

Franklinite

Introduction

Franklinite is the official state mineral for New Jersey. The neighboring boroughs of Franklin and Ogdensburg in Sussex County comprise the Franklin mining district and are home to two of the world's most famous zinc mines, the Franklin Mine and the Sterling Hill Mine (fig. 1). These two former mines contained the largest concentration of franklinite in the world where it is found in the zinc ore body of the Franklin Marble. Today, both mines are used as educational facilities and offer tours, exhibits and gift shops.

Franklinite is found with a wide array of minerals, many of which are fluorescent including willemite and

calcite, and may also occur with orange zincite. Twenty-six countries and seven states in the US have reported a minor occurrence of franklinite. However, none of which compared to the quantity as found in the Franklin mining district of New Jersey. The Franklin mining district orebodies are world-renowned and remarkable for their exceptional variety of mineral species, and the characteristics of the minerals contained therein.

Approximately 400 different mineral species have been identified within these two mines, including approximately 14 rare minerals that have never been found elsewhere in the world, one of them being franklinfurnaceite (Dunn and others, 1987). In 1968, Franklin was declared the "Fluorescent Mineral Capital of the World" due to how many fluorescent minerals occur here. It is still commonly referred to by this name.

The question of how the ore deposits formed has been debated for decades. The discovery of sea-floor hydrothermal (metal-rich, hot, circulating water) vent deposits in the 1960's led to the thought that the zinc ores formed in a hydrothermal system during the Mesoproterozoic Era (1.6 billion to 900 million years ago) (Johnson and Skinner, 2003). The limestone, altered in a hydrothermal system, was later buried and heated to high-grade (granulite facies) metamorphism. Evidence supports that the minerals were produced by high-grade regional metamorphism associated with the Grenvillian orogeny (1.08 billion to 980 million years ago) during the assembly of the supercontinent of Rodinia. Orogeny is a process in which a section of the earth's crust is folded and deformed by lateral compression to form a mountain range. This means a specimen of franklinite ore is slightly older than 1 billion years old!

Franklinite (fig. 2), a metamorphic mineral, has a striking black color. Specimens of franklinite showing both iridescence and opacity are common and have a metallic to dull luster (Palache, 1935). Franklinite is paramagnetic, meaning that it is weakly magnetic. At one time franklinite was used to produce many different products. Large crystals of previous mining eras are no

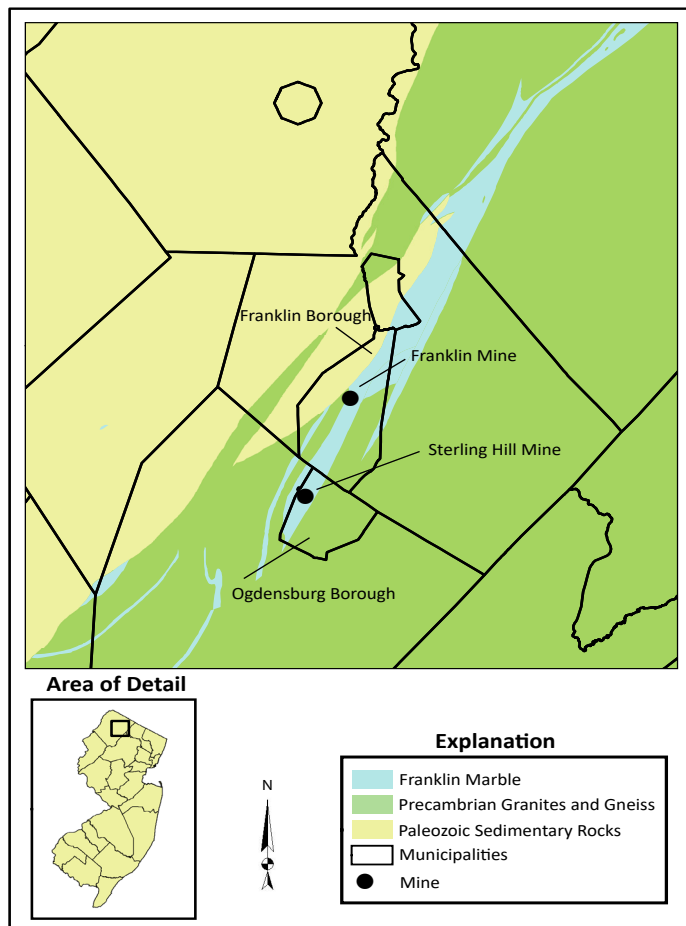


Figure 1. Generalized geological map showing the location of the Franklin and Sterling mines in the Franklin Marble.

longer found. Today, franklinite has a worldwide reputation and is a mineral much sought-after by collectors.

History

Little was understood about franklinite when it was first discovered in the 1700's as it was often mistaken as magnetite, an iron oxide mineral. Both are black and magnetic, though franklinite's magnetism varies. Because of this, franklinite drew the attention of the early settlers since magnetite was a desired iron mineral. After the mining of franklinite began, efforts to



Figure 2. Franklinite. (Photo, J. Dooley)

smelt this new mineral were unsuccessful. Franklinite requires a higher temperature than magnetite for true successful smelting, and the technology of the time produced only a semimolten mass from which liquid iron refused to separate. Higher temperatures were needed than could be produced in the early charcoal-fired furnaces.

William Maclure (1763-1840), an American-Scottish geologist, visited the Franklin mining district (fig. 3) in the early 1800's and was intrigued by the ore there. He sent samples of franklinite and zincite to Pierre Berthier, a French geologist, in 1819. Berthier discovered franklinite's chemical and mineralogic nature and named it for the location in which it was first found (Franklin, NJ), to honor the American scientist, Benjamin Franklin (Berthier, 1819).

William Maclure, credited with publishing the first geologic map of America (Maclure, 1809), is known as the 'father of American geology' (Aber and Aber, 2015). As iron mining began to dwindle,



Figure 3. Franklin Mine, Franklin Furnace, New Jersey. (From G. W. Baker, 1881).

zinc found in the form of zincite, franklinite, and willemite became the focus of the mining efforts in the Franklin mining district. These zinc minerals were found in such abundance that the Franklin and Sterling Hill mines were home to two of the greatest zinc deposits on earth.

Uses of Franklinite

Franklinite had little to no known use for a long period of time after first being discovered in the mid-1700s. There was no commercial value attached to franklinite until the 1850's when advances in furnace technology allowed extraction of the zinc contained in the franklinite to be separated from the iron. Until this discovery, the franklinite ore was left underground or thrown into piles near the mines.

Quickly after the process to separate zinc from franklinite was discovered, a furnace and mills were built in Newark, New Jersey in 1851 to process the franklinite ore. Because of its iron content, franklinite's slightly magnetic property was utilized to separate franklinite from the accompanying ores using a large magnetic separator after a crushing process (Jackson, 1850). This began the common utilization of franklinite for many products.

One of the earliest uses of franklinite was as an ingredient in brown paint (Jackson, 1850). Brown paint made from franklinite was even used in the House and Senate wings of the United States Capitol in Washington, D.C. during construction in the 1850s. The original brown paints that were made by the New Jersey Zinc Company were used as a factory-applied, rust-inhibitive primer on the cast-iron door and window enframements installed at the Capitol (Welsh, 2008).

The main use of franklinite would be as an additive in iron and steel making. Strong, durable iron made with manganese-bearing franklinite was used in many products including steamboat shafts, railroad cars, axles for train engines (Tenney, 1854), and horseshoes (Robinson, 1862). Franklinite as an additive to iron and steel was valued for the extra durability it gave extending the life of iron and steel products.

Franklinite was also notably used to strengthen safes. Herring & Company, a major safe manufacturing company in the US during the mid-1800's, began manufacturing its safes with franklinite. The steel-plate safe walls made with franklinite were touted as making the safes practically burglar and fire proof due to the strength of the manganese in franklinite. Many banks, insurance companies and others businesses around the world in search of the most impenetrable safes purchased safes made with New Jersey franklinite ore (New York Times, 1862).

Mineralogy

Franklinite is a zinc, iron and manganese mineral of opaque black color. Franklinite often occurs as octahedral crystals with eight triangular crystal faces (fig. 4), but additional faces are commonly present. Rounding of the crystal edges is common resulting in rounded franklinite grains (fig. 5). It is a moderately hard mineral (5.5 to 6.5 on Mohs hardness scale) with a high specific gravity (5.07 to 5.22), (Palache, 1935) meaning it feels heavy in the hand.

Franklinite's chemical composition differs from magnetite as there are varying amounts of zinc and manganese rather than mainly iron (table 1). Magnetite is strongly magnetic while most franklinite is paramagnetic, however, franklinite can range from strongly to weakly magnetic depending on the

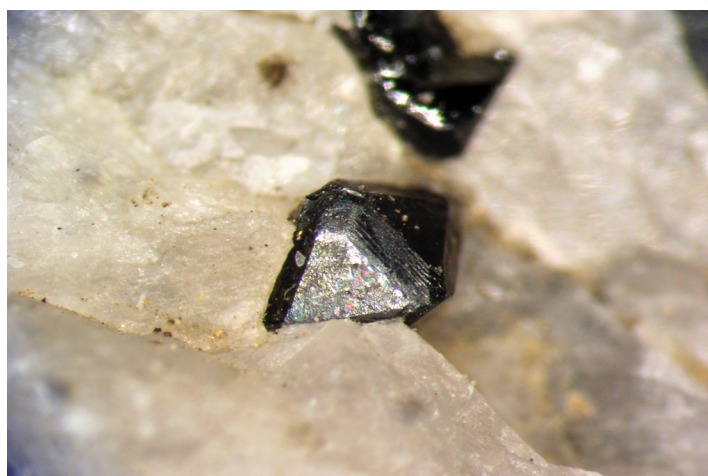


Figure 4, An isolated, dominantly octahedral franklinite crystal in coarsely crystalline calcite of the Franklin Marble. (Photo. J. Dooley)



Figure 5. An example franklinite grains (black) and calcite (white). (Photo, D. Harper)

amounts of zinc, manganese, and ferrous iron present. Magnetic franklinite is attracted by electromagnets used in separating machines to assist in the collection of the mineral from other associated zinc-ore minerals.

Table 1. Chemical Formulas for Franklinite, Magnetite, Willemite, and Zincite.

<u>Name:</u>	<u>Chemical Formula:</u>
Franklinite	$(\text{Zn}, \text{Mn}^{+2}, \text{Fe}^{+2})(\text{Fe}^{+3}, \text{Mn}^{+3})_2\text{O}_4$
Magnetite	$\text{Fe}^{+2}\text{Fe}^{+3}_2\text{O}_4$
Willemite	Zn_2SiO_4
Zincite	ZnO

The Franklin and Sterling Hill mines are both famous for abundant, brilliantly fluorescent minerals that glow in a variety of colors under long and short-wave ultraviolet (UV) light, however, franklinite is not a fluorescent mineral. When looked at under a UV light, franklinite will remain black while other fluorescent minerals around it glow bright, unique colors, such as pink and green (fig. 6). A specimen can be checked for fluorescence with a UV light in a dark space.

Summary

New Jersey once led the nation in iron production (25 million tons: Bayley, 1910: Sims, 1958). These magnetite deposits in the Highlands drew in settlers who mined the land from the late seventeenth to the mid twentieth century. Unknown to the settlers at the time, franklinite was mistaken as magnetite and often mined alongside of it. Franklinite was eventually recognized as a new mineral species. It is now highly prized by the mineral-collector community.

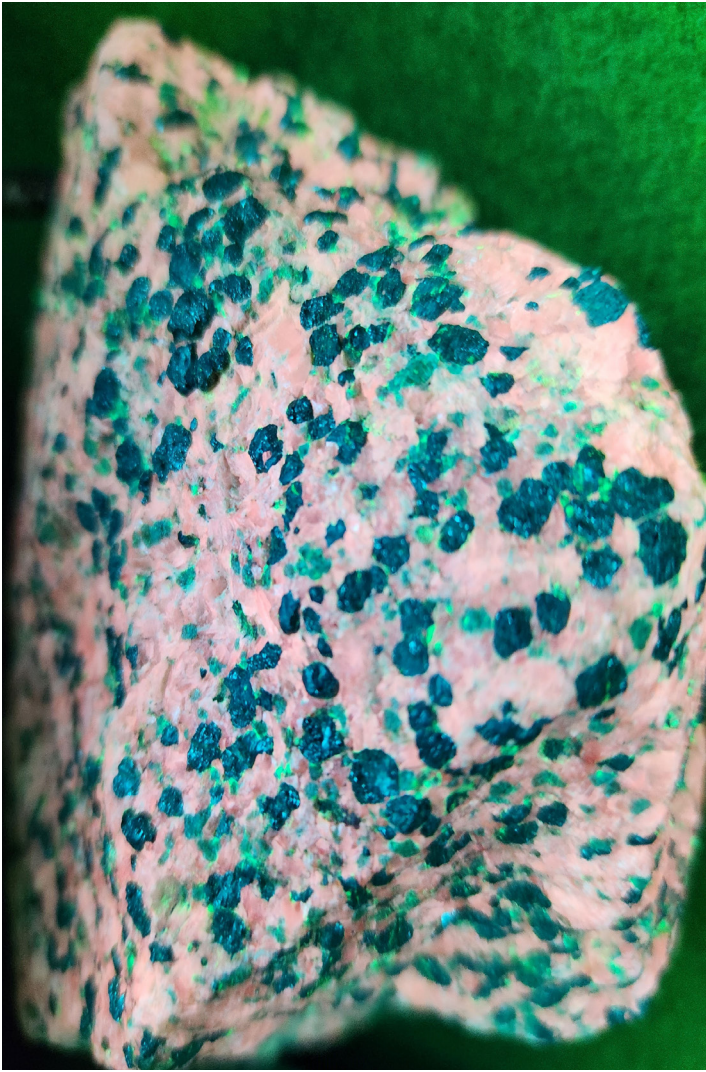


Figure 6. Ogdensburg, New Jersey ore viewed under ultraviolet and visible light. The reflected visible light accounts for the unusually pale pink color of the calcite (which normally fluoresces a saturated orange-red color) plus the visibility of textural detail in the franklinite, which otherwise under UV would appear dead black. (Photo, T. Pallis)

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STATE OF NEW JERSEY

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Prepared by John Dooley, Cailey Green and Ted Pallis

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Comments or requests for information are welcome.

NJGWS, P.O. Box 420,

Mail Code 29-01, Trenton, NJ 08625

609-292-1185

<https://www.njgeology.org/>

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To download a copy of the New Jersey Geological and Water Survey Information Circular, **Franklinite and the New Jersey State Symbols - Lesson Plan**, go to the link below.

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Banner photographs:

Photograph # 1, Franklinite, Photo, J. Dooley

Photograph # 2, Franklin Mine, Photo, Library of Congress

Photograph # 3, Franklinite surrounded by glowing willemite, Photo, T. Pallis

Photograph # 4, Sterling Mine headframe, NJGWS file photo