = 1.782 - 1.790$

Pleochroism, when present, is rose-red and colorless. If no pleochroism, it is colorless in thin section.

Composition

$H_2 Mn_7 Si_3 O_{14}$ (Palache).

$Mn_7 (OH) Si_3 O_{12}$ (Winchell).

SiO ₂	26.36%
MnO	60.63
ZnO	3.87
MgO	0.21
CaO	5.67
Na ₂ O	0.24
K ₂ O	0.39
H ₂ O	2.64

C. H. Warren, analyst.

100.01%

Nesosilicate.

Remarks

S. L. Penfield and C. H. Warren in 1899, (28), were the first to establish leucophoenicite as a new mineral species. The specimen was given to Warren by J. J. McGovern in 1897. The material at hand did not permit him to learn the system of crystallization, however. This information was not given us until 1910 by Charles Palache.

For years leucophoenicite was fairly abundant in the Parker shaft. Some specimens came from the Buckwheat mine. Grains of leucophoenicite occurred with green willemite and some brown vesuvianite. It formed an interesting color combination of minerals—raspberry red, green, brown. At first it was mistaken for clinohedrite. The linings of some cavities in the ore must have been very attractive since the lining consisted of clear red leucophoenicite, green willemite, and white scalenohedrons of calcite on drusy pale yellow garnet.

The name is derived from the Greek for "pale or light" and "purple-red."

LOSEYITE

Crystallography

Monoclinic.

Forms (001), (101), (011), (130), ($\bar{1}36$), ($\bar{7}.14.2$).

$a : b : c = 0.70 : 1 : 0.62$

Angle beta = $94^{\circ}30'$

Lath-shaped crystals elongated parallel to orthoaxis.

Physical Properties

Color bluish white.

No visible cleavage.

H = 3 sp. gr. = 3.27

Elongated parallel to b-axis. Striated parallel to zone of orthodome.

Crystals very small, in radiating bundles.

Optical Properties

Biaxial, positive.

$2V = 64^{\circ}$

Alpha = 1.637 beta = 1.648 gamma = 1.676

Weak dispersion with red greater than violet.

Colorless in thin section.

Composition

$2(\text{Mn, Zn, Mg}) \text{CO}_3 \cdot 5(\text{Mn, Zn, Mg}) (\text{OH})_2$ (Palache).
 $(\text{Mn, Zn})_7 (\text{OH})_{10} (\text{CO}_3)_2$ (Winchell).

MnO	39.94%
FeO	0.64
ZnO	32.77
MgO	3.42
CO ₂	12.59
H ₂ O	13.83
SiO	0.16
Mn ₂ O ₃	1.03

L. H. Bauer, analyst.

99.38%

Remarks

Where the crystals came from that were discovered in the Stanton collection, and later called loseyite, is not known. The crystals were studied and named by L. H. Bauer and Harry Berman, (29), who, in 1929, first told us about the new species. They named it after S. R. Losey, an ardent collector of Franklin minerals.

The delicate lath-shaped, bluish-white crystals, most often occurring in radiating groups, had been found in small cavities of veins which were composed of sussexite and altered pyrochroite coated by fragile needles of chlorophoenicite. Loseyite has been a very rare mineral, and there is little likelihood of specimens being found in the future by the average collector of Franklin minerals.

MAGNESIUM CHLOROPHOENICITE

Crystallography

Monoclinic.

Physical Properties

White or colorless.

Excellent orthopinacoidal cleavage.

Sp. gr. = 3.37

Optical Properties

Biaxial, positive.

Alpha = 1.669

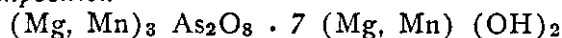
beta = 1.672

gamma = 1.677

2V = small.

Dispersion strong with violet greater than red.

Composition



SiO₂ 3.36%

Fe₂O₃ 3.85

ZnO 8.90

MgO 29.95

MnO 15.57

As₂O₅ 21.16

H₂O 10.81

CaCO₃ 6.29

F. A. Gonyer, analyst.

Known to contain about 25%
impurities, however.

99.89%

Remarks

Although several Franklin and Sterling Hill minerals are extremely scarce, magnesium chlorophoenicite is the most scarce of all minerals. Only one specimen was found, this being collected by George Stanton in the 750-foot level (pillar 859) of the Franklin mine, in 1930 or shortly before this. The specimen was white fibers grouped in radial aggregates on the surface of a small veinlet composed of zincite and carbonates.

MANGANPYROSMALITE

Crystallography

Hexagonal.

a : c = 1:0.537

Physical Properties

Brown colored.

Basal cleavage, perfect.

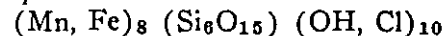
H = 4.5 sp. gr. = 3.13

Optical Properties

Uniaxial, negative.

Omega = 1.669 epsilon = 1.631

Composition



MnO 39.09%

FeO 12.43

MgO 0.74

ZnO 1.94

SiO₂ 34.13

As₂O₅ 0.13

Cl 3.80

H₂O 8.18

L. H. Bauer, analyst.

100.44%

Manganopyrosmalite, friedelite, and schallerite apparently are polymorphs.

Remarks

Manganopyrosmalite was first described by C. Frondel and L. H. Bauer, (30), in 1953. The type specimen came from Sterling Hill, and it has not been found elsewhere. It formed granular veinlets with friedelite, bementite, and willemite in ore of franklinite. Some granular aggregates are reported to have a somewhat schistose structure.

MARGAROSANITE

Crystallography

Triclinic.

$a : b : c = 0.750 : 1 : 1.285$

Alpha = $74^{\circ}37'$ beta = $129^{\circ}29'$ gamma = $101^{\circ}5'$

Forms (001), (010), (100), (011), (110).

Physical Properties

Colorless to white, transparent.

Perfect brachypinacoidal cleavage; good basal and parallel to macrodome.

Pearly luster on cleavage faces.

H = 2.5 sp. gr. = 3.991

Fluoresces in pale-violet tint under the iron-arc spark.

Optical Properties

Biaxial, negative.

$2V = 83^{\circ} \pm 5^{\circ}$

Alpha = 1.729 beta = 1.773 gamma = 1.807,

all ± 0.005

Perceptible dispersion with red greater than violet.

Composition

Pb Ca₂ (SiO₃)₃ (Palache).

Pb Ca₂ Si₃O₉ (Winchell).

SiO₂ 33.71%

PbO 43.50

CaO 21.73

MnO 1.14

H₂O 0.58

W. M. Bradley, analyst.

100.68%

Cyclosilicate.

Palache accepts margarosanite as a member of the pyroxene group of minerals.

Remarks

Margarosanite has been found at Franklin only in lamellar masses; closely packed thin plates. In fact, individual crystals for study were unknown until the discovery of the mineral at Langban, Sweden, three years after they were discovered at Franklin.

This new mineral species was named margarosanite because of its platy or tablet-form and its pearly luster, using the Greek for these descriptive words. W. E. Ford and W. M. Bradley, (31), named and described the new species in 1916.

Although it was not described until 1916, margarosanite was but one of the very many minerals found in the Parker shaft as early as 1898; others found at that time included barite, garnet, hancockite, roebbingite, nasonite, franklinite, willemite, axinite, datolite, and manganophyllite. It is obvious why the Parker shaft was the mineral collector's Paradise, i.e., those mineral collectors who had access to this world-famous shaft.

McGOVERNITE

Crystallography

Hexagonal (?)

Physical Properties

Is bronze red in reflected light but is deep red-brown in transmitted light.

Crystals are unknown. Individual grains show cleavage in coarse granular masses.

Cleavage pronounced in one direction. Basal (?)

Sp. gr. = 3.719

Optical Properties

Uniaxial, positive.

Omega = 1.754

Composition

(Mn, Mg, Zn)₇ OH As SiO₄ · 3H₂O (?)

SiO ₂	8.92%
MnO	42.73
FeO	1.53
MgO	11.27
ZnO	10.22
As ₂ O ₃	4.45
As ₂ O ₅	12.48
H ₂ O	8.49

L. H. Bauer, analyst.

100.09%

Nesosilicate.

It is chemically unique among minerals by having its arsenic in two states of oxidation, i.e., As_2O_3 and As_2O_5 .

Remarks

In 1927 McGovernite was first found at Sterling Hill. It was found in the north drift of the 900-foot level. Here it formed the main portion of a vein that cut the massive zinc ore. Although much of it was in the vein, for some unexplained reason very few specimens for a time were to be had. Recently Sterling miners have unloaded considerable quantities of it. Were they hoarded? The mineral was first described by Charles Palache and L. H. Bauer, (32), in 1927. They named it in honor of J. J. McGovern of Franklin because for years he had been in charge of the picking tables at the mine and also because he was one of the foremost mineral collectors of his time.

MOOREITE

Crystallography

Monoclinic.

$a : b : c = 0.553 : 1 : 0.963$

Angle $\beta = 122^\circ 23'$ (Winchell); $142^\circ 27'$ (Bauer and Berman).

Forms are (001), (010), (100), (10 $\bar{1}$), ($\bar{1}01$), ($\bar{1}02$), (011), (121), ($\bar{1}11$), ($\bar{1}13$), ($\bar{1}15$).

Physical Properties

Colorless.

Habit is tabular, parallel to clinopinacoid.

Cleavage is perfect clinopinacoidal.

H \approx about 3 sp. gr. \approx 2.470

Optical Properties

Biaxial, negative.

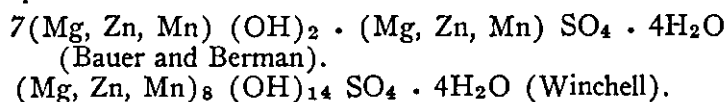
$2V = 50^\circ$, approximate.

$\alpha = 1.533$ $\beta = 1.545$ $\gamma = 1.547$

Z to c $= 44^\circ$

Dispersion red greater than violet, perceptible.

Composition



MgO	25.38%
MnO	11.93
ZnO	24.58
SO ₃	10.99
H ₂ O	27.12

L. H. Bauer, analyst.

100.00%

Remarks

Mooreite, occurring as glassy white or colorless tabular crystals in small cavities and veinlets with fluoborite and pyrochroite in a vein of the usual calcite-franklinite-willemitite assemblage of minerals, was found for the first time in 1929 at an unrecorded location at Sterling Hill. Although an inconsiderable number of small crystals were doubly terminated they generally were seen as subparallel groups or aggregates, each of the colorless crystals possessing clinopinacoidal habit. A bluish white variety was also seen, but this had a slightly different composition and did not occur in crystals (see delta-mooreite).

Mooreite, no other mineral being very closely related to it, was first described in 1929 by L. H. Bauer and Harry Berman, (33). They named this new mineral species in honor of Gideon H. Moore who was chemist of the Passaic Zinc Company. It might be stated that it was this Moore who first described brushite, chalcophanite, and hetaerolite.

NASONITE

Crystallography

Hexagonal.

$a : c = 1 : 1.317$

Forms $(11\bar{2}0)$, $(10\bar{1}0)$, $(10\bar{1}1)$, $(90\bar{9}2)$.

Physical Properties

Color is white.

Luster is greasy to adamantine.

$H = 4$ sp. gr. 5.525 to 5.43 (?)

Crystals at Franklin practically unknown. Practically at all times found in a granular or massive form.

Cleavage good basal, indistinct prismatic. Due to cleavage breaks into somewhat rectangular forms.

Optical Properties

Uniaxial, positive.

Omega = 1.917 (Franklin) epsilon = 1.927 both \pm 0.005

Omega = 1.9453 epsilon = 1.9710 (Langban)

Composition

Pb₈Ca₄ (Si₂O₇)₃ Cl₂ (Fron del and Bauer).

Pb₄ (Pb, Cl)₂ Ca₄ (Si₂O₇)₃ (Palache).

(Ca, Pb)₁₀ Cl₂ (Si₂O₇)₃ (Winchell).

SiO₂ 18.47%

PbO 65.68

ZnO 0.82

MnO 0.83

FeO 0.10

CaO 11.20

Cl 2.81

H₂O 0.26

G. H. Warren, analyst.

100.17%

Sorosilicate.

Considered by mineralogists as the chlorine end-member of ganomalite, which contains OH instead of Cl, there being a somewhat complete series from this OH compound to the Cl compound.

Remarks

Although nasonite was described by S. L. Penfield and C. H. Warren, (34), in 1899, it was not specimens taken directly from the mines that gave them material for study. It was, rather, crystals of nasonite in a barite matrix located in the Canfield collection. Crystals of nasonite at Franklin always have been extremely rare, the usual occurrence being a massive granular form acting as a matrix of glaucochroite crystals. Today few specimens of nasonite are extant. Crystals of nasonite were discovered at Langban, Sweden, in 1916, or seventeen years after their discovery in the famous Parker shaft at Franklin.

About 1950 white granular masses of nasonite were "rediscovered" in the 800-foot level of the Parker shaft, where it with its greasy to adamantine luster was associated with barysilite, granular datolite, white fibrous prehnite, willemite, axinite, hancockite, garnet, clinohedrite, and manganophyllite.

POLYDELPHITE—A varietal name, to be discarded.

Crystallography

Cubic.

Physical Properties

Color brownish yellow.

Massive, though a few rough crystals were found embedded in calcite.

H = 3.7 - 4.1 (?)

Optical Properties

Isotropic.

N = 1.90 ±

Composition

(Ca, Mn)₃ (Fe, Al)₂ Si₃O₁₂

SiO₂ 34.28%

Al₂O₃ 3.12

Fe₂O₃ 25.53

MnO 7.41

CaO 29.20

MgO 0.39

L. H. Bauer, analyst.

99.93%

Nesosilicate.

Considered to be a variety of andradite garnet.

Remarks

To the somewhat manganiiferous garnet, usually massive and never in good euhedral crystals, and always brownish yellow in color, Thomas Thomson gave the name polyadelphite. The word is derived from the Greek words meaning "many" and "brother" because "it contains five different silicates united." The name appeared for the first time in his "Outlines of Mineralogy," 1836, (35). He had previously given a chemical analysis of the mineral in 1829, (36), however. The garnet apparently was restricted to the Trotter and Parker shafts.

It is doubtful if today the term "polydelphite" is accepted by all mineralogists. Review of the literature shows that the term has been somewhat ignored. Perhaps it is just as well to call it simply a manganiiferous andradite. It seems that even as early as 1891 "polyadelphite" was a synonym for andradite. As far as the writer is aware, the term polyadelphite has never been used outside the Franklin district.

ROEBLINGITE

Crystallography

Orthorhombic (?)

Crystals too minute for positive crystal-system determination.

Physical Properties

Crystals tiny prismatic; white to colorless dense or compact masses.

Luster like that of unglazed porcelain; dull.

H = 3 sp. gr. = 3.433

Optical Properties

Biaxial, positive.

Alpha = 1.64 beta = 1.64 gamma = 1.66

Elongation is negative.

2V = small.

Parallel extinction.

Composition

H₁₀ Ca₇ Pb₂ Si₅ S₂O₂₈ (Palache).

2 PbSO₄ · H₁₀ Ca₇ Si₆O₂₄ (?) (Winchell).

SiO₂ 23.58%

CaO 25.95

SrO 1.40

MnO 2.48

Na₂O 0.40

K₂O 0.13

Average of two analyses.

H₂O 6.35

PbO 9.00

SO₂ 31.03

H. W. Foote, analyst.

100.32%

Nesosilicate.

Remarks

Fibrous white to colorless compact masses of tiny crystals of roeblingite, near the center of a mass of spongy to cellular axinite, was first found at the 1,000-foot level of the Parker shaft. The discovery was near a pegmatite-limestone contact, where great amounts of garnet were found. It is said that the largest of these masses of roeblingite was the size and shape of an average coconut, and weighed approximately 5 pounds. For some unknown reason little of this original find was preserved. After this 1897 discovery, its being described in that year by S. L. Penfield and H. W. Foote, (37), no other crystals or masses of crystals of roeblingite were found until 1927. A few, small, compact masses of crystals were then discovered

in an unrecorded portion of the Parker shaft, these being associated with calcium larsenite and clinohedrite.

This new mineral species was named in honor of Col. W. A. Roebling of Trenton. Roebling has been for years, and still is, a well-known name to all residents of New Jersey. Col. Roebling at that time was not only a celebrated engineer but was also a mineral collector known to all local mineralogists.

Roeblingite is also found at mineral-famous Langban, Sweden.

ROEPPERITE

Crystallography

Orthorhombic.

$a : b : c = 0.466 : 1 : 0.586$

Forms (001), (100), (010), (110), (101), (021), (111), (121), (211).

Physical Properties

Color of exterior is black but when broken the fresh surfaces are mottled dark green and yellow.

Transparent in thin pieces.

Most commonly found as crystals with either a prismatic or tabular habit; when tabular it is parallel to the brachypinacoid.

The crystals, however, frequently appear as if a solution of some sort had reacted with them, the faces and face-terminations usually being somewhat rounded. Also found in granular form.

Greasy luster on cleavage surfaces, such surfaces being parallel to 001 and 010.

$H = 5.5 - 6$ $sp. gr. = 3.95 - 4.08$

Optical Properties

Biaxial, negative.

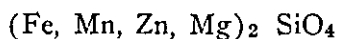
$\alpha = 1.758$ $\beta = 1.768$ $\gamma = 1.804$

all ± 0.003

$2V = 77^\circ \pm 5^\circ$

Dispersion strong with red greater than violet.

Composition



SiO ₂	30.76%
FeO	33.78
MnO	16.25
ZnO	10.96
MgO	7.60

W. T. Roepper, analyst.

99.35%

Nesosilicate.

Roepperite is a variety of knebelite, $(\text{Mn, Fe})_2 \text{SiO}_4$ and is thus a member of the olivine group of minerals.

Remarks

W. T. Roepper first described the mineral later named for him by G. J. Brush. The description by Roepper was published in 1870, (38), but the name of the new mineral species did not occur in print until Brush named it two years later, (39). It is of interest to note that the type material described by Brush was first called "sterlingite" by Kenngott. It was associated with franklinite, gahnite, and jeffersonite.

Palache says, "—there was a large deposit of it (roeperite) high on the east leg of the ore body at Sterling Hill, more than 100 tons of which was mined and shipped as iron ore. It was not noticed at the time, however, as a new or peculiar mineral, and the deposit was exhausted without many specimens having been saved. Roepper's specimens were stray fragments picked up years later. The best specimens are in the Canfield collection where there are single crystals as much as 5 inches long and 2 inches broad, as well as groups of crystals implanted on the matrix."

ROEPPERITE

Crystallography

Orthorhombic.

$a : b : c = 0.916 : 1 : 0.735$

Forms: (010), (100), (101).

Physical Properties

Color light brown.

Habit is narrow laths, to fibrous in parallel bundles.

Cleavage 101, poor.

H = 5 sp. gr. = 2.92

Optical Properties

Biaxial, negative.

$2V = 15^\circ$

Alpha = 1.648

beta = 1.660

gamma = 1.663

Composition

H₂ Mn Ca B₂O₃

MnO 28.30%

MgO 1.66

ZnO 3.13

CaO 25.40

B₂O₃ 32.40

H₂O 8.51

Insol. 0.84

H. Berman, analyst.

100.24%

Remarks

Roweite probably is one of the rarest of Franklin minerals. Only three small specimens of it are known to the writer to be in existence, one of these in the possession of the Department of Geology, Rutgers, The State University of New Jersey, (40). In 1940 the specimen was donated by Captain George Rowe of Franklin, shortly before his death. The mineral was described in 1937 by H. Berman and F. A. Gonyer, (41). They named it in honor of Mine Captain George Rowe who gave them the mineral for identification.

The specimen received for identification purposes was intimately associated with thomsonite.

SCHALLERITE

Crystallography

Hexagonal, scalenohedral (?)

Crystals never found.

Physical Properties

Reddish brown to light brown in color.

Perfect basal cleavage revealing pearly luster.

H = 4.5 - 5 sp. gr. = 3.37

Occurs in granular masses only; crystals unknown.

So similar to friedelite that the two minerals cannot be differentiated by physical properties alone.

Optical Properties

Uniaxial, negative.

Omega = 1.704

epsilon = 1.679

Composition

$\text{Mn}_8 (\text{SiO}_3)_6 (\text{OH}) (\text{As}_2\text{O}_3)_5 3\text{H}_2\text{O}$ (Palache).
 $(\text{Mn}, \text{Fe})_8 (\text{OH}, \text{Cl})_{10} (\text{Si}, \text{As})_6 \text{O}_{15}$ (Winchell).

SiO_2	31.44%
MnO	44.70
FeO	2.12
MgO	2.19
CaO	0.36
ZnO	0.54
Cl	0.08
As_2O_3	12.24
H_2O	6.55

L. H. Bauer, analyst.

100.22%

Phyllosilicate.

Schallerite, friedelite, and manganopyrosmalite apparently are polymorphs.

Remarks

Schallerite was named in honor of that great mineralogist of the U. S. Geological Survey, W. T. Schaller. This new mineral species was found by R. B. Gage in 1924 and was described by Gage, E. S. Larsen, and H. E. Vassar, (42), in 1925. The specimens came from a small vein one-half to two inches wide composed entirely of the one mineral. They came from a depth of 700 feet in an unrecorded part of the mine. Schallerite occurred with rhodonite veins in ore near the hanging wall of the shaft pillar (Parker and Palmer areas) just above the 1,050 level, in the early 1950's. Hedyphane and allactite were associated with it.

SUSSEXITE

Crystallography

Orthorhombic.

Physical Properties

White, with a tinge of pink or yellow.

Translucent.

Luster is pearly or silky.

Found as silky fibers, usually in parallel groups that are parallel with, at times transverse to, the vein-walls.

$H = 3$ sp. gr. = 3.42

Optical Properties

Biaxial, negative.

$2V = \text{small}$.

$\text{Alpha} = 1.630$

$\text{beta} = 1.712$

$\text{gamma} = 1.709$

Composition

H (Mn, Mg, Zn) BO₃ (Palache).

	(1)	(2)	
B ₂ O ₃	31.89%	33.31%	
MnO	40.10	38.08	
MgO	17.03	15.92	
H ₂ O	9.59	8.53	(1) G. J. Brush, analyst.
ZnO	....	3.24	(2) Penfield and Sperry, analysts.
	<hr/> 98.61%	<hr/> 99.08%	

Sussexite is a variety of szaibelyite with manganese being dominant.

Remarks

From the Hamburg mine came the first known specimens of sussexite. These were first discovered and described in 1868 by G. J. Brush, (43). Brush stated that the first specimens were in a vein of franklinite at the opening on the north end of Mine Hill, associated with franklinite, zincite, willemite, and calcite. Since 1868 small amounts of sussexite have been found in the Parker shaft, Taylor mine, and Trotter mine. Few specimens have been preserved in museums or in private collections. It is reported that many specimens that are today labeled sussexite are in reality tremolite asbestos cemented by calcite, or are calcozincite, a local term for a mixture of fibrous calcite and zincite. Some rare specimens of sussexite are very delicate white fibers associated with pale pink rhodochrosite, others are dull pink masses interwoven with yellow willemite. Brush stated that the structure is not only fibrous but sometimes is asbestiform and occurs in seams in calcite, sometimes with the fibers at right angles to the walls of the seam, and in other specimens parallel to these walls. Sussexite recently was abundant in the deepest levels of the Sterling Hill mine, with associated mooreite in fresh and altered crystals. The sussexite was of both the colored cherty and the silky white fibrous varieties together in red willemite ore somewhat altered.

Named for Sussex County.

TEPHROITE

Crystallography

Orthorhombic.

a : b : c = 0.462 : 1 : 0.591

Forms (100), (010), (001), (110), (210), (120), (130), (270), (101), (103), (011), (021), (121), (131), (122).

Physical Properties

Crystals rare. Usually coarse granular aggregates.

Granular masses are flesh-red, red-brown, brown, or ash-gray in color. Some isolated crystals are bluish green by natural light and pink by artificial light.

Good cleavages parallel to 001 and 010.

H = 5.5 - 6 sp. gr. = 3.87 - 4.12

Luster is greasy to vitreous.

Optical Properties

Biaxial, negative.

2V = 60° (Palache) 50° (Winchell).

Alpha = 1.77 beta = 1.807 gamma = 1.825

Dispersion perceptible red greater than violet.

Colorless in thin section.

Z = greenish blue Y = reddish X = brownish red

Absorption Y greater than Z greater than X.

Composition

(Mn, Mg, Zn)₂ SiO₄ (Palache).

Mn₂ SiO₄ (Winchell).

	(1)	(2)	(3)
SiO ₂	29.64%	30.63%	29.96%
MnO	66.60	49.80	30.00
MgO	....	10.16	15.19
ZnO	....	5.74	18.90
FeO	0.92	3.33	1.54
CaO	....	....	1.20
Al ₂ O ₃	....	....	1.25
H ₂ O	2.70	....	1.38
	<hr/> 99.86%	<hr/> 99.66%	<hr/> 99.42%

(1) From Franklin. T. Thomson, analyst.

(2) From Sterling Hill. L. H. Bauer, analyst.

(3) From Franklin. G. C. Stone, analyst.

Nesosilicate.

A member of the chrysolite group of minerals.

Remarks

This ash-gray mineral (Greek = ash-gray) was, according to Palache, "first analyzed by Thomas Thomson under the name 'silicate of manganese.' Breithaupt had given the name 'tephroite' to material from Sterling Hill obtained from a private collector in Dresden, and this material was later analyzed by Rammelsberg, who recognized its identity with Thomson's mineral. For many years

thereafter the mineral was quite overlooked by Franklin collectors until Brush again called attention to its abundance at Sterling Hill."

August Breithaupt described and named the mineral in 1823.

At Sterling Hill some isolated crystals were discovered in limestone. At Franklin considerable amounts occurred with franklinite, willemite, and zincite in a calcite gangue. From the picking tables at Franklin, crystals measuring up to 1.2" x 3.5" have been obtained. Large masses of the mineral were collected from the Buckwheat open cut.

Some forms of tephroite can easily be mistaken for willemite.

TORREYITE

Crystallography

Monoclinic.

No crystals have ever been found.

Physical Properties

Bluish white in color.

Granular.

Cleavage perfect clinopinacoidal.

H = about 3. sp. gr. = 2.665

Optical Properties

Biaxial, negative.

2V = 40°, approximately.

Alpha = 1.570 beta = 1.584 gamma = 1.585.

Polysynthetic twinning.

Composition.

(Mg, Mn, Zn)₇ (SO₄) (OH)₁₂ · 4H₂O

where Mg : Mn : Zn = 5 : 3 : 4

MgO	17.27%
MnO	17.98%
ZnO	26.30%
SO ₃	11.64%
H ₂ O	26.39%
B ₂ O ₃	Present
SiO ₂	0.08%

L. H. Bauer, analyst.

99.66%

Remarks

Delta-mooreite was the name given by Bauer and Berman, (44), in 1929 to the mineral now called torreyite. They stated (in reference to mooreite and delta-mooreite) "It cannot be said which of the two varieties is the more typical chemically for it could not be

determined whether the one of them was forming at the expense of the other. Delta-mooreite appeared to be replacing pyrochroite in one place which might be interpreted that it was first to form and was intermediate between the manganese hydrate, pyrochroite, and the magnesium-rich mooreite."

Palache stated that the two varieties differ chiefly in the relative proportion of three metallic bases. Which of the two is chemically the more typical of the species could not be decided, and that possibly one species was developed at the expense of the other.

When a powder photograph of this delta-mooreite was made by Joan Prewitt-Hopkins in 1949, (45), it was found to be quite different from that of mooreite. Thus mooreite and the mineral under discussion are now known to be structurally different, and are distinct species. For this mineral the name torreyite was proposed by Prewitt-Hopkins in honor of John Torrey, a man who was early interested in Franklin minerals.

Torreyite occurs only at Sterling Hill.

TROOSTITE—A varietal name, not a species.

Crystallography

Hexagonal, trirhombohedral.

$a : c = 1 : 0.6675$

See "willemite" for further information, troostite being a variety of willemite.

Physical Properties

Reddish to gray variety of willemite (which see).

Cleavage poor parallel to 0001 and prism $11\bar{2}0$.

Stout to slender prismatic crystals with rhombohedral terminations.

$H = 5.5$

sp. gr. = 3.9 - 4.3

Optical Properties

Uniaxial, positive.

$\Omega = 1.714$

$\epsilon = 1.732$

(for 6.80% MnO)

Composition

$(\text{Mn, Zn})_2 \text{SiO}_4$

SiO_2 27.75%

ZnO 60.61

MnO 10.04

FeO 1.80

G. A. Koenig, analyst.

100.20%

Nesosilicate.

Remarks

It must here be mentioned that the name troostite has for years been applied to the darker colored manganiferous varieties of willemite that have or are supposed to have a slightly different cleavage from that of willemite, this being perhaps more true for the stout crystals from Sterling Hill than from other places. Hintz, in his world-famous *Handbuch der Mineralogie*, conceded the difference. At Franklin, both types of this manganese-zinc silicate are recognized.

To a supposed manganese silicate described by T. Thomson in 1828, C. U. Shepard in 1882 gave the name "troostite" just two years after M. Levy discovered and named willemite from Moresnet, Belgium. Troostite and willemite have been proved to be essentially identical.

Lardner Vanuxem and W. H. Keating, however, were the men who first recognized willemite as a new mineral species, calling it a "siliceous oxide of zinc." To Vanuxem and Keating belong the honor of discovery at Franklin in 1824, but to Levy belongs the honor of naming it in 1830. See "willemite" for further information.

Named in honor of Professor G. Troost.

WILLEMITE

Crystallography

Hexagonal trirhombohedral.

$a : c = 1 : 0.6612$ (Palache, 1910).

$a : c = 1 : 0.6679$ (Palache and Graham, 1913).

Forms (0001), (11 $\bar{2}$ 0), (10 $\bar{1}$ 0), (3120), (31 $\bar{4}$ 0), (21 $\bar{1}$ 3), (11 $\bar{2}$ 3), (4223), (01 $\bar{1}$ 5), (01 $\bar{1}$ 2), (10 $\bar{1}$ 1), (02 $\bar{2}$ 1), (5234), (51 $\bar{4}$ 3), (41 $\bar{3}$ 2), (31 $\bar{2}$ 1), (21 $\bar{3}$ 1), (52 $\bar{3}$ 1), (43 $\bar{7}$ 1), (8261), (13 $\bar{5}$.8.3.), (14 $\bar{5}$.9.1), (1765), (13 $\bar{2}$ 2), (1344), (1341), (1561).

Physical Properties

Color pale green, bright green, wine-yellow, flush-red, mahogany-red, dark brown, colorless, white, gray. Weathered surfaces at times are black.

Hexagonal prisms with basal or rhombohedral terminations.

Also fine granular aggregates or fibrous aggregates.

H = 5.5 sp. gr. = 3.89 - 4.19

Cleavage parallel to 0001.

Luster vitreous to resinous.

Some crystals are transparent.

Some willemite, other than the white and troostite varieties, fluoresce. Some have strong phosphorescence in green.

Optical Properties

Uniaxial, positive.

Omega = 1.691 - 1.697

epsilon = 1.719

Composition

(Zn, Mn)₂ SiO₄

	(1)	(2)	(3)	(4)
SiO ₂	25.44%	25.00%	27.40%	27.20%
ZnO	68.06	71.33	66.83	65.82
MnO	6.50	2.66	5.73	6.97
FeO	....	0.67	0.06	0.23
H ₂ O	....	0.34	0.18	....
	<hr/> 100.00%	<hr/> 100.00%	<hr/> 100.20%	<hr/> 100.22%

(1) Red colored; Sterling Hill. W. H. Keating, analyst.

(2) Red colored; Sterling Hill. L. Vanuxem, analyst.

(3) Apple green in color; Franklin. W. G. Mixter, analyst.

(4) White; Franklin. G. Stone, analyst.

Nesosilicate.

Remarks

Everyone is acquainted with the fact that willemite, named in honor of William the First, King of the Netherlands, is an abundant constituent of the whole ore body at Franklin and that it is one of the economically valuable zinc ore-minerals from which spelter is made. Willemite, usually green or yellow or red in color, occurs in grains mixed in various proportions with franklinite, calcite and, once in awhile, zincite. Not infrequently these are arranged more or less in layers.

In the Parker shaft transparent delicate green crystals were associated with nasonite, glaucochroite, leucophoenicite, and datolite. From the same shaft masses of transparent, glassy, yellow-green willemite weighing slightly more than a pound have been found.

Everyone knows the beauty of some willemite crystals or masses. The most beautiful crystals, according to Palache, are those found in 1928 that came from a vein, location not recorded, at Franklin. Palache states, "Coating the vein wall is a crust of drusy yellow garnet and on it are pink hodgkinsonite crystals—, bluish tephroite crystals with tips blackened by manganese oxide, crystals of clear or snow-white barite, and a few microscopic needles of a vanadate, believed to be a mangiferous descloizite. Many of the specimens from this vein are studded with willemite crystals of peculiar beauty. They are prisms of absolute transparency, colored a fine uranium-

green——. So clear is the material that striations on the back of a crystal are plainly visible through its thickness."

Many crystals that today are in collections came from the Trotter, Taylor, and Buckwheat mines. From the Hamburg mine came slender beryl-colored crystals of willemite embedded in pale rose-tinted manganiferous calcite. Fibrous willemite has been taken from the Buckwheat open cut, this form being prized for its wonderful fluorescence. At Sterling Hill willemite is widely distributed but has not been so abundant as at Franklin. It was the reddish or flesh-colored specimens from Sterling Hill that were named troostite.

Lardner Vanuxem and W. H. Keating, (46), in 1824, first described and analyzed willemite, calling it "siliceous oxide of zinc." Thomas Thomson, in 1828, made poor analyses on material supplied by Torrey and Nuttall, resulting in confusion regarding the nature of willemite. Thomson made it out to be a silicate of manganese. To this supposed manganese silicate C. U. Shepard, (47), in 1832 gave the name "troostite." Now, two years before this in 1830, M. Levy discovered and named the willemite from Belgium. Many later investigators discovered Thomson's mistake, and stated that troostite and willemite are identical.

The name "troostite" continued to be used, even up to the present day, for the dark colored manganiferous variety of willemite.

Tephro-willemite, a mineral formerly supposed to be somewhere between troostite and willemite in composition, is a term no longer in use. If it is used, it must be as a synonym for troostite.

Lardner Vanuxem and W. H. Keating, as stated previously, recognized willemite as a new mineral species, making the mistake of calling it "siliceous oxide of zinc" rather than giving it a real name. To these two men belong the honor of discovery at Franklin in 1824. To M. Levy belongs the honor of naming it in 1830. State and national pride make it necessary to call attention to this great international problem. The discovery is more important than the naming.

Willemite is not an uncommon mineral as many believe. Of course it is not a really common mineral. Because so much has been written about the beautiful crystals from Franklin, and so much has been stated about their fluorescence that willemite crystals from other localities have gone unsung. One may be surprised to learn that the species has been found in at least twenty-three localities. A few of these are Balmat, New York; Salida, Colorado; Sinaloa, Mexico; Moresnet, Belgium; Musartut, Greenland; and Tchioumba, French Congo.

WOODRUFFITE

Physical Properties

Chocolate-brown to iron-black in color.

Usually found as masses or crusts with a pronounced botryoidal surface. Isolated grains never found.

It is extremely fine-grained and, even when crushed, is seen to be opaque.

Brown streak.

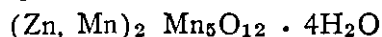
H = 4.5 to much softer.

sp. gr. = 3.71 (about)

Fracture conchoidal.

Dull luster.

Composition



Na ₂ O	0.06%
K ₂ O	0.55
BaO	0.12
MgO	0.62
ZnO	13.89
MnO	7.88
MnO ₂	64.27
Fe ₂ O ₃	0.26
Al ₂ O ₃	0.14
SiO ₂	0.86
H ₂ O	10.48

Lee C. Peck, analyst.

99.13%

Remarks

Clifford Frondel, (48), first described the new mineral "woodruffite," from Sterling Hill, in 1952, and stated that it occurs in masses associated with chalcophanite and zincian cryptomelane and "occurs chiefly as masses and crusts with a botryoidal surface and a concentric, coarsely layered internal structure.—Occasionally, corroded crystals of franklinite are found embedded in the masses, and certain of the layers, usually the outermost, may contain disseminated, platy crystals of chalcophanite. Some specimens are rather hard, about 4.5, with an iron-black color and brownish streak, but the mineral also occurs as soft, almost pulverant coatings of a chocolate-brown color. The hard material has a specific gravity of 3.71 and the fracture is smooth-conchoidal with a dull luster."

Named in honor of Samuel Woodruff, for years a miner at Franklin.

YEATMANITE

Crystallography

Triclinic: pseudo-orthorhombic.

$a : b : c = 0.7811 : 1 : 0.4775$

Angle alpha equals $103^{\circ}49'$: angle beta is $101^{\circ}45'$:

angle gamma is $87^{\circ}12'$

Crystal forms present are (100), (010), (210), (023).

Physical Properties

Color is deep brown.

Streak is very light brown.

H = 4. sp. gr. = 5.02

Brittle.

Good cleavage parallel to 1100.

Optical Properties

Biaxial, negative.

Alpha = 1.873 beta = 1.905 gamma = 1.910

$2V = 49^{\circ}$ (from indices) $2V = 40^{\circ}$ (estimated)

Composition

(Mn, Zn)₁₆ Sb₂ Si₄O₂₉

SiO₂ 13.50%

Sb₂O₅ 18.01

MnO 33.00

FeO 0.36

ZnO 35.54

H₂O (plus) 0.54

L. H. Bauer, analyst.

9.95%

Nesosilicate.

Remarks

In 1938 Charles Palache, L. H. Bauer, and Harry Berman, (49), stated that in 1937 several specimens were found at Franklin in which an unknown pink mineral attracted their attention. This mineral proved to be sarkinite, a mineral up to then having been found only in Sweden. This arsenic-bearing mineral was embedded in green willemite. In this latter mineral was a very small amount of clove-brown plates of what they named yeatmanite in honor of the distinguished local mining engineer, Pope Yeatman.

Yeatmanite is the first mineral found at Franklin that contains antimony. It is, indeed, a rare mineral. As the discoverers state "Its discovery, as well as that of sarkinite, adds two more features of resemblance between the mineral assemblages of Franklin and Langban (Sweden)."

ZINCITE

Crystallography

Hexagonal-hemimorphic (Palache).

Dihexagonal-pyramidal (Winchell).

$a : c = 1 : 1.587$

Forms $(10\bar{1}1)$, $(40\bar{4}5)$, $(50\bar{5}4)$, $(10\bar{1}0)$, $(000\bar{1})$.

Physical Properties

Color deep red to orange-yellow (rare).

Cleavage perfect parallel to unit prism, but seldom is it seen.

Basal parting.

Crystals rare; commonly found as granular, foliated, or compact masses. As crystals, terminated at one end by steep pyramid, other end by a pedion.

Translucent with subadamantine luster.

$H = 4$ sp. gr. $= 5.5 - 5.684$

Streak is orange-yellow.

Optical Properties

Uniaxial, positive.

$\Omega = 2.013$ $\epsilon = 2.029$

In thin section is deep red, non-pleochroic.

Composition

$(Zn, Mn)O$

	(1)	(2)	
ZnO	92.00%	93.48%	
MnO	....	5.50	
FeO	8.00	....	(1) A. Bruce, analyst.
Fe ₂ O ₃	....	0.80	(2) A. A. Hayes, analyst.
	<hr/> 100.00%	<hr/> 99.78%	

Remarks

One of the first real mineralogical studies made in this country was that of Dr. Bruce, (50), in 1810 when he analyzed and described the first of the now well-known zinc ore minerals of Franklin, zincite. This was one of the first papers concerning mineralogy to be published in American scientific literature and its publication caused great scientific interest. Bruce suggested that the mineral be used in the manufacture of brass. He did not call it by its present name but, rather, "red oxide of zinc." In 1844 the name "sterlingite" was proposed by Francis Alger but the name proposed a year later in 1845 by Haidinger, "zincite," has been accepted in the literature. It was called zincite because of its composition. As late as 1852 Brooke

and Miller endeavored to have the name "spartalite" given because of the occurrence of the red zinc oxide in glacial boulders near the town of Sparta. It should here be recorded that Shepard used the term "calcozincite" for a mechanical mixture of powdery yellow and red zincite and calcite. Mineral names must not be given to mixtures of minerals.

Zincite apparently was much more plentiful in the outcrops at Sterling Hill than at Franklin during the early days. The striking color combination of bright red zincite, green or red willemite, black franklinite, and snow-white calcite caused mineral collectors from far and wide to add these specimens to their collections. Hundreds, if not thousands, succeeded in doing so. Zincite usually is intermixed with franklinite and willemite throughout the zinc camps here. Specimens of these three minerals today are to be found sparingly when dumps are turned over for the convenience of the mineral collector and for profit to the owners of the dumps.

Zincite is an ore of zinc, especially used for the production of zinc white (zinc oxide).

Spelled zinkite by A. N. Winchell.

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