## TINGUAITE AND BOSTONITE IN NORTHWESTERN NEW JERSEY

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ABSTRACT

The possible utilization of tinguaite and bostonite intrusions in northwestern New Jersey is given. The petrography of these rocks is discussed.

### INTRODUCTION

In Sussex County, northwestern New Jersey, there is a zone of alkali-rich intrusions which parallels the northeastward strike of the enclosing Martinsburg shale, of Ordovician age, from half-way between Libertyville and Sussex southwestward to $1\frac{1}{2}$ miles southwest of Wykertown. These intrusives as a group have been briefly described by Wolff.[1] Individual intrusives have been mentioned by Parker,[2] and Milton and Davidson.[3] About 2.5 miles northwest of this zone is the better known intrusion of nepheline syenite described by Emerson,[4] Kemp,[5] Iddings,[6] Wolff,[7] Aurousseau and Washington,[8] Wilkerson,[9] and Parker.[10]

The possible utilization of these rocks for ceramic use (glass making) has led several investigators to re-examine the area. In 1937 the United States Bureau of Mines,[11] and in 1945 the Rutgers University Bureau of Mineral Research,[12] came to the conclusion that from the main nepheline syenite area northwest of Beemerville a product acceptable for glass making could not be obtained.

[1] Wolff, J. E., Post-ordovician igneous rocks: *U. S. Geol. Survey, Folio* **161,** 13 (1908).

[2] Parker, J. M., New Jersey's potential feldspar resources: *Rutgers University Bureau of Mineral Research,* **5,** 57 (1948).

[3] Milton, C., and Davidson, N., An occurrence of natrolite, andradite, and allanite in the Franklin Furnace quadrangle, N. J.: *Am. Mineral.* **35,** 500–507 (1950)

[4] Emerson, B. K., On a great dyke of foyaite or elaeolite syenite, cutting the Hudson river shales in N. W. New Jersey: *Am. Jour. Sci.,* (3) **23,** 302–308 (1882).

[5] Kemp, J. F., The elaeolite syenite near Beemerville, Sussex County, New Jersey: *N. Y. Ac. Sci., Tr.* **11,** 71, (1892).

[6] Iddings J. P., Nepheline syenite from Beemerville, Sussex County, New Jersey: *U. S. Geol. Survey, Bull.* **150,** 209–211 (1898).

[7] Wolff, J. E., Leucite tinguaite from Beemerville, N. J.: *Harvard Coll. Mus. C.Z. Bull.* **38** (Geol. Ser. 5), 273–277 (1902). Wolff, J. E., *op. cit.,* pp. 12–13.

[8] Aurousseau, M., and Washington, H. S., The nepheline syenite and nepheline porphyry of Beemerville, N. J.: *Jour. Geol.,* **30,** No. 7, 571–586 (1922).

[9] Wilkerson, A. S., Nepheline syenite from Beemerville, Sussex County, New Jersey: *Am. Mineral.,* **31,** 284–287 (1946).

[10] Parker, J. M., *op. cit.,* p. 53.

[11] Metcalf, R. W., Feldspar chapter in Mineral Yearbook, 1938 (Review of 1937): *U. S. Bur. Mines,* 1218 **(1938).**

[12] Wilkerson, A. S., and Comeforo, J. E., New Jersey nepheline syenite: *Ceramic Age,* **48,** no. 3, 103–104 (1946).

The northeastward-trending zone of somewhat closely spaced intrusions consists of tinguaites and bostonites. Although fair to good quarry sites and good roads are usually available, and ample tonnages are often possible above ground water level, and the overburden consists only of residual soil and some boulders; however, the fineness of grain, the locally relatively large amounts of mafic constituents present, the alteration of the feldspar and/or nepheline, and the local presence of numerous mafic inclusions in the feldspar and/or nepheline make all the rocks of the zone unsuitable for glass manufacture. Some of the rocks are probably suitable for roofing granules and most could be used for local road ballast. These facts have also been stressed by Parker.[13]

Following is presented a detailed petrographic description of the rocks of this northeastward-trending zone. The area was re-mapped and several intrusions are located differently from their positions as originally shown in the Franklin Furnace folio. The mislocation of one of the dikes was first called to our attention by Parker.[14]

## Petrography

### *Tinguaite*

Intrusions of tinguaite occur at nine localities: nos. 1, 3, 4, 5, 6, 7, 13, 14 and 15 (see Fig. 1). In length they range from 150 ft. (no. 6) to 2400 ft. (no. 3); in width they range from 50 ft. (no. 6) to 150 ft. (nos. 1 and 13). The usual strike is N 35° E to N 50° E and apparently follow the strike and dip of the enclosing Martinsburg shale, although contacts are not exposed. At locality no. 15 the tinguaite occurs as a dike with an eastwardly trend and is seemingly vertical. These intrusions, as well as those of bostonite to be described, usually form low-ridges in an otherwise flat or gently rolling country.

The rock is medium gray to dark gray in color but locally has a slightly greenish tint. Usually it is altered, and fresh specimens would be difficult to obtain. In texture it is aphanitic or porphyritic. Phenocrysts of feldspar 2.5 cm.×1 cm. in size, cross-sections of greasy appearing nepheline, about 5 mm. in diameter, and biotite crystals 1.5 mm. across locally are prominent against the gray or greenish-gray groundmass. There is a wide range in the phenocryst-to-groundmass ratio, which varies from 5 per cent (no. 3) to 50 per cent (no. 7), but the phenocrysts normally comprise about 20 per cent of the rock. The phenocrysts are orthoclase, microperthite, nepheline, biotite, and aegirine-augite. Feldspar and nepheline are present usually in approximately equal amounts and great-

[13] Parker, J. M., *op. cit.*, pp. 55, 57.
[14] Parker, J. M., *op. cit.*, p. 54.

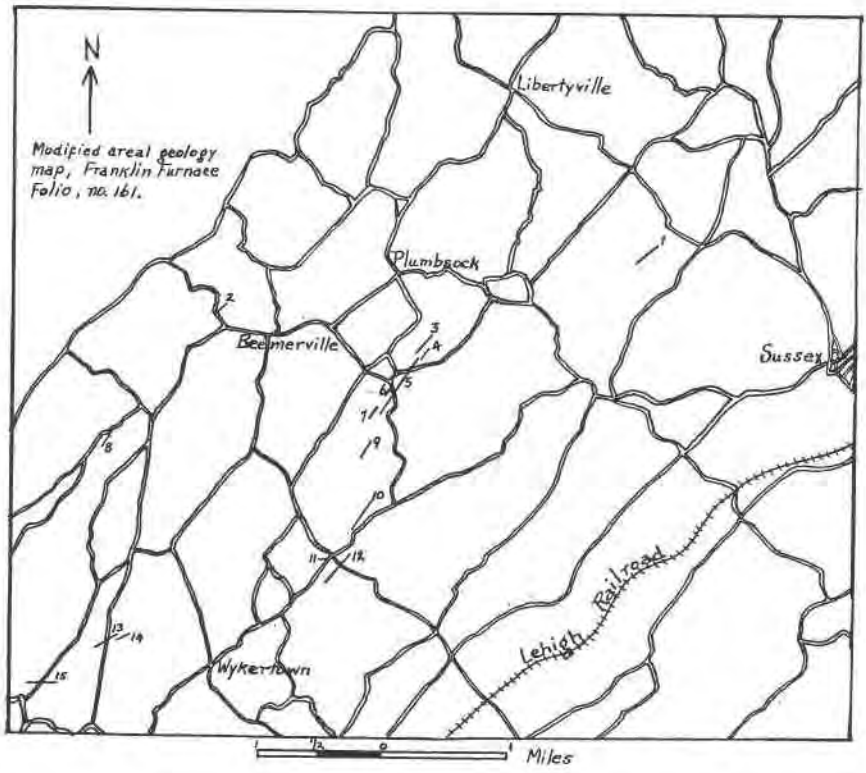


FIG. 1. Index map showing locations of intrusions.

ly exceed the quantity of either biotite or pyroxene.

Feldspar phenocrysts seldom attain a size greater than 10 mm.×3.5 mm., are subhedral, and are frequently twinned on the Karlsbad law. They frequently have numerous inclusions of all the primary minerals, but especially nepheline. Much of the feldspar is altered to clay materials and a colorless mica; locally it is altered to calcite or epidote; locally sodalite replaces portions of the orthoclase.

Phenocrysts of nepheline seldom are greater than 6.0 mm.×3.0 mm. in prismatic sections. Sphene and soda pyroxene are the most common inclusions. Much of the feldspathoid has altered to a colorless mica and calcite; locally to sodalite. Some phenocrysts have been completely altered and are recognizable only by their hexagonal outline.

Biotite seldom comprises as much as 10 per cent of the phenocrysts and usually does not exceed 1.5 mm.×0.75 mm. in size. Inclusions of sphene and apatite are common. Where unaltered the pleochroism is: X = light yellow, Y = Z = reddish brown. Biotite usually is much altered,

however, to a mixture of chlorite, magnetite, locally epidote, and some calcite.

Aegirine-augite seldom comprises as much as 10 per cent of the phenocrysts and usually is not greater than 3.0 mm.×0.05 mm. in size. Pleochroism is: X=pale greenish brown, Y=medium yellow-brown, Z =medium greenish brown. It is usually rimmed with aegirine. Sphene is the only inclusion.

The groundmass is a fine aggregate of nepheline, orthoclase, microperthite, biotite or soda pyroxene, sphene, apatite, magnetite, and zircon, stated in the usual sequence of decreasing abundance. Nepheline and feldspar occur in relatively the same amounts and generally together comprise about 90 per cent of the minerals. Biotite or soda pyroxene seldom is present in an amount greater than 15 per cent. At the middle portion of the sill at location 5 and at location no. 15, garnet comprises 10 per cent of the minerals. The size of the minerals of the ground mass varies slightly in the different intrusions, but the average size is 0.50 mm.×0.10 mm. to 0.10 mm.×0.05 mm. Locally there is an ill-defined flow structure.

Nepheline usually occurs as small squares and as prismatic sections 0.50 mm.×0.20 mm. in size. Locally it contains inclusions of soda pyroxene and magnetite. Much is altered to a colorless mica, calcite and cancrinite but usually it is less altered than where it occurs as phenocrysts.

Orthoclase is more abundant than microperthite. Both occur in subhedral to anhedral forms, and infrequently orthoclase is twinned on the Karlsbad law. The usual size is 0.40 mm.×0.10 mm. Somewhat common are inclusions of nepheline, sphene, apatite, and zircon. Orthoclase is less altered than where it occurs as phenocrysts, but much of it has altered to a colorless mica and calcite. Parker[15] states that nepheline and orthoclase at no. 15 are considerably altered to cancrinite and melilite, which locally compose about 12 per cent of the rock.

Anhedra of biotite, some containing inclusions of aegirine, are partially to almost completely altered to chlorite, magnetite, and calcite.

Aegirine exceeds aegirine-augite in quantity in the groundmass and occurs as small prisms 0.15 mm.×0.03 mm. in size. The pleochroism of aegirine is: X=blue-green, Y=yellow-green, Z=pale yellow to colorless.

Sphene, magnetite, apatite, and zircon also occur. Highly birefringent sphene occurs as wedges, some of which are twinned and which measure up to 1.3 mm ×1.0 mm. in size. Locally sphene comprises one per cent of the mineral assemblage. Locally it is altered to leucoxene, other places to calcite and anatase in shades of blue.

[15] Parker, J. M., *op. cit.*, p. 57.

Magnetite locally comprises 5 per cent of the groundmass. It usually is only 0.02 mm. to 0.30 mm. in diameter. Much is altered to red iron-oxide.

Apatite occurs in prisms up to 1.5 mm.×1.1 mm. in size but usually it is 0.30 mm.×0.10 mm.

At location no. 6 garnet(?) of undetermined variety occurs in perfect dodecahedrons. It has completely altered to an aggregate of a fine, black, opaque substance part of which is magnetite, or to this opaque material plus biotite and/or calcite and/or chlorite. The average size of the crystals is 0.08 mm. in diameter and comprises 10 per cent of the mineral assemblage. At location no. 17 garnet, variety melanite, is dark brown in color. These crystals, which average 0.10 mm. in diameter and seldom attain a diameter greater than 0.3 mm., are frequently so filled with small inclusions of nepheline and orthoclase that melanite occurs here as skeleton crystals.

*Bostonite*

Intrusions of bostonite occur at six locations: nos. 2, 8, 9, 10, 11, and 12. In length they range from 200 ft. (no. 2) to 1400 ft. (no. 12); in width they range from perhaps 1 or 2 feet (no. 8) to 125 ft. (no. 12). All but one strike N 35°–45° E and, since contacts are not exposed, are apparently conformable with the bedding of the Martinsburg shale. The strike of the intrusion at location 11 is N 80° E and thus cuts across the strike of the shale.

The rock is medium gray to dark gray but locally has a greenish hue. In texture it is aphanitic and usually porphyritic. Phenocrysts of weathered feldspar up to 8 mm.×1.5 mm. in size usually are identifiable. At locality no. 11 the rock has a scoriaceous appearance due to numerous solution cavities.

Under the microscope the bostonite is holocrystalline, fine grained, and porphyritic except at locations nos. 8 and 12 where it is fine grained, hypautomorphic-granular. At location no. 8 the rock is composed almost entirely of tabular orthoclase crystals, 0.3 mm.×0.03 mm. in size, with outlines that are moderately sutured. It has a trachytic texture. At location no. 12 it is composed essentially of orthoclase laths and microperthite which average 0.80 mm.×0.13 mm. in size and which contain numerous inclusions of aegirine and magnetite. Here the feldspars have a rough trachytic texture; locally they have a tendency to sperulitic groupings. At all other localities phenocrysts of orthoclase and microperthite comprise about 10 per cent of the rock. They seldom exceed 2.5 mm.×1.5 mm. in size and are moderately altered to clay materials, a colorless mica, and calcite.

The groundmass has a rough trachytic texture. The principal constituent is orthoclase, but at location no. 11 there is also microperthite. The feldspar, normally 0.25 mm.×0.10 mm. in size, makes up 95 per cent of the mineral assemblage. Much of the feldspar is altered to a colorless mica and calcite. Locally a small amount of plagioclase ($Ab_{68}$ at no. 2 and $Ab_{90}$ at no. 11) is present. Aegirine, with pleochroism in yellow and shades of green, occurs in irregular bunches and as needles up to 1.0 mm.×0.02 mm. in size. At locality no. 9 aegirine comprises 30 per cent of the minerals but usually the amount does not exceed 5 per cent. Remnants or 'ghosts' of biotite are numerous, the biotite having altered to chlorite and magnetite. Sphene locally altered to leucoxene, magnetite altered to red iron oxide, and unaltered apatite and zircon are invariably present in minor amounts. Many irregularly shaped patches of calcite are present. Locally, as in portions of the intrusions at nos. 2, 8 and 11, a small amount of nepheline may have been present but has altered to cancrinite and a colorless mica.

## TORBERNITE IN MISSOURI FIRE CLAY

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Torbernite, $Cu(UO_2)_2P_2O_8 \cdot 12\ H_2O$, hitherto unreported from Missouri, has been found filling thin cracks in a fire clay deposit of Pennsylvanian age in the north central fire clay district of Missouri. The occurrence is about 14 miles east of Auxvasse and $4\frac{1}{2}$ miles south of Martinsburg, on a farm owned by Mr. Robert Bailey.

Metatorbernite was reported by Grawe (1943) from a fire clay deposit near Gerald, Missouri, in the diaspore region south of the Missouri River, about 50 air miles from the torbernite occurrence. An isolated find of carnotite near Ste. Genevieve, located about 80 air miles southeast across the flank of the Ozark dome was reported by Muilenberg and Keller (1950).

The torbernite occurs in a soft, gray, semi-flint fire clay which has been open-pit mined intermittently. A pocket or seam of torbernite-bearing clay was encountered in a shallow prospecting shaft at a depth of about 10 feet below the upper surface of unweathered fire clay. Rain water filled the shaft which was abandoned and the water has remained high in the shaft ever since, due to the impervious nature of the clay. The writer did not see the walls of the shaft before water filled it, but collected the torbernite from the subsequently slaked fire clay which had been thrown out of the shaft. The clay is typical of Missouri Cheltenham (Keller, 1946) semi-flint fire clay.

The torbernite occurs invariably in a thin coating or scales on the clay