THE FRANKLIN STERLING MINERAL AREA

by

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TRIP E

Introduction

The area which we shall visit is a limestone region lying in the New Jersey Highlands, which is part of the Reading Prong. It extends in a northeasterly direction across the northern part of the state.

The rocks are Precambrian "crystallines" with narrow belts of infolded and infaulted Paleozoic sedimentary rocks. Major longitudinal faults slice the fold structures, so that the area has been described as a series of fault blocks extending from south of the Sterling Mine to Big Island, N. Y.

For many years the Franklin Limestone yielded enough zinc to make New Jersey a leading producer of this commodity. Mining has steadily decreased in this area, and in 1955 the Franklin Mine was shut down permanently, so that mineral specimens are derived mainly from surface dumps and quarries. Some twenty million tons of ore were removed from Franklin before it was shut down.

Prior to mining, the ore outcropped in two synclinal folds completely within the limestone, which pitched to the northeast at an angle of about 25° with the horizontal. In these two horseshoe shaped bodies were developed the Franklin and the Sterling Mines. This zinc ore is unique in its lack of sulfides and lead minerals, and in the occurrence of franklinite and zincite as substantial ore minerals.

The limestone has produced nearly 200 species of minerals, some 33 of which were first found in Franklin, and about 30 of which have never been found elsewhere.

The emphasis for this trip will be on mineral collecting, and no attempt will be made to demonstrate the many complex mineralogical and geological problems still unsolved here.

History

A very brief history of the area may be of interest. The earliest records go back to about 1640, when Dutch miners in the Minisink Valley prospected the Sterling ore.

Originally this was a pig iron center, the first forge built at Franklin about 1770. The unsuspected zinc and manganese prevented successful smelting, so the industry came to a standstill by 1820.

Between 1820 and 1850, Dr. Samuel Fowler, his son Col. Samuel Fowler, and a number of other scientists, studied the ores and recognized their composition and properties.

In 1841 the N. J. Zinc and Copper Mining and Manufacturing Co. was chartered, and in 1850 the ore bodies were successfully exploited, the principal product being zinc oxide. In 1854, the company started roasting franklinite for zinc oxide, and smelting the residue for manganiferous iron.

From this time on there was continuous expansion; in 1880, the Trotter shaft was sunk into the pegmatite and the pneumatolytic zones; the Buckwheat area near Mine Hill was opened and stripped; and in 1888, electromagnetic concentration of ore resulted in the production of zinc oxide and spiegeleisen from the franklinite, and zinc from the willemite. In 1896, the Parker shaft was opened, and many new species were found.

Much litigation among the various companies had interfered with production, but in 1897 all the properties were consolidated in the present New Jersey Zinc Co., and the mines were continually productive until 1954 when the Franklin Mine could no longer be worked profitably, and was completely shut down in 1955. The Sterling Hill Mine at Ogdensburg is still expanding.

General Geology

Franklin is located in a zone of Precambrian rocks flanked by Paleozoic inliers. The zinc ores, as well as some iron ores, occur exclusively in Precambrian rocks, generally classified as metasedimentary, igneous and metavolcanic types. A detailed study of the Precambrian geology of this area is to be found in Baum (1957).

The Franklin Marble, which contains the ore, is a crystalline white limestone and dolomite, sometimes siliceous, and characterized by the presence of blocks and bands of dark gneiss which were broken and displaced by the deformation of the marble.

West of the Franklin Marble has been mapped a zone called the "Pochuck Gneiss," which more recently has been described on the basis of mineral assemblage, rather than as a unit formation.

To the east of this area the Precambrian Bryam gneiss outcrops. Baum (1957) divides this into three major types, based on grain as well as mineralogical criteria.

The pegmatites found in the the Precambrian rocks have been divided into sodic and potassic types. The contact zones of these pegamtites are the locale for many of the rare mineral species found in this region.

The Kittatinny Limestone is a thick dolomitic series of early Cambro-Ordovician Age, which outcrops to the north and east of Franklin Pond. The Kittatinny is separated from the Precambrian rocks by longitudinal faults which trend northeast. In the graben at Franklin Pond the Kittatinny shows some post-Ordovician folding, but this is not indicated in the Precambrian rocks.

Origin of the Ore

Many hypotheses concerning the origin of the ores in this area have been advanced, but so far no single hypothesis has satisfactorily explained all the peculiarities present. Pinger (1948) has reviewed and discussed these hypotheses, which come under the following general headings:

1. Igneous injection.
2. Sedimentary ore deposited in the limestone and later metamorphosed.
3. Contact metamorphism due to injection of the pegmatites.
4. Replacement from magmatic solutions.

The hypothesis which comes closest to fulfilling the conditions observed is that of replacement of favorable horizons in the limestone by a primary oxide ore, since elimination of sulphur after emplacement is difficult to explain. Sampson (1957) has given additional detail of features and facts which must be considered in the formulation of a theory of origin.

The minerals which could be considered "rare and interesting" rather than ore minerals, are generally interpreted as "contact" minerals, formed by the interaction of hydrothermal solutions with limestone or dolomitic host rock. The host rock supplied calcium and magnesiu, the magmatic solutions brought in silica, water, and rare elements like boron, fluorine, and beryllium. (See Montgomery, Picking Table, June 1960.)

Route Stops

On the accompanying sketch map (taken from Pinger, 1948) numbers have been placed to locate the areas which we shall visit.

Below is a brief note on each location, but specific information concerning details of the mineral descriptions, paragenesis and associations can be best obtained from the paper by Palache (1935).

<u>Stop No. 1, Sterling Hill</u>:

The Lord Sterling Pits, the earliest known workings (1770) outcropped in the legs of a syncline in the Franklin Limestone, which pitches northeast at an angle of about 50° from the horizontal. Details of the structure are quite complex. About 1913 a shaft was sunk and extensive underground development started.

The ore appears to have followed definite stratigraphic horizons in the folded structure, since the banding of the Franklin Limestone and the complex folding of the ore veins appear to conform. Pegmatites are not present with the ore, so fare minerals are fewer than at Franklin. Minerals reported from this area (other than the common species listed on the chart) include: Chalcophanite, McGovernite, Mooreite, and Roepperite.

Stop No. 2, Farber Quarry:

The Farber Quarry (formerly the Bigelow Quarry) on Cork Hill Road at the Franklin-Ogdens rg line is the only active local quarry.

In this white limestone may be found tremolite in fluorescent crystals, pyrite crystals and calcite, chondrodite, norbergite, magnetite, dolomite, edenite, fluorite, graphite, hematite, phlogopite and scapolite.

Stop No. 3, Slag Heap:

Along the east side of Cork Hill Road are large dark boulders which represent slag from the old Franklin Furnace. Many minerals are present in some of the boulders, and the "vesicles" in the slag show a variety of fillings representing secondary mineralization.

Stop No. 4, B. Nicol Quarry (Formerly the Fowler Quarry):

This was the largest quarry in the area, and was active at the turn of the century as a source of flue for the blast furnace.

It is requested that visitors stay clear of the buildings of the Cellate Corporation, and do not smoke in the vicinity of the buildings or drums.

Recent visits to this quarry have yielded specimens of amphibole, apatite, arsenopyrite, chondrodite, diopside, edenite, fluorite, graphite, magnetite, phlogopite, pyrite, pyrrhotite, pyroxene, quartz, scapolite, spinel and green and brown tourmaline.

Stop No. 5, Furnace Quarry:

This is an abandoned quarry in the white limestone which has yielded many metamorphic minerals, including arsenopyrite, edenite, fluorite, graphite, norbergite, pyrite, pyrrhotite, rose quartz, sphene, spinel and tourmaline.

Stop No. 6, Buckwheat Dump:

In 1852 the eastern leg of the syncline was discovered, and was stripped to form the Buckwheat open cut. Much of the overburden was removed to the dump.

The accompanying key lists 50 minerals which are likely to be found there. Since the town of Franklin turns the dumps over at intervals, fresh materials are exposed, so that there is a likelihood that a variety of species will be available.

In the sheds at the foot of the dumps some long and short wave ultraviolet lamps will be available for determining fluorescent phenomena. Accompanying this paper is a chart describing the fluorescence of Franklin minerals, as observed and as reported in the literature. Not all samples of a given mineral will display the described fluorescence, but it is certain that Buckwheat will yield some fluorescent material.

Stop No. 7, Mine Replica:

The mine replica is an authentic duplicate of a typical working space in the abandoned Franklin Mine, and a display of fluorescent minerals under ultra-violet light. This is an optional trip and involves a 50-cent admission charge. Since only a limited number can be accommodated at one time, arrangements for this visit will be made while the rest of the group is collecting at the various quarries.

This trip also offers a good view of the Buckwheat open cut.

Lunch:

Lunch will be at the Village Inn on Route 23 (sandwiches, homemade pie, coffee - $1.00). Please make your reservation in advance at the registration desk.

Acknowledgments

The Franklin-Ogdensburg Mineral Society have cooperated generously with the committee, and we want to thank both Mr. William Spencer, their president, Mr. Frank Edwards, secretary-treasurer, and all the members and experts on Franklin minerals who have kindly given their time to aid the group in identification of specimens.

We wish also to thank Mr. R. Provost of Cellate, Inc., for permission to visit the B. Nicol Quarry, and Mr. F. M. Dunn for permission to visit the Farber Quarry.

Bibliography

A complete bibliography with annotations is given in the U.S.G.S. Prof. Paper 180, "The Minerals of Franklin and Sterling Hill, Sussex Co., N. J." by Charles Palache, 1935.

New Mineral species are frequently discovered and described, old species restudied for further detail or validation. This material usually is available in relatively short papers in the following publications:

American Mineralogist - Journal of the Mineralogical Society of America. Editor, L. S. Ramsdell.

Franklin Digest - a booklet published annually by the Franklin Mineralogical Association, Box 408, Middleburgh, N. Y. This specializes in reprinting important papers on Franklin Mineralogy.

Notes on Minerals of Franklin and Sterling Hill, N. J. - A quarterly published by John S. Albanese, P. O. Box 221, Union, N. J.

Rocks and Minerals - A bimonthly magazine edited by Peter Zodac, Box 29, Peekskill, N. Y.

The Picking Table - A publication of the Franklin-Ogdensburg Mineralogical Society, Inc., Box 146, Franklin, N. J.

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Brief Key to 50 Common Minerals
(as found in Franklin-Sterling area)

LUSTER - METALLIC

Color	H	Streak	Disting. Properties	Name
Black	6	Black	Octahedrons or massive; no cleavage; strongly magnetic.	Magnetite
	6	Brown	Rounded octahedrons or massive; no cleavage; weakly magnetic.	Franklinite
Gray	1	Black	Folia; greasy feel; flexible; marks paper.	Graphite
	$2\frac{1}{2}$	Gray	Isometric-cubes; perfect (100) cleavage.	Galena
	6	Red-brown	Tabular crystals; no cleav.; parting good.	Hematite
Blue-gray	1	Blue-gray	Hexagonal folia, flexible; marks paper; heavier than graphite.	Molybdenite
Silver white	6	Gray-black	Prismatic striated xls.; massive; imperf. cleav.	Arsenopyrite
Brass-yellow	$3-3\frac{1}{2}$	Greenish-black	Usually hairlike xls., in cavities; not plentiful in Franklin.	Millerite
	4	Greenish-black	Usually massive, tarnished bluish, cleav. imperfect; yellower and softer than Pyrite.	Chalcopyrite
	$6\frac{1}{2}$	Brown-black	Pyritohedrons, cubes, massive; no cleav.	Pyrite
Bronze-yellow	4	Gray-black	Usually massive or "drops" hexag.; no cleav.; tarnishes brown; magnetic	Pyrrhotite
Bronze-brown	3	Gray-black	Tarnishes purple; usually compact; no cleav.	Bornite
Copper-red	3	Red, metallic	Usually dendritic, wires; malleable	Copper

LUSTER - NON-METALLIC

Color	H	Streak	Disting. Properties	Name
Colorless-to-white	2½-3	-	Irregular platy elastic flakes; perf. cleavage.	Muscovite
	3	-	Usually opaque; cleavage rhombic; may be pink, brown; effervesces in dilute HCl; fl. red.	Calcite
	3	-	Usually cleavages - perfect - or massive; heavier than calcite. Fl. pale blue.	Barite
	3½-4	-	Usually crusts on other minerals. Rare, fluor-yellowish cream.	Aragonite
	3½-4	-	Curved rhombic xls.; massive granular; good cleavage.	Dolomite
	4	-	Earthy white films; good cleav.; fl. cream.	Smithsonite
	5	-	Usually translucent - transparent; often cox-comb xls. Good cleav.	Hemimorphite
	6	-	Usually columnar or fibrous; fl. blue.	Tremolite
	6	-	Rare color. May fl-green; cleav. imperf.	Willemite
	6	-	Usually massive; good cleav.; twin planes.	Albite
	7	-	Many small vitreous colorless xls. in pockets.	Quartz
Yellow	5.5	-	Massive, honey colored, opaque.	Chondrodite
	5.5	-	Massive, honey colored. Fl. (at Franklin) buff.	Norbergite
	7	-	Yellow brown, wedge shaped xls.; massive; Fl. red	Axinite
Brown	2½	-	Usually brown, may be green; massive, compact, fibr.	Serpentine
	2½	-	Irregular elastic plates, blackish-brown	Biotite
	2½-3	-	Hexagonal, bronze colored elastic platy xls.	Phlogopite
	3-5½	Yellow-brown	Mustard colored powdery alteration product.	Limonite
	4	Yellow	Usually massive resinous luster, yellow-brown.	Sphalerite

LUSTER - NON-METALLIC (Cont'd)

Color	H	Streak	Disting. Properties	Name
Brown (cont'd)	5-6	-	Orthohombic; massive; conchoidal fract.	Bementite
	6	-	Usually massive, imperf. cleav.; fl. green.	Willemite
	7	-	Good dodecahedrons, or granular massive, may be black (polydelphite). No cleavage.	Garnet (spessartite)
	8	-	Isometric xls - octahedrons. Imperf. cleav.	Spinel (Gahnite)
Gray	6	-	May be massive gran; tetragonal prismatic xls; good cleav.; may fl. orange or yellow.	Scapolite
	$6\frac{1}{2}$		Var. of olivine; granular-massive; good cleavage.	Tephroite
Gray-Green	5		Hexagonal, prismatic xls; good termin. fl. yellow-orange - pinkish.	Apatite-Svabite
	6		Monoclinic, prismatic xls; good (110) cleav.	Diopside
	9		Hexag. prisms, good basal cleav.	Corundum
Green	2		In tiny plates or folia-flexible-deep green.	Chlorite
	4		Usually massive, compact, apple-green.	Malachite
	4	Yellow	Resinous, translucent-fluor. orange.	Sphalerite-cleiophane
	6	-	Imperf. cleav. Fluor. green.	Willemite
	6	-	Good cleav. - 2 directions; Triclinic.	Amazonstone
	6-7	-	Massive, granular, crystalline, medium green.	Epidote
Blue	4	-	Usually massive, granular, light to medium blue.	Azurite

LUSTER - NON-METALLIC (Cont'd)

Color	H	Streak	Disting. Properties	Name
Pink	$3\frac{1}{2}$-4	-	Massive, granular, good rhombic cleav., opaque.	Rhodochrosite
	5.5-6	-	Triclinic - bright pink prismatic xls; massive, granular	Rhodonite - bustamite
	6	-	Salmon-pink. Good cleav. - 2 directions.	Microcline
	9	-	Hexagonal barrel-shaped xls, basal cleavage.	Corundum (ruby)
Red	4-$4\frac{1}{2}$	Orange	Xls rare; usually grains or plates. 1 cleavage.	Zincite
	6	-	Brownish-red, imperfect cleavage. Fl. green.	Willemite
Purple	4	-	Comes in all shades - white, cubic xls, good triangular cleav. faces. Streaks in ls.	Fluorite
Black	6	-	Greenish black, silky luster, columnar xls, prismatic cleavage; wedge shaped.	Amphibole - edenite
	8	-	Isometric xls - octahedrons; imperfect cleavage.	Spinel - gahnite

FLUORESCENT FRANKLIN-STERLING MINERALS

Name	Daylight Color and Characteristics	Iron Arc.	Short Wave	Long Wave
RED FLUORESCENCE				
Corundum	red or green - in ls.	-	weak red	bright red
Rhodonite	pink to brownish pink	-	-	pink to deep red
Calcite	white-pink cleavages		bright red	purple-red
Mooreite	white (may have been mis-identified)		red	
Axinite	yellow, or xlized man-ganaxinite	-	dull red	pale red
Sphalerite	light greenish brown	-	pale red	bright orange
PURPLE FLUORESCENCE				
Barylite	white plates in hedyphane, with willemite	lavender		
Hardystonite	white to pink grains in ls.	violet	violet	purple to none
ORANGE FLUORESCENCE				
Pectolite	colorless or white	yellow	yellow-orange	same
Sphalerite	vitreous green-brown-cleiophane	-	rose-orange	bright orange
Clinohedrite	amethystine-white, vitreous	orange	orange	pale yellow - none
Wollastonite	white, silky, bladed	-	bright orange	pale orange
Svabite	gray apatite	-	yellow-orange	none
YELLOW FLUORESCENCE				
Tourmaline	brown, yellow, green, prisms		yellow	-
Scapolite	white, gray, translucent xls	-	pale	yellow-orange
Cerussite	colorless, white - mainly Sterling	-	pale	bright yellow
Norbergite	honey colored in ls.	-	buff	-
Phlogopite	bronze mica with calcite	-	dull yellow	
Calcium larsenite	white, opaque, greasy luster	lemon-yellow	bright lem. yel.	pale yellow
Willemite	small crystals from Sterling Hill		gold to lemon yel.	-

GREEN FLUORESCENCE

Name	Daylight Color and Characteristics	Iron Arc.	Short Wave	Long Wave
Willemite	massive, resinous, colorless, red, green, black		bright yel. gr.	duller green
Fluorite	gray to purple, compact granular	blue	blue-green	blue-green to none
Apatite	crystals-prisms, translucent blue		pale green	-
Levco phoenicite	brown-purplish red, isolated grains or massive granular		yellow-green	dull green

BLUE FLUORESCENCE

Name	Daylight Color and Characteristics	Iron Arc.	Short Wave	Long Wave
Hydrozincite	white powdery alteration; films, crusts	-	blue to blue wh.	faint white
Hedyphane	small brilliant white to buff xls. Not confirmed.	grayish blue		
Diopside	colorless to gray, basal parting, twinned	-	creamy blue	-
Anorthite	gray tabular crystals in pegmatite	-	pale blue	-
Tremolite	gray or white xls in ls., some fibers		pale greenish blue	-
Thomsonite	var. calcio thomsonite, radial aggregates of fine needles	-	none	pale blue
Nasonite	white, rectangular blocks greasy luster		blue (not confirm.)	
Margarosanite	white, rhombic cleav., colorless, lamella masses	pale violet -blue	pale violet-blue	
Calcite	white, Franklin ls.		bright blue	

WHITE-CREAM FLUORESCENCE

Name	Daylight Color and Characteristics	Iron Arc.	Short Wave	Long Wave
Smithsonite	white crusts and coatings	-	-	yellowish cream
Barite	white, transparent, colorless, plates	-	pale bluish cream	pale blue
Amazonstone	green microcline	-	blue-white	-
Aragonite	white films and crusts	-	white	white
Pectolite	gray-white to colorless, massive	yellow	chalky orange	white

VALIDATED FRANKLIN-OGDENSBURG MINERAL SPECIES

As of February 1961, some 176 species (exclusive of varieties) of F-O minerals have been validated by Professor C. Frondel. Others are being investigated. The order of listing follows Dana, except for the silicates.

Species found only at Franklin or Sterling are marked with an asterisk.

native elements

1113 Silver
1114 Copper
1115 Lead
1211 Arsenic
1242 Graphite

sulfides

2321 Chalcocite
243 Bornite
2611 Galena
2621 Sphalerite
2631 Chalcopyrite
2642 Greenockite
2651 Pyrrhotite
2653 Niccolite
2655 Millerite
26.10 Realgar
2911 Pyrite
2922 Gersdorffite
2931 Loellingite
2933 Rammelsbergite
2934 Pararammelsbergite
294 Marcasite
2951 Arsenopyrite
2961 Molybdenite
2.10.11 Skutterudite

3242 Tennantite

oxides

411 Cuprite
413 Water
4213 Manganosite
4221 *Zincite
4411 Corundum
4412 Hematite
4413 Ilmenite
4511 Rutile
4514 Todorokite
453 Brookite

hydroxides

6111 Brucite
6112 Pyrochroite
613 Manganite

multiple oxides

7122 Goethite
7211 Spinel
7213 Gahnite
7216 Magnetite
7217 *Franklinite
7221 Hausmannite
7222 *Hetaerolite
7223 Hydrohetaerolite
761 *Chalcophanite

unlisted oxides

Birnessite
Hydrohausmannite
Woodruffite

halides

9.2.1 Fluorite

carbonates

14.1.1.1 Calcite
14.1.1.3 Siderite
14.1.1.4 Rhodochrosite
14.1.1.6 Smithsonite
14.1.3.1 Aragonite
14.1.3.4 Cerussite
14.2.1.1 Dolomite
14.2.1.3 Kutnahorite
16.1.1 *Loseyite
16.1.3 Hydrozincite
16.1.4 Aurichalcite
16.1.6 Malachite
16.1.11 Azurite

borates

26.1.1 Fluoborite
26.1.5.1 *Sussexite
26.1.6 *Roweite
27.1.2 *Cahnite

sulfates

28.3.1.1 Barite
28.3.1.2 Celestite
28.3.1.3 Anglesite
28.3.2 Anhydrite
29.6.3 Gypsum
~~29.6.6.1 Hexahydrite~~
31.1.3 *Mooreite
31.1.4 *Torreyite
31.3.2 Ettringite

phosphates, arsenates

38.2.1.2 Manganberzeliite
40.2.4.2 Brandtite
40.2.15.2 Erythrite
41.1.2 *Holdenite
41.1.4.1 *Chlorophoenicite
41.1.4.2 *Mg. Chlorophoenicite
41.2.4 Allactite
41.5.2.1 Descloizite
41.6.3.3 Sarkinite
41.7.7.1 Fluoapatite
41.7.3.1 Svabite
41.7.3.2 Hedyphane

Quartz

Orthoclase
Hyalophane
Microcline
Anorthoclase
Albite
Anorthite

Diopside
Hedenbergite
*Jeffersonite
Johannsenite
Schefferite
Augite

Rhodonite
Bustamite
Wollastonite
Pectolite

Anthophyllite
Cummingtonite
Tremolite
Edenite
Riebeckite
Hastingsite

Cuspidine

Barysilite
Nasonite
Margarosanite
Barylite
*Roeblingite

Grossularite
Almandite
Spessartite
Andradite

Glauchochroite
Forsterite
Hortonolite
Tephroite

*Larsenite
*"Calcium Larsenite"

Willemite

Friedelite
Manganpyrosmalite
*Schallerite

*McGovernite

Scapolite

*Hardystonite

Idocrase

Zircon
Thorite

Sillimanite
Kyanite

Datolite

Zoisite
Epidote
Allanite
*Hancockite

Axinite

Prehnite

Norbergite
Chondrodite

*Leucophoenicite

Kentrolite

Hemimorphite
*Clinohedrite

Tourmaline

Xonotlite
Ganophyllite
Apophyllite
Heulandite
Stilbite
Chabazite
Natrolite
Thomsonite

Muscovite
Biotite
Manganophyllite
Phlogopite

Stilpnomelane

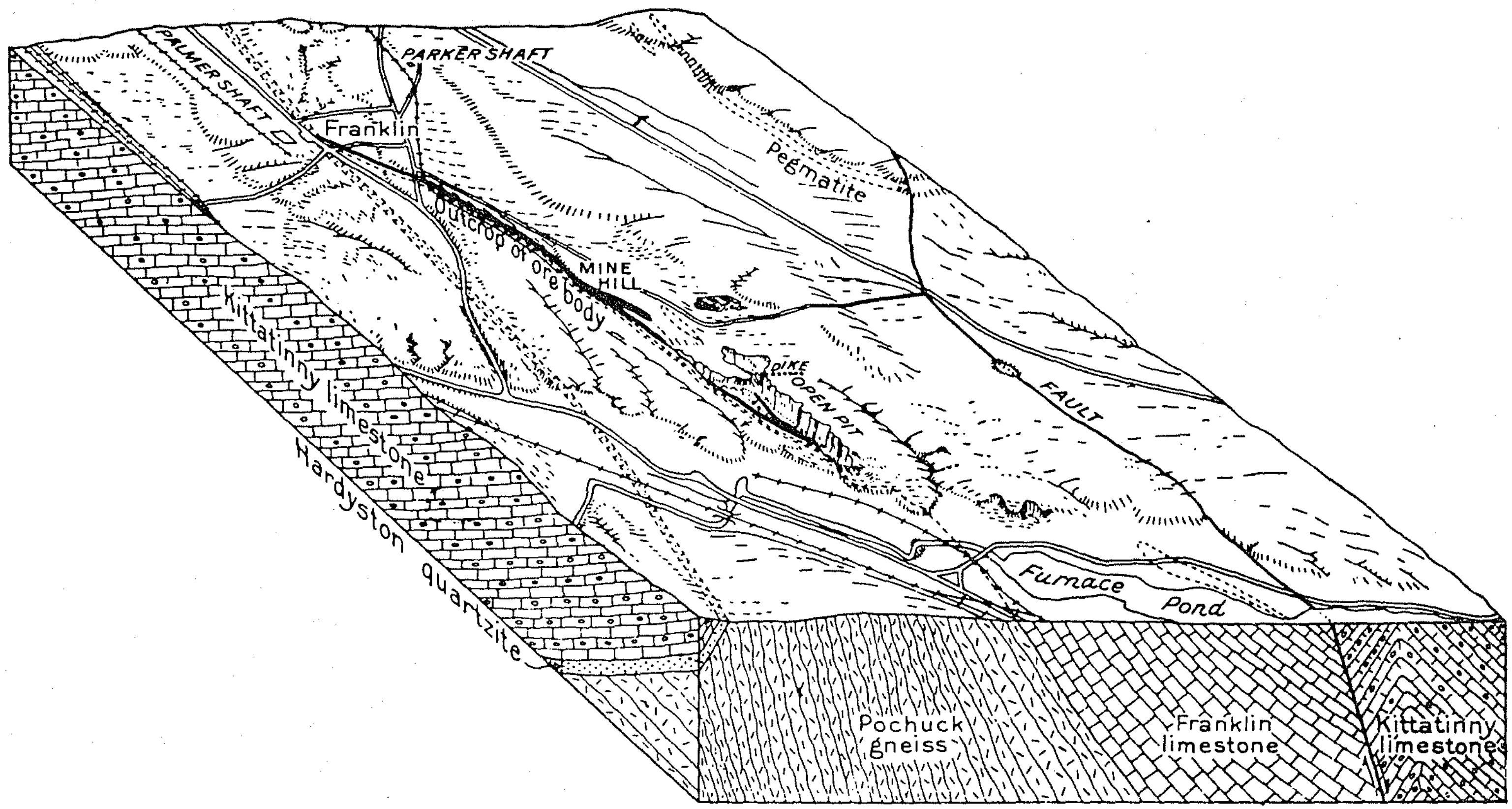
Antigorite
Bementite
Chrysotile

Zimalsite

*Hodgkinsonite
*Gageite

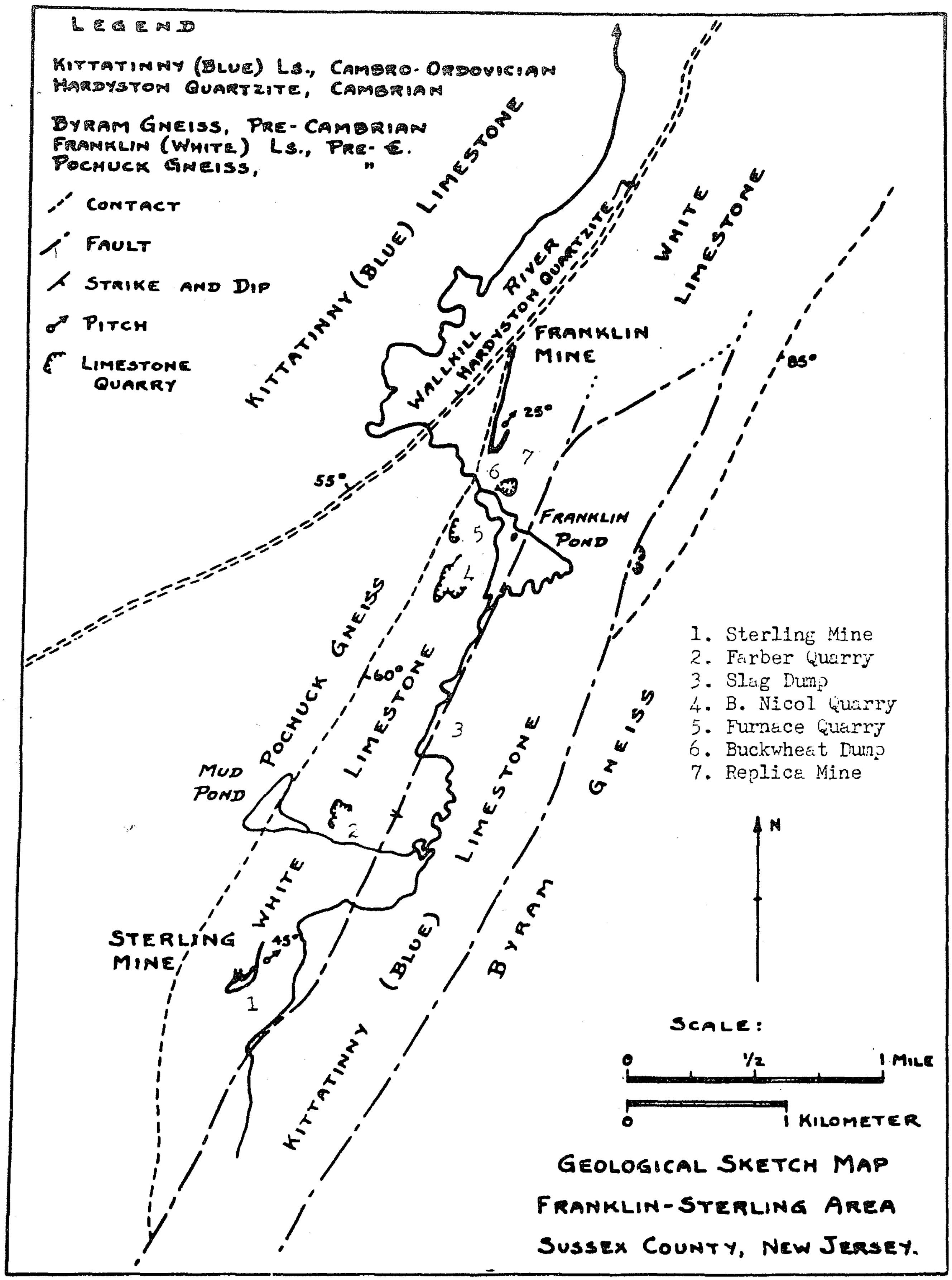
Sphene

Yeatmanite



Block diagram illustrating the general relations of the ore deposits at Franklin, the geography of the surface, and the contacts in the vicinity of the ore

From: Internat. Geol. Congress XVI, Guidebook 8, p.7



From: Geological Society of America, Guidebook, 1948