

The Franklin Marble: One of New Jersey's Most Famous Geologic Formations

Introduction

Few rocks in New Jersey are as attractive or as well known as the Franklin Marble, which displays a virtual rainbow of colors from white, to light gray, pale pink, orange, pale green, or pale blue. Samples of Franklin Marble are displayed in many museum exhibits nationally and internationally because of its importance as host rock for the world-famous zinc-iron-manganese deposits at the Franklin and Sterling Hill mines in Sussex County. These deposits contain more than 350 minerals, of which 90 are fluorescent. If ever there were a contender for the official state rock of New Jersey, Franklin Marble would certainly be among those at the top of the list.

Early in the study of the state's geologic history, all marble was simply called white or crystalline limestone (Cook, 1868). The name "Franklin white limestone" was first introduced by Wolff and Brooks (1898) for marble at the zinc deposits in Franklin Borough. This was later shortened to "Franklin limestone" on one of the early state geologic maps of New Jersey (Lewis and Kümmel, 1910-1912), and in contemporary publications of that time (for example, Spencer and others, 1908; Kümmel, 1940). New Jersey Zinc Company geologists (Hague and others, 1956) referred to the marble at the Franklin mine as the "Franklin Marble". This is perhaps the earliest use of the name in the literature, and it has since been retained as a formal name on the bedrock geologic map of New Jersey (Drake and others, 1996).

Franklin Marble

Marble in New Jersey occurs only in the New Jersey Highlands Province (fig. 1) where it makes up about two percent of the rock exposed there. It is most abundant in the northwest part of

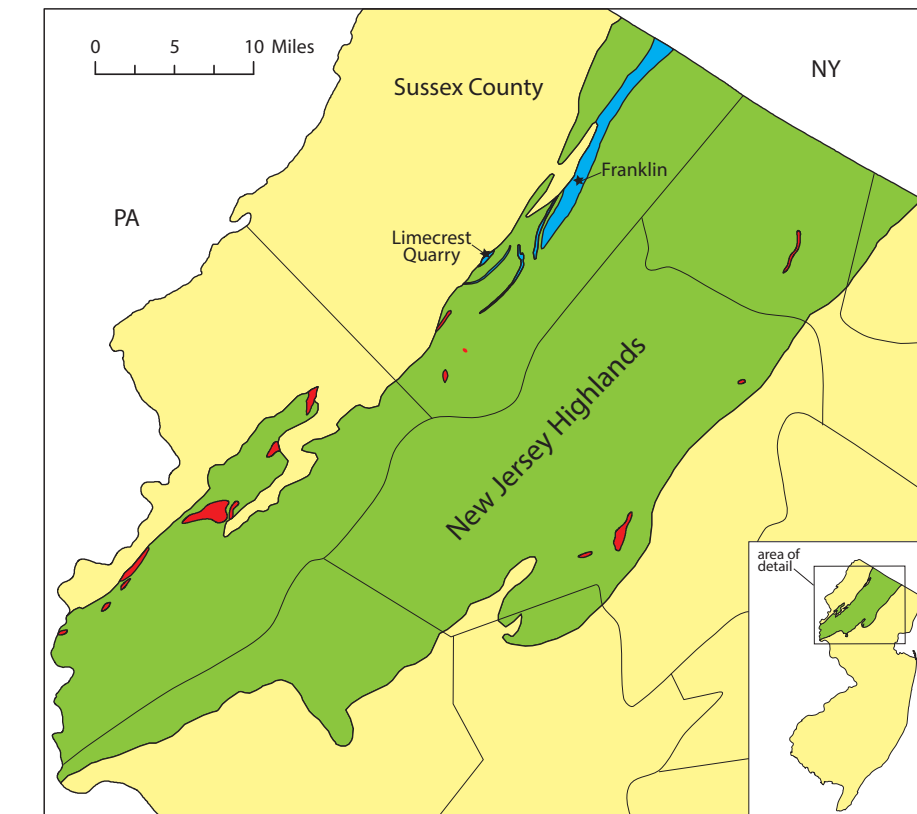


Figure 1. Distribution of the Franklin Marble (shown in blue) and other uncorrelated marble deposits (shown in red) in the New Jersey Highlands.

the area, where it forms a nearly continuous 21-mile-long belt in Sussex County. Marble also crops out in small, detached bodies in the southwestern and eastern Highlands. Although these rocks are similar in most respects to Franklin Marble, geologists are unable to positively correlate them to the marble at Franklin. Franklin Marble is characteristically medium to coarse-grained and texturally massive (fig. 2). It consists mainly of the mineral calcite (calcium carbonate), but may also contain varied amounts of other minerals such as graphite, phlogopite mica, and various silicate and non-silicate minerals. Marble is a metamorphic rock. That is, it must be converted or metamorphosed from a sedimentary precursor of similar composition.

Because of marble's high calcium content, its importance as lime to condition agricultural soils has long been

known. As a result, Franklin Marble was quarried extensively during the 20th century, although most of the quarries are no longer in operation. Less well known, but equally important, was the use of Franklin Marble from the Limecrest Quarry (fig. 1) in Sussex County, by Thomas Edison in 1906 as pulverized lime in the making of cement.

Despite nearly a century and a half of scientific inquiry into the Franklin Marble, some very important questions remained unanswered. These included: 1) the age of the marble; 2) the conditions of its metamorphism during burial in the Earth's crust; 3) the specific type of environment in which it formed; and 4) its geologic relationship to other rocks in the New Jersey Highlands. Answers to these questions were obtained between 2004 and 2009 by the author, in collaboration with other scientists, through



Figure 2. Outcrop of fairly typical coarse-grained Franklin Marble from near Franklin, Sussex County. Lens cap for scale. Photo by Rich Volkert.

detailed geologic mapping and studies using geochemistry, combined with interpretation of the isotopes of carbon, strontium and uranium-lead.

Age and Origin of the Marble

The age of the Franklin Marble could not be determined directly because the rock lacks appropriate minerals for dating. Instead, volcanic gneisses lying directly beneath and above the marble were dated at 1294 and 1299 million years using isotope analysis of uranium and lead (Volkert and others, 2010). Because these gneisses formed contemporaneously with the marble, an age of about 1295 million years was interpreted for the time of deposition of the limestone precursor of the marble.

Uranium-lead isotope analysis also provided a precise age of 1050 million years for the time of metamorphism from limestone into marble. Using isotopes of carbon to calculate the equilibrium relationship between calcite and graphite in marble, a temperature of 769°C (about 1,400°F) was determined for the peak of metamorphism (Peck and others, 2006). During this metamorphism, the precursor limestone was buried to a depth of about 13 miles in the Earth's crust where it

recrystallized into the metamorphic rock marble. Many of the 350 minerals in the marble were formed at this time, either from layers of different chemical composition or from metamorphic fluids intruded into the rock about 1000 million years ago (Volkert and others, 2005).

The environment in which the Franklin Marble formed was determined using several lines of evidence. Based on previous geologic studies of

the marble, as well as recent geologic mapping by the New Jersey Geological and Water Survey, combined with detailed geochemical and isotope studies of the bedrock, some of the gneisses and marble were interpreted as forming in an ocean setting in a basin located off the ancestral North American continental margin (Volkert and others, 2010). A chain of volcanoes similar to those of the present-day Cascade Mountains in the Pacific Northwest was situated farther to the east (fig. 3). The carbon and isotope values (Peck and others, 2006), and the strontium isotope values of calcite in the marble showed they formed in seawater. Additionally, fossil colonies of single-celled algae known as stromatolites were discovered in the marble (fig. 4), confirming that it formed in an ocean environment. During the collision of eastern North America and ancestral South America at about 1050 million years ago, rocks in the New Jersey Highlands were buried deep in the Earth's crust where they were metamorphosed. They were later uplifted and are now exposed at the surface following erosion of the rocks that once covered them.

It's not often that geologic conditions combine to form something as unique and famous as the zinc-iron-manganese deposits in Sussex County hosted by the Franklin Marble. In fact, only one other location in the world, Långban, Sweden, has a marble-hosted

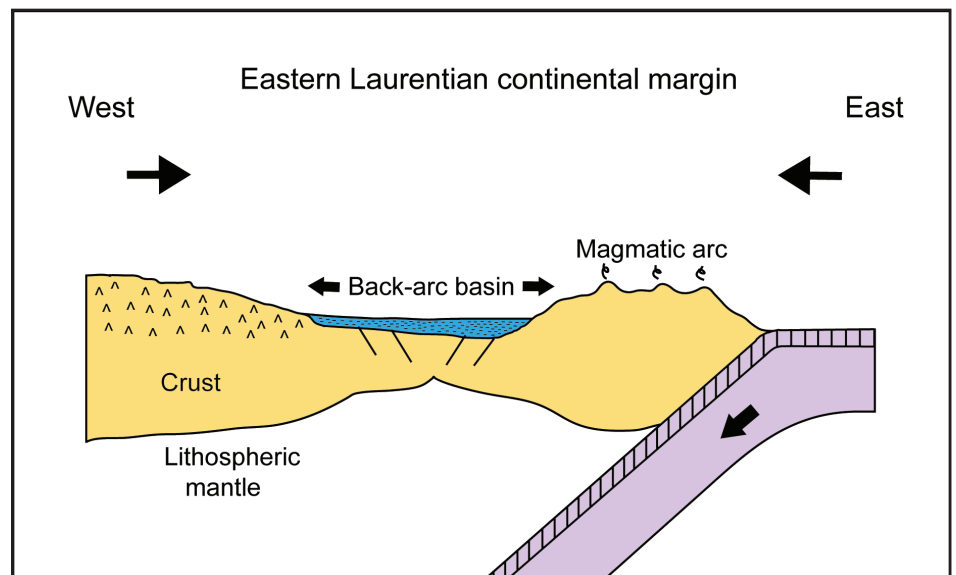


Figure 3. Simplified diagram showing back-arc basin in which the limestone precursor of Franklin Marble was deposited. Basin formed between the continental margin to the west and a volcanic arc and subducted ocean crust (lavender) to the east.

deposit of comparable rarity. New Jersey is fortunate in that its geologic past has provided us with one of the world's geologic masterpieces. The next time you are looking for some adventure, consider going to the Sterling Hill Mining Museum (www.sterlinghillminingmuseum.org) at Ogdensburg Borough and the Franklin Mining Museum at Franklin Borough, to see these fascinating deposits and the Franklin Marble, one of the state's most famous geologic formations.

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Figure 4. Wavy-laminated, dark gray colonies of stromatolites (beneath ruler) in Franklin Marble. Photo by Brett Kent.

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2013

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