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CHARLES D. WALCOTT, DIRECTOR

THE GEOLOGY

OF

EASTERN BERKSHIRE COUNTY

MASSACHUSETTS

BY

BENJAMIN KENDALL EMERSON

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AMHERST COLLEGE,
Amherst, Mass., July 6, 1898.

SIR: The accompanying work is presented for publication as a bulletin of the United States Geological Survey. It is supplementary to the text of the Housatonic folio of the Geologic Atlas of the United States, and should be used in connection with the maps and sections of the folio.

Very respectfully, your obedient servant,

B. K. EMERSON.

Hon. CHARLES D. WALCOTT,
Director United States Geological Survey.

THE GEOLOGY OF EASTERN BERKSHIRE COUNTY, MASSACHUSETTS.

By B. K. Emerson.

INTRODUCTION.

The country here described is represented on the Becket and Sandisfield sheets, and in Bear[1] Mountain extends into the area of the Sheffield sheet, of the topographical map of the State of Massachusetts. On the east it adjoins the territory discussed by the author in a recent monograph of the United States Geological Survey.[2] On the north it is bounded by the Hoosac Mountain area, which has formed the subject of a monograph by Professors Pumpelly and Wolff.[3] It is a section across the Green Mountain chain in Massachusetts, a deeply eroded region of pure Appalachian type, composed of sharply folded pre-Cambrian and Paleozoic crystallines.

This territory forms part of a deeply trenched plateau, and along the western border of the area the ground sinks by a steep scarp to the low limestone valley of the Housatonic. Upon the upland the surface is underlain by a series of pre-Cambrian anticlines, more or less overturned to the west, which form an almost continuous band across the State. They are included in a much broader band of Cambrian conglomerate-gneisses. The Cambrian quartzite and the Stockbridge limestone rise somewhat onto the upland from the west, and the Cambrian gneisses dip steeply beneath newer sericite-schists along the east border of the area.

The axes of the folds strike mainly north and south, but in the western-central part of the tract they bend in great curves to the west, even into sickle shape, and in extreme form are overturned and at the same time bent in curves, producing a complex, fan-like structure.

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[1] The United States Board on Geographic Names has decided that the name used for this mountain in the publications of the United States Government shall be Bear, and not Beartown. The author of this bulletin states that there are other "Bear" mountains, and that this mountain will always be known in the region as Beartown Mountain.—Editor.

[2] The geology of Old Hampshire County, Massachusetts, by B. K. Emerson: Mon. U. S. Geol. Survey, Vol. XXIX.

[3] The geology of the Green Mountains in Massachusetts, by R. Pumpelly, J. E. Wolff, T. Nelson Dale: Mon. U. S. Geol. Survey, Vol. XXIII.

TOPOGRAPHY.

The region under discussion preserves distinctly the form of a plateau. A most striking topographical feature of this plateau is its rapid sinking on the west to a limestone plain 1,000 feet above sea level. Where the limestone penetrates far east into the crystalline area, in Dalton, East Lee, and Tyringham, it is sunk to the same low level as in the open valley to the west, and that this is due to the solubility of the limestone is suggested by the fact that the Cheshire quartzite, much more exposed and softer, is preserved across the central part of Washington fully as far to the east and at a much higher level.

A low crest line runs N. 10° W. through Peru, in the northeast corner of the area considered, rising to 2,295 feet 2 miles south of the center of the town and continuing north as the crest line of Hoosac Mountain (Spruce Hill, 2,480 feet). From this crest line the plateau sinks slightly westward to where its bluffs look down on the Housatonic Valley, with the highest peaks rising from 1,740 feet in the northern part of the area to 2,075 feet in the central part.

In the southern half of the area the bluff which has formed the western edge of the plateau clear across the State extends westerly in Bear Mountain (1,865 feet), facing northward for several miles, and is then lower and less pronounced across the southern half of the area, sinking to 1,750 feet across New Marlboro.

Also in the southern half of the area another broad crest, replacing the first, rises on the west side of the plateau, reaches 2,120 feet in Becket Mountain, and broadens to the south across Tyringham and New Marlboro. These crests sink gradually toward the south. A broad but slight depression, occupied by many ponds, crosses the area between the crests, from Hinsdale to the Otis reservoir.

There is also a southeastward sinking of the level from the second crest line to 1,450 feet at the southeast corner of the area, so that the plateau dips west in its northern half and east in its southern half.

The watershed follows the first crest for several miles, then crosses the depression transversely to the west, and continues down the western crest. This throws most of the drainage into the Connecticut River, though the watershed makes a wide detour to the east around the headwaters of the Housatonic.

This watershed crosses three well-marked wind gaps or valleys, which are not occupied by any water course but from which tributaries of the Housatonic flow northwest and those of the Connecticut southeast. These are (1) the deep canyon between Washington Station and Becket, occupied by the Boston and Albany Railroad; (2) the prolongation of the East Lee Valley at Greenwater Pond; and (3) the less marked upland prolongation of the low Tyringham Valley which connects with the Clam River Valley. These wind gaps form the centers of the three important transverse features of the topography. The deep limestone bay of Dalton is continued in the pre-Cambrian basin of Hinsdale at a higher level, and this narrows into the Becket Canyon, which is continued in the Westfield River Valley across the whole range. Thus is formed the only passageway for a railroad across the range.

The Dalton limestone bay was caused by the removal of the Stockbridge limestone, which here penetrates far into the mountain mass. East of this bay the greater solubility and consequent erosion of the gneisses and limestones of the overturned pre-Cambrian anticline has caused the broad Hinsdale depression where the anticline is wide; and the same anticline narrows and becomes vertical where it bends southeastward, making the deep canyon which extends from Washington Station to North Becket.

The divide is now at Washington Station, and the Housatonic, coming down from the Washington Hills, flows north across the low depressions here mentioned and swings around to the south, following the larger limestone valley; the Westfield River flows south through the canyon and then southeast until it joins the Connecticut.

From Becket eastward the position of the Westfield is normal, depending on the original southeast slope of the plateau and disregarding the geological structure, except that it seems somewhat influenced by faults. Above this point the structure has controlled the course of the stream from Washington to Becket and forced it into the canyon; and the drainage also seems to have been inverted, that from Dalton, Windsor, and Hinsdale, which formerly went into the Westfield River at Washington, being now carried westward by the Housatonic. If the course of the Housatonic from Dalton south be inverted, nearly all the tributaries on the west would then flow southeast in normal relation to it. A similar statement is true of several of those on the east in so far as they have not come under the influence of the limestone, which has by its solution produced long ponds and deflected several streams into them. Indeed, each lobe of the pre-Cambrian has become the bed of a brook.

The present course of the Housatonic across Hinsdale is complicated by the extensive glacial lake deposits in that town. When the ice had just shrunk away from the uplands and still filled Pittsfield Valley and the Dalton bay, the valley of the Westfield became a main outlet for the glacial waters, which widened above Becket Canyon into a lake across the low ground of Hinsdale and Washington, producing the broad sand flats that extend across this area and the great delta flat which rises just east of Hinsdale station and extends to the Center. Its lobed southward-facing front, swinging in a great loop between these two places, is well marked on the map. The extremely sinuous course of the Housatonic is due to its passage, with slight fall, across these fine sands.

The notch across the mountains seen in the East Lee-Farmington River Valley is formed in a similar way. The Stockbridge limestones project but little into the East Lee Valley of pre-Cambrian limestones, but this valley is prolonged into the Farmington River Valley, which cuts clear across the range. In its lower third, from New Boston south, the stream runs in a narrow gorge cut by itself without regard to the substructure and controlled by the old surface of the base-level plain over which it began its flow. The middle third is controlled in some degree by the Otis fault (see map, Pl. IX). The northwestern third is controlled similarly to the Hinsdale area, by the solution and erosion of the limestone and the formation of the deep East Lee Valley along the long and narrow anticline which sweeps in a broad curve from East Lee to West Becket.

South of the southern end of Greenwater Pond there is a low divide in the deep valley bottom. South of this point the waters flow into the Farmington River; north of it they flow, by Greenwater Pond Brook, into the Housatonic. This brook seems also to indicate a reversed drainage, as the tributaries make obtuse angles with the main brook and seem to have once been tributary to a southeast stream.

The Dalton phase is lacking here, as the Stockbridge limestone does not penetrate the crystallines.

The great Lenox fault at the foot of the mountains cuts across the mouth of the valley and gives access to it by dropping the western half of the Tyringham pre-Cambrian below the bottom of the Housatonic Valley.

In the Tyringham Valley, next south, the limestones once penetrated far southwest along the Tyringham fault, but have now been mostly cleared out from the deep, narrow valley, which is abruptly closed at its lower end but continues at a much higher level to connect with the transverse valley of Clam River, which joins the Farmington River at New Boston.

One can dimly discern in the Tyringham Valley a fragment of pre-Cambrian topography and its explanation. In the Hop Brook gorge, at the head of the valley, the pre-Cambrian limestones appear as the core of an anticline, which ends, with sharp southeastern pitch, near the mouth of Hayes Pond. This anticline extends along the axis of the valley beneath the Cambrian and appears in its middle at the Brookside mill below the "Cobble," and its erosion in pre-Cambrian times can be said, with considerable probability, to have formed a long, narrow bay, into which the progressive transgression of the Cambrian sea brought first the sand beds of Cambrian times and then the deep-water calcareous deposits which formed the Stockbridge marbles that once filled the valley. The steep southern pitch of the limestone core of the anticline at its south end caused the abrupt termination of the valley in that direction.

In a similar way a curious topographical feature was formed in the basin of Goose Pond. A long, narrow, curved anticline brought the limestone to a level where it could be reached by solution and erosion, and this deep linear depression is the result.

In Monterey the limestones extend again far eastward, and their solution has produced a broad upland valley and a westerly drainage whose limits are quite closely coincident with the former area of limestone.

Finally, in the southern portion of the area there are many small ponds occupying pre-Cambrian limestone areas and surrounded by Cambrian gneisses, where I suspect that the solution of the limestone has caused the caving in of the gneisses, and that their final removal by the ice has produced these small and peculiar land-locked ponds.

HISTORICAL SKETCH OF THE BUILDING OF THE PLATEAU.

The country is now a central section of a deeply eroded mountain region of Appalachian type, sharply folded, and overturned northwesterly by forces acting from the east.

The pre-Cambrian rocks were folded and eroded—no one knows how much—in pre-Cambrian time, and toward the close of that time a deep north-south depression occupied the position of the present Housatonic Valley, extending far westwardly, and lateral valleys branched from it to the east up the present Tyringham, East Lee, and Dalton valleys.

The great transgression or passage of the waters across the region from the west, which introduced the Cambrian era, admitted water into this valley system, and as it advanced it deepened them so that limestones were formed in the valleys, while just east sandstones and conglomerates were laid down nearer the shore line, and there are many transitions from limestone to sandstone. The waters stretched west to the foot of the Adirondacks and continued east across Massachusetts, surrounding a large pre-Cambrian area which extends from the southeastern part of Worcester County across Connecticut to the mouth ot the Connecticut River, and reaching some large land body east of the present coast which furnished the material for the abundant conglomerates that appear in the Cambrian gneiss at Monson and in the Hudson arkose in Hudson and Marlboro and in Worcester County, and stretch far northeast into Maine, marking perhaps an old shore line near which the altered eruptives in the Marlboro region were extruded.

The continued sinking of the land, which sent the shore line so far east, beyond the region here studied, caused the conglomerates to change into sandstones, and these into shales which have now become the Rowe hydromica-schists and which are represented in Worcester County by the Paxton whetstone-schist.

Shales continued to be deposited in the east after the partial uprise of the Stockbridge limestone caused it to be covered by the shales which have become the Berkshire schists and which are continued east in the Goshen and Conway schists, and by the Brimfield schists east of the Connecticut. These may be about on the horizon of the Lower Trenton beds.[1]

The increased folding brought nearly all this area above the level of the sea and produced the Bernardston Upper Devonian basin on the

[1] The Washington limestone, by Dr. C. H. Richardson: Proc. Am. Assoc. Adv. Sci., 1898, p. 295.

Connecticut, and the Worcester late Devonian or Carboniferous basin, both apparently opening toward the north.

For the later movement of folding and crushing, the New York horizontal Paleozoic country is the unfolded "foreland" toward which the folds advanced; the "rearland," or country from which the pressure came, has sunk into the Atlantic off the present east coast; the great bands of granite which cross the middle of the State are the eruptives on the concavity of the folded ranges melting up in the great synclines. Here, in the core of the range and a long way west across the foreland, eruptives of the time of the folding are wanting.

The Connecticut and Housatonic valleys are "graben,"[1] or long narrow areas sunk between faults. These faults bound the intermediate block or "horst" which forms the Green Mountain upland. It is simpler to assign them both to the same pre-Triassic era.

Erosion has since worn the mountain range down to its roots, and the "Cretaceous base-level" thus formed may have extended, with some approach to horizontality, across the area and westward, touching the crests of the Taconics and of Greylock and Mount Washington, to the north and south, respectively. If this be true, all the later irregularities would depend upon the unequal capacity for erosion of the two areas, especially upon the solubility of the limestone. The alternative would be that the great depression of the Housatonic limestone valley was in some large part caused by the later downthrow of the limestone area between faults already established. The former supposition seems to me more probable. It would place the downthrow wholly before the Cretaceous base-leveling.

GEOLOGY.

I have distinguished the following subdivisions of the pre-Cambrian and Paleozoic rocks in the Becket and Sandisfield quadrangles, which are described in this paper.

SECTION OF PRE-CAMBRIAN AND PALEOZOIC ROCKS IN WESTERN MASSACHUSETTS.

SILURIAN.

West of the pre-Cambrian.	*East of the pre-Cambrian.*
BERKSHIRE SCHIST.	ROWE SCHIST.
Chloritic hydromica- or sericite-schist.	Light greenish gray sericite-schist, grading southwardly into a feldspathic mica-schist.
STOCKBRIDGE LIMESTONE (upper part).	HOOSAC SCHIST.
A white sugary marble, often tremolitic, with included schist and quartzite beds.	Dark-gray albitic sericite- (hydromica-) schists.

[1] Suess, Das Antlitz der Erde.

CAMBRIAN.

West of the pre-Cambrian.

STOCKBRIDGE LIMESTONE (lower part).

CHESHIRE QUARTZITE.

White sugary quartzite, often tourmaline bearing.

BECKET GNEISS.

A light-gray, fine-grained, two-mica- or biotite-gneiss, often conglomeratic, with subordinate beds of quartzite and schist.

East of the pre-Cambrian.

BECKET GNEISS.

A light-gray friable gneiss, often granitoid.

PRE-CAMBRIAN.

WASHINGTON GNEISS.

Rusty, graphitic, and garnetiferous blue-quartz gneiss, becoming fibrolitic toward the south.

TYRINGHAM GNEISS.

Coarse, highly stretched biotite-gneiss, barren of accessories.

LEE GNEISS.

A perfectly banded, medium, black, hornblendic gneiss, sometimes alternating with a white, fine-grained, often micaless, gneiss.

HINSDALE LIMESTONE.

Coarse, highly crystalline, chondroditic limestone.

HINSDALE GNEISS.

Coarse, granitoid biotite-gneiss, often epidotic.

PRE-CAMBRIAN ROCKS.

INTRODUCTION.

A long series of isolated outcrops of pre-Cambrian rocks occupies the western rim of the high ground which extends from north to south across the eastern portion of Berkshire County and looks down on the limestone valley of the Housatonic. They form the axis of the Green Mountains across Massachusetts. (See map, Pl. IX.)

The most northerly outcrops of the pre-Cambrian within the limits of the State are the area of Stamford gneiss of Oak Hill, north of North Adams, and that stretching along the crest of the Hoosac Range south of the tunnel. These have been described in detail by Professors Pumpelly and Wolff, and their relations to the inclosing Cambrian gneiss have been elucidated in a work which marks an epoch in the investigation of the crystalline rocks of New England.[1]

The Hoosac area is described as consisting of "a coarse granitoid gneiss which forms the core of Hoosac Mountain proper, occupying the

[1] The geology of the Green Mountains in Massachusetts, by R. Pumpelly, J. E. Wolff, and T. Nelson Dale: Mon. U. S. Geol. Survey, Vol. XXIII.

surface of the mountain for several miles, then disappearing below the overlying rock, but cut in the Hoosac tunnel for nearly 5,000 feet." It is called the Stamford gneiss. It is "a coarse-banded gneiss, composed of long lenticular crystals of pinkish feldspar, flattened lenses of blue quartz, and thin, irregular, greenish layers of a micaceous element (biotite or muscovite, or both) mixed with small epidote crystals."[1] It varies but slightly in microscopic and macroscopic characteristics, and Professor Wolff does not attempt to subdivide it in the field or to decide whether it is an eruptive granite or a highly metamorphosed member of a detrital series.[2] Specimens have been taken from the material of this age brought to the surface in the central shaft of the Hoosac tunnel to illustrate pre-Cambrian gneissoid granite in the educational series of rocks distributed by the United States Geological Survey.

All the other outcrops of the series are described in this bulletin, beginning with the Hinsdale area in the Becket quadrangle, which is traversed by the north and south portion of the Boston and Albany Railroad, and extending south across that and the Sandisfield quadrangle. The series continues southwest across Connecticut and New York to the Highlands. Several of these areas extend a little way over into the Sheffield quadrangle on the west, and Professor Hobbs thinks that the Cambrian gneisses are worn through, exposing small areas of the pre-Cambrian, on Warner Mountain in Great Barrington and on Brush Hill in Sheffield. The Canaan Mountain pre-Cambrian enters the Sheffield quadrangle, but not the State of Massachusetts. There are thus twenty-three pre-Cambrian areas in the western part of the State.

These areas change progressively as they cross the State. The Hoosac Mountain area is a monotonous mass of coarse porphyritic, granitoid gneiss of doubtful, but probably eruptive, origin.

The Hinsdale area is a closely appressed and slightly overturned anticline, exposing a nucleus of ancient epidotic gneiss surrounded by a thick bed of highly crystalline, chondrodite-limestone, and this by a band of dark gneisses, while the series is closed by a rusty graphitic blue-quartz gneiss. The whole is in apparent conformity, and no striking unconformity marks its contact with the surrounding Cambrian gneisses. On the west of this anticline the blue-quartz gneiss alone is exposed in the Dalton anticline as the core of a normal fold, in sharpest unconformity to the Cambrian conglomerate.

Widely separated on the east, the Coles Brook limestone band is thrust up irregularly through the Cambrian gneisses. It is extremely long and narrow, and the dark East Lee gneiss accompanies it at its southern end.

To the south of these the broad Tyringham area shows extensive bands of a barren and monotonous coarse biotite-gneiss (the Tyring-

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[1] Loc. cit., p. 45.

[2] Loc. cit., pp. 47, 48.

ham gneiss) characterized by such extreme stretching that the biotite masses are drawn out into long pencils, and foliation surfaces of the rock appear as if fingers had been dipped in ink and drawn across them. This is bordered by the Washington blue-quartz gneiss, the upper member of the series, and strips of this rusty blue-quartz rock are infolded as synclines in it, while the East Lee dark-banded gneiss appears as anticlines. When the latter is worn through, the limestone, or the pyroxene-wernerite or actinolite rock which represents it, appears. In the northern part of the Tyringham area the pre-Cambrian is in apparent conformity with the Cambrian gneisses above, but in the southern part it is in plain unconformity with them. In the latitude of Otis village the blue-quartz gneiss begins to be fibrolitic, and this character becomes more and more pronounced toward the south. The broad Sandisfield area is a low dome which scarcely exposes anything except the Washington gneiss—there a rusty fibrolite-gneiss rarely showing blue quartz and allanite, which extends into Connecticut and carries small beds of chondrodite-limestone.

Finally, in the small areas to the southwest, which are exposed by the solution of the limestone and the sinking and removal of the Cambrian gneisses, the rock is still more strongly ferruginous than farther north, and much magnetite, pyrite, and pyrrhotite appear.

From Campbell Falls south long bands of a dark schistose biotite-gneiss occur, which are full of rounded nodules of microcline largely changed to muscovite and full of fibrolite. The same occur in the southern part of the Sandisfield band.

This change in the character and arrangement of the pre-Cambrian rocks has had a marked influence upon the topography of the range throughout its course across the State of Massachusetts.

In the solid block of the Stamford gneiss the pre-Cambrian composes the crest of the mountain range, while farther south its limestones have by their solution formed all the passes across the mountains and many rock-bordered ponds.

HINSDALE ANTICLINE.

A large portion of the towns of Hinsdale and Washington is occupied by this area of pre-Cambrian rocks, which form an anticline closely appressed and slightly overturned to the west. It is 12 miles long and 4 miles wide. For the greater portion of its length its axis is north and south, but it narrows at its southern end and bends southeastward in sympathy with the Tyringham anticline, ending in the river bed a mile below North Becket station. It also sends an irregular fold southwestward past Washington Center. To the north it ends in several lobes projected far into the town of Windsor.

The east-west fault which limits the Dalton anticline on the south extends far into the center of this anticline and nearly bisects it. As a result, it is much more sharply folded to the south of this fault, forming a compensation for the fold of the Dalton anticline, which is only partly continued in a slight fold south of the east-west fault.

The Hinsdale anticline is taken as the type of the pre-Cambrian areas, since it is the only one which exposes a gneiss older than the Hinsdale limestone and the one which shows the pre-Cambrian rock series in the fullest way. For this reason the names of the different subdivisions have been mainly drawn from this tract.

HINSDALE GNEISS.

This rock emerges from beneath the Hinsdale limestone and lies in the bottom of the Hinsdale Basin. The upper pre-Cambrian gneisses and, in an even more marked way, the Cambrian gneisses form an unbroken line of high hills around it on every side.

The great area of deeply rotted rock which surrounds the Washington station and which was sheltered from the erosive action of the ice suggests that the whole basin was deeply decomposed at the beginning of the Glacial period and was thus in part excavated by the ice.

The only place where it can be studied in considerable outcrops is on both sides of the roads forming a square a mile north of Hinsdale Center. The commonest rock along the western road of the square is a light-colored, well and coarsely bedded, epidote-biotite-gneiss (see detailed description, page 23, and fig. 1 of Pl. I, p. 26). The large, curved-faced feldspars are mostly crushed to a granular mass, and the result is a rock somewhat like the white Cambrian gneiss, but much firmer and coarser and often showing muscovite of secondary origin on the foliation faces. Other beds are compact and massive and show some blue quartz, which is rare in the Hinsdale gneiss.

Farther north along this road the rock is a coarse granitoid feldspar-quartz mass, rudely foliated by distant biotite-epidote films, and in places strongly stretched. Rocks of this type extend north into a great double-topped hill and make up its western crest.

A peculiar altered limestone bed about a rod thick can be followed from north to south along the top of this western crest. It is mostly changed to silicates, among which tremolite in coarse blades forms beautiful cabinet specimens, and a green clinochlore in coarse plates is very abundant. It is in places broken up into a series of great lenses which run along the strike. This is plainly a result of the solution of part of the limestone and the compression of the gneiss around the remnants. One of these lenses is a mass of hornblende-pyroxene-epidote-calcite rock with eozoön structure.

This limestone appears north of the road running southeast from the center of Hinsdale, near the creamery. The rock is a rusty thin-bedded gneiss, with traces of a layer of limestone, now almost wholly changed to a coarse salite-actinolite-graphite-calcite rock. A shaft was sunk 16 feet deep on this rock in 1885, in search of graphite, and later, in 1895, more digging was done at the same spot in search of iron. The adjacent rock is exceptional on this horizon, and resembles the Washington gneiss which surrounds the basin as the newest member of the pre-Cambrian series. It lies in the middle of the anticline.

On the eastern road of the square, layers of very dark gneiss carrying much biotite and hornblende alternate many times with the common gray biotite-gneiss and are shot through by small pegmatite veins.

This structure is very characteristic across the eastern peak of the double hill already mentioned. Bands of the two rocks only 3 to 10 inches thick and preserving their widths for long distances, alternate regularly, and the lighter rock weathers more easily into deep grooves, bringing out strongly the continuous strike or in places the great contortions of the bed. This bed can be followed south about 2 miles.

The most interesting type of the Hinsdale gneiss and the most accessible outcrops are 50 rods north of Hinsdale station, on the west side of the railroad. The gneiss rests directly upon the limestone, the rocks being there overturned, and dips 35° SE. It is a peculiar, fresh, coarse gneiss of very white color, although it contains a jet-black biotite in considerable quantity. (See detailed description below.)

These rocks seem characteristic of the horizon just under the limestone, and there is a similar curious rock developed on a similar horizon at the northwest corner of the square of roads mentioned above. It is a coarse flesh-colored gneiss made up almost wholly of feldspar, with a foliated structure imparted by widely separated streaks and flat blotches, all stretched in a common direction and containing a dark-green fibrous hornblende, epidote, and dark-brown titanite.

Structure.—There is a marked prevalence of northerly strikes and moderate easterly dips in the structure planes of the coarse gneisses, and when separate beds can be traced they take the same direction. This agrees with the posture of the limestone bed which surrounds the Hinsdale gneiss.

If the limestone bed at the creamery is an integral part of the series, it is not improbable that the whole may be of sedimentary origin. It makes, however, the impression of a very coarse and not greatly altered granite.

PETROGRAPHICAL DESCRIPTION.

Biotite-microcline-gneiss.—Fifty rods north of the railroad station at Hinsdale is a coarse, white, biotite-epidote-microcline-gneiss of granular texture. In its lower layers the fresh black biotite is in widely separated films mingled with epidote grains. In its upper layers the biotite is aggregated into flattened lenticular biotite-epidote masses, placed an inch apart in the foliation planes. The mass of the rock is a dull white mixture of much feldspar and a little pale bluish quartz. It contains pyrite in small pentagonal dodecahedrons and submicroscopic zircons of a dark clove-brown color. The feldspar which forms nearly the whole mass of the rock is uniformly microcline in large cleavage pieces, which are granulated at the border and included in broad patches of the granulation mosaic. The remaining fragments are strongly and regularly curved in the cleavage faces, but show no trace of the intergrowth of albitic bands. Sections parallel to OP (001) show with the lens small, rounded, opaque spots, which on examination prove to be bodies placed in the intersection of the two twinning systems. They are cylindrical, with rounded ends, and seem to be muscovite crystals elongated parallel to the *c* axis and slightly twisted; often a slight, lateral pressure has changed them into a pile of overlapping scales. An immense number of epidote grains, small crystals, and microlites, and many minute-lobed plates of biotite are evenly distributed. This multitude of inclusions causes the opaque-white look, but there does not seem to be any trace of kaolinization or weathering. It is epidotization due to metamorphism proper.

The feldspar has the complete microcline structure and pronounced prismatic cleavage, and large patches are still untwinned microcline.

The quartz contains a few short, straight, black microlites unlike the long rutile trichites of the granites. The trains of cavities are very abundant, and often run through several grains of quartz, suggesting crushing. They are made up of very small cavities with motionless bubbles unaffected by heat.

Biotite-gneiss and granulite.—Following the railroad a few rods north from the outcrop of the white gneiss described above, one finds in the wall of the railroad cut an outcrop of a dark-gray, stretched, granitoid gneiss of more normal texture and somewhat finer grain than that last described, which abounds in minute garnets, so that as the mica disappears from some layers they become a light-colored granulite.

Under the microscope it is very unlike the former rock. Microcline is almost wanting, and the mass of the rock is a quartz mosaic of irregular grain, with little microcline and orthoclase, with very wavy extinction, and with a triclinic feldspar near albite. The dark olive biotite is raveled out at the edges and changed to chlorite. The small, round, red-brown garnet grains are generally without inclusion and are nonpolarizing. The only remarkable peculiarity of the rock is that large grains of quartz and plagioclase have their centers full of blebs of garnet, quartz, and biotite, while there is entire freedom from nodules or water bubbles. There is every sign of rapid crystallization.

Epidote-gneiss.—Next above the preceding rock is a coarser gneiss, in which greenish layers of biotite, mixed with much green epidote and secondary chlorite in broad, distinct sheets, inclose a fine granular mosaic.

In sections cut across the foliation the microscope shows this mosaic to be made up of elongate-opaque patches, with intervening transparent portions. The latter are a quartz mosaic; the former are portions of a feldspar so filled with minute pale-green epidote that the character of the feldspar can not be determined. The frequency of crushing is

PLATE I.

PLATE I.

FIG. 1.—Hinsdale gneiss, from near N. B. Whitman's house, in the northern part of Hinsdale. The lighter quartz bands are drawn with polarized light to obtain the boundaries of the grains in the mosaic. The darker bands of plagioclase are drawn with common light to obtain a clear view of the minute epidote, biotite, and chlorite crystals. × 14.

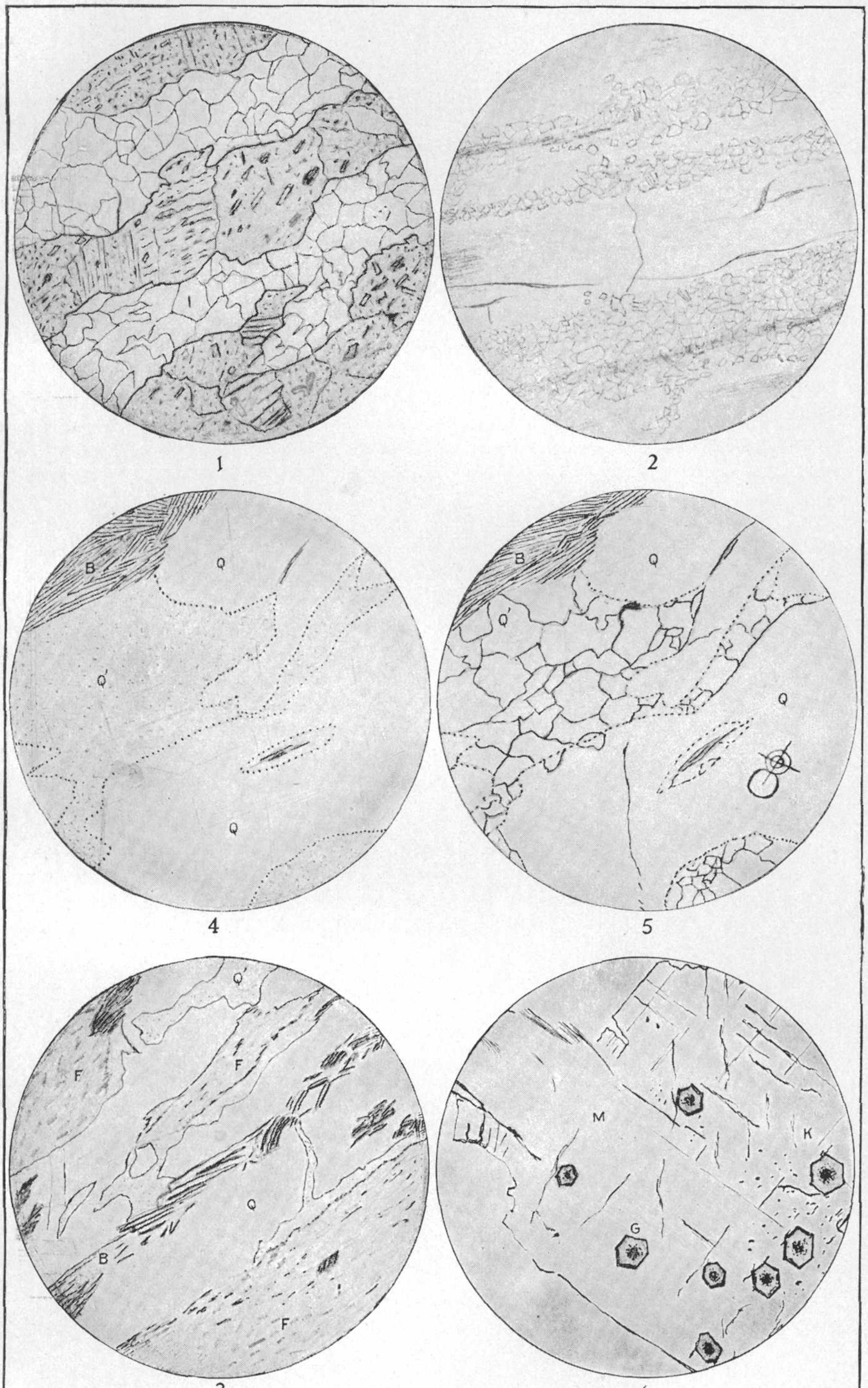
FIG. 2.—Washington gneiss, Peru; H. A. Messinger farm. (Slide F.) The granular bands represent a fine quartz-feldspar mosaic, in which much newly formed muscovite is regularly disseminated in fine scales. The intervening bands are of limpid quartz, which is little fissured. The slide is drawn with polarized light and the strong undulose extinction of the quartz bands is represented by shading. × 14.

FIG. 3.—Washington gneiss, Washington, north line of Pittsfield road. Three bands of a quartz-feldspar-muscovite mosaic (F) and a central biotite-muscovite band (B) are separated by three bands of blue quartz (Q) in the dotted portion of which (Q′) the blue color has been discharged. A well-defined rhombohedral cleavage appears in part of the quartz. × 3, natural light.

FIG. 4.—A portion of the lower part of the upper-quartz band of fig. 3. The dotted portions (Q′) do not show the blue color, but are not otherwise distinguishable, and the cleavage lines run through both portions. × 14, natural light.

FIG. 5.—The above slide (fig. 4) seen with polarized light, showing the coincidence of the crushed and colorless portions (Q′) and of the parts with undulose extinction and those with the blue color (Q). The cleavage lines make an angle of 74° instead of 94°, and the oblique position of the axial cross agrees with this decrease of the cleavage angle.

FIG. 6.—Cyanite (K) changing to muscovite (M) with included garnets (G). Becket, p. 84.



THIN SECTIONS OF GNEISSES AND CYANITE.

shown by the sheets of cavities passing through the quartz grains. These cavities rarely show bubbles, and only the smaller show motion. When heated to 70° C. they are not changed.

Blue-quartz gneiss.—At N. B. Whitman's house, in the north part of Hinsdale, is a granitoid gneiss (Pl. I, fig. 1) in which the small distant aggregates of black biotite and epidote do not much aid the foliation. Pyrite is abundant. Bands of blue quartz, about 1 to 3 millimeters wide and about twice that distance apart, run interruptedly through the rock; they have crushed borders or dissolve entirely into a white mosaic. Between these is an opaque white mosaic of feldspar crowded full of minute epidotes.

The quartz mosaic represented in the figure by the two broad light bands is very fresh. Sheets of minute pores or solid particles pass from grain to grain. Many of the grains have a delicate wavy extinction. The feldspar, which crosses the figure in three bands, is much coarser, and the feldspars are uniformly a plagioclase with extinction 2 degrees to 12 degrees, generally very low, indicating an acid plagioclase. It is very fresh, and the small sharp epidote, biotite, and chlorite crystals are spread evenly over the field, like the small crystals in a micro chemical experiment, giving the band a glistening, satiny look in the thin section. There is no indication of decomposition, but rather of an original formation of the feldspar mass made up of large allotriomorphic grains, a fissuring of it, a subsequent formation of blue quartz in the fissures, and a later mylonitic effect upon the whole. It is interesting that there is here no trace of microcline or orthoclase, but that the abundant growth of the small, sharp epidote, biotite, and chlorite crystals appears equally well in the plagioclastic as in the microcline-bearing rock, and seems in both to be a result of intercrystallization rather than a secondary alteration of the feldspar.

HINSDALE LIMESTONE.

In the more regular portion of the syncline across Hinsdale so many outcrops of the rock have been found that it is quite certain that a heavy band of limestone, often changed in whole or in part to amphibolite, steatite, or serpentine, encircles or did once encircle the lowest gneisses. It is marked by a series of abandoned limekilns, and before the opening of the "Western Railroad" was of economic value. Several of its outcrops were mentioned by President Hitchcock, and Professor Dana[1] called attention to the locality at Hinsdale Station as containing chondrodite, and from this fact assigned these rocks to the Archean—that is, to the pre-Cambrian.

As exposed in the railroad 50 rods north of the Hinsdale station the limestone is a very coarse, wholly crystalline rock—a white coccolite-limestone containing graphite, chondrodite, phlogopite, and coccolite

[1] Am. Jour. Sci., Vol. XXXIII, 1887, p. 275.

in grains, and hornblende in larger masses, some of which are a foot across. Only 25 feet is exposed, and it is covered by the coarse Hinsdale biotite-gneiss. A mile south, where the highway crosses the railroad near a bridge, the bed reappears and continues for a long distance southward by the roadside, more than 100 feet in thickness being exposed. It is here a very coarse crystalline limestone, the grains often 50 to 100 mm. across and multiple twinned, with crystals of bronzy and pink phlogopite 20 to 30 mm. across, and black to pale-green hornblende, clove-brown pyroxene, green coccolite, graphite, and pyrite. It is in places changed into great masses of matted pale-green tremolite, and this can be followed a long way southward as a very impure tremolitic limestone. It appears as a phlogopite-limestone farther south, at the E. Cheesman place, a half mile west of the next railroad crossing. From this point the bed is covered for a long way south, and I have located it approximately on the map by fixing the boundary between the coarse Hinsdale gneisses and the upper rusty gneisses and also by the fact that its course is marked by abandoned limekilns and ponds and swampy areas where it has been deeply dissolved. In the second cut south of the Hinsdale station are great bowlders of serpentine which came from some portion of the bed.

Just east of Muddy Pond, north of Washington Station, the band is represented by the old graphite mine of Washington (see fig. 3, p. 36), which reminds one, except for the size of some constituents, of the graphite vein at Ticonderoga. It contains very coarse calcite, graphite in broad hexagonal plates, coarse white salite, coarse green pyroxene and hornblende masses, groups of finely terminated pistachio-green pyroxene, brown sphene, pericline, adularia, and garnets, followed paragenetically by coarse calcite with phlogopite, and this by quartz. This has been opened 6 rods along the strike and a shaft sunk 25 feet.

A hundred yards of a fine-grained compact gneiss containing much ilmenite, which I associate with the older gneiss, separates this deposit from a thin bed of limestone on the east; these two beds can be traced south, and cross the road, beneath the two most easterly houses on it, as two beds of amphibolite. South of the pond the outcrops are good, and but a single bed of a pyroxene-hornblende rock can be found as the representative of the united beds, and this swells and contracts in a series of great bunches, due to the removal of most of the limestone by solution.

A remarkable outcrop occurs in the eastern band, 50 rods west of the house of O. Bills and 150 rods east of the southernmost railroad crossing in Hinsdale. Here great layers 3 feet thick are made up almost exclusively of red chondrodite and bright-green clinochlore, the latter in plates up to an inch across, and the change into serpentine and talc has taken place on a large scale.

Farther north, at River Bend Farm, below the mill pond on the Housatonic branch, the limestone is exposed at the sawmill with a thickness of 600 feet and the base is not seen. At top the bed is changed into a compact, firm, granular, apple-green talc for a thickness of 50 feet, and dark-gray slaty serpentine appears here also in bowlders. It is divided by a narrow band of gneiss. The limestone is marked by distant partings of phlogopite and much of it is a fine white marble, faintly banded by dark interrupted streaks. Other extensive outcrops occur farther north, but add nothing to the petrographical characteristic of the rock.

The bed can be traced up to the southern end of the Ashmere reservoir, and the long, deep depression occupied by this pond may be taken as its continuation, and the ruins of an old kiln may be found just beyond the north end of the pond, on a rusty calcite-garnet-hornblende rock.

A mile and a half north, on the northern branch of the Housatonic, is E. Cady's lime pit. Extensive excavations have been made in a bed

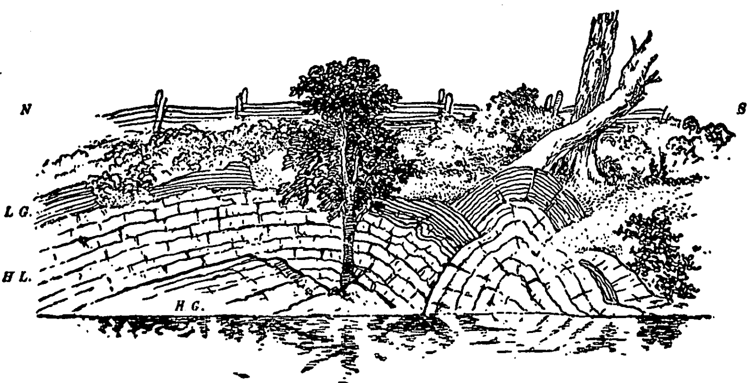


FIG. 1.—Section at iron bridge, Windsor. LG, Lee gneiss; HL, Hinsdale limestone; HG, Hinsdale gneiss.

of coarse limestone which has strike, N. 20° E., dip, 45° E. at its south end, and strike, N. 10° W., dip, 65° E. at the north end, where the bed is 83 feet thick, including one rod of coarse hornblende-gneiss. The limestone contains much hornblende and phlogopite. One layer of a dark amphibolite is two inches thick with the bedding.

A most interesting outcrop occurs farther north on the Hinsdale-Windsor road at the iron bridge. This is at the apex of the northeastern lobe of the limestone. (Fig. 1.) A sharp fold of the overlying gneisses exposes the limestone in a narrow band which runs up from the last locality, and whose apex is exposed here on the bank of the brook. The older gneiss upon which the limestone rests appears beneath the latter at the level of the brook and the newer gneiss (the dark Lee gneiss) arches with many faults over the coarse white limestone, and it is very clear that there has been much solution of the latter and adjustment during the folding of the rocks. The Lee gneiss is a white crushed gneiss with large blotches of hornblende and allanite. The allanite is especially abundant beneath the bridge, and the hornblendic rock appears as a thick bed of a massive black, heavy, white-spotted gneiss in the fine cliff across the road to the west.

To the west of this outcrop is the high hill of black, crumpled, fine-grained mica-schist (phyllite). The lobe of pre-Cambrian rocks which runs up the east side of this hill is matched by a similar lobe running up the west side, and the curved reservoir pond seems to lie in the continuation of the limestone.

The dam at the outlet of the pond is a wavy bed of dark-green amphibolite, which still contains a central band, 1 to 5 feet thick, of coarse crystalline limestone.

A little farther down the brook, and easily reached by a footpath from the Windsor or Wakonah Falls, is an extensive bed of steatite. Here the limestone bed has changed through actinolite into steatite (fig. 2), and the influence of the removal of the limestone is clear. The steatite has been worked out of great chambers, the back walls of which are composed chiefly of gneiss. The gneiss layers can be seen to be

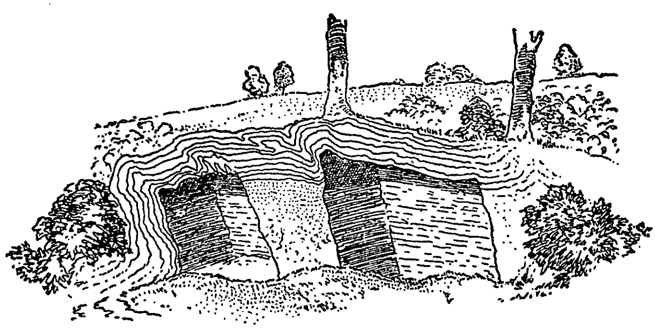


FIG. 2.—Steatite quarry near Windsor Falls, Hinsdale. Gneiss folding round a bed of steatite.

very complexly corrugated in the immediate vicinity of the steatite, and at the left of the figure they bend at right angles and run, with many corrugations, down the whole end of the steatite bed, cutting it off completely. The strike here is N. 30° E. with the plane of the figure, and the dip is 50° E., or from the observer. The gneiss is the white-and-black banded Lee gneiss. Its position plainly indicates that it has been crushed in around the remnant of the limestone bed spared from solution and sharply faulted.

Upon following the limestone S. 30° W. a half mile, to the point where it runs into Dalton and crosses the east-and-west road south of P. Mitchel's, it is seen that the boundary line soon begins to be marked by a great number of serpentine bowlders. Thirty rods north of the residence of D. J. Pratt a great bed of serpentine 3½ rods wide has been quarried and is exposed. It is very dolomitic and slaty; much of it is still matted tremolite and actinolite. It sometimes shows a rich nickel-green color, but is much fissured and worthless.

From this point the limestone bed is concealed, and I have followed it, by bowlders and by the strike of the adjacent rocks, for a long distance southeast. It occupies—and its removal has, I think, caused—the deep depression at the north and east foot of the high, rocky hill a mile north by east from Hinsdale Center.

The bed appears beside the western road of the square mentioned in describing the gneiss,[1] in a deep excavation several rods long, with an exposed thickness of 20 feet. The black Lee gneiss is in place just west, and to the east is the peculiar titanite gneiss mentioned on page 23. The limestone is a very pure white, coarse crystalline rock, with small bright coccolite grains and much shining black mica. It is peculiar that this mica is arranged in long streaks and blotches in distant planes and exactly simulating the white, stretched gneiss which occurs so commonly just below the limestone.

It is not until we reach the blind road which runs up onto the hill from near the cemetery at the center of Hinsdale that we again come to ledges showing traces of the limestone band; but the Lee gneiss, which is its constant associate, can be followed almost continuously in the high ground of the hill. In the head of the brook bed east of the second house on this road appear great bowlders, apparently almost in place, of an actinolite-limestone which fixes the position of the bed.

PETROGRAPHICAL DESCRIPTION.

Chondrodite-limestone.—At Hinsdale, north of the railroad station, is a limestone which ranges in color from white to pink, a rather coarse (grains 3–5 mm.), highly crystalline rock, with a certain translucency in the grains which immediately distinguishes it from all the other limestones of western Massachusetts and allies it to the limestones of the Adirondacks.

It carries coccolite, phlogopite, biotite, actinolite, chondrodite, pyrite, and magnetite. Generally the coccolite or the chondrodite, or both, are so abundantly and evenly scattered through the mass that it deserves the name coccolite-limestone or chondrodite-limestone, and the accessory minerals are so arranged as to give the mass a distinct foliation, especially where the chondrodite and biotite predominate.

The chondrodite is disseminated through the rock in yellow patches, elongate and parallel to each other, and as in places it changes into black patches, by the admixture of a green mica and magnetite, the resemblance to the boltonite from Bolton, Massachusetts, is striking, especially in specimens of the latter which are changing to serpentine. In large masses it is a rich deep red, like the chondrodite from the Tilly Foster mine. Under the microscope the patches of the mineral are seen to be composed of crystalline grains, fresh and free from inclusions and wrapped around by scales of a pale-green micaceous mineral, without any indication that the one mineral has been derived from the other. The mineral shows strong dichroism, honey-yellow to

[1] Lat. 42° 28′; long. 73° 6′.

deep red-brown. Toward the surface of the ledge the chondrodite weathers to a honey-yellow, opaque, serpentinous mass.

The phlogopite is in small, thick crystals with rounded borders, and has exactly the same bronzy color as the phlogopite from Templeton, Canada. Its crystals are generally surrounded by a band of scales of greenish-gray biotite. Both minerals are fresh, and there is no indication of a transition of one into the other. It has often a beautiful peach-blossom color.

The biotite is often in black scales, at times in isolated crystals with rounded contours, at times bordering the phlogopite in greenish-gray matted scales.

The pyroxene occurs in dark-green grains of coccolite scattered through the limestone, and in small, stout, limpid, emerald-green prisms in the pink variety of the rock.

The magnetite occurs in small crystals and crystalline grains, often associated with the chondrodite; the pyrite is always in small complex crystals.

An analysis of a specimen of this limestone, made in the laboratory of Amherst College by Mr. F. H. Fitts, is here given:

Analysis of chondrodite-limestone from Hinsdale Station.

	Per cent.
Insoluble in HCl	21.96
CaO	41.31
MgO	1.87
FeO	.68
CO_2	34.71
Total	100.53

Actinolite-limestone.—Forty rods north of Hinsdale station, in the canal beside the stone mill, there is a green massive rock of medium grain, showing a paler green massive pyroxene, a darker green fibrous hornblende, and much pyrite.

With the lens the slide shows little chlorite and much epidote, and in a few places the colorless ground appears. Under the microscope this colorless ground proves to be a much-twinned calcite, into which the terminations of the epidote crystals project. Large colorless areas of pyroxene are intergrown with the hornblendic mineral, which varies in appearance from actinolite to tremolite.

In the Massachusetts survey collection No. XV, 168, is a vein or layer of siliceous calcite in gneiss, labeled "Augitic gneiss, Washington, NW. part." It contains a dark-green fibrous hornblende in large blades, derived apparently from a light-green pyroxene which exists in remnants, and also from crystals of a dark-brown titanite.

LEE GNEISS.

The type of the Lee gneiss is found in the hill overlooking East Lee on the northeast, where the rock is a heavy-bedded black gneiss. It is often a flat-banded black gneiss, alternating in thin layers with a white, sugary granulite.

The most accessible outcrops of this rock along the western side of the area are in the bed of the river near the stone mill just north of the Hinsdale station. The light and dark banded gneisses are tough and granitoid, and abound in epidote to an unusual degree. Several varieties of the rock can be studied at this locality:

1. A light-gray, flat, and thin-foliated biotite-gneiss, so much like the newer, friable Becket gneiss that one is surprised at its toughness.

2. A coarser gneiss, with the greenish biotite segregated into broad, distant sheets and containing thin, lenticular layers of a coarse, reddish granite. Under the microscope the bands of granular quartz are separated by bands of granular epidote, which seem to have wholly replaced the feldspar. The biotite layers often contain much epidote and a secondary green chloritic mineral. The trains of pores run through several quartz grains and rarely show bubbles; only the smaller bubbles show motion.

3. A flesh-colored, thin-foliated gneiss, with greenish films and membranes of biotite, breaking with much difficulty and with little regard to the foliation. This grades, by the entire change of the feldspar, into a quartz-epidote rock.

The Lee gneiss occurs in fine and typical development in the high ridge that extends 2 miles north from Hinsdale cemetery. It includes heavy amphibolite beds and alternating bands of a white granulitic gneiss, with distant blotches of hornblende.

By following the main road north from the cemetery a little way past the top of a small hill, 1,040 feet high, large outcrops may be seen in the open field to the left, and here the coarse, white, greatly crushed granitoid beds are distinctly blotched by biotite, and by stretching the biotite is extended in long bands. The rock abounds in blue quartz, while one large amphibolite layer sends off apophyses into the gneiss like an eruptive. Northward, on the crest of the hill 1,720 feet high, the exposures are abundant and the true sedimentary structure is found, together with the secondary foliation produced by pressure. The two have uniformly the same strike, and the latter has generally a lower dip to the west than the former. At the quarry opposite the entrance to Windsor Falls the rock is extremely thin and fissile and superficially resembles the quartzite, but it is really a very feldspathic crushed rock, and carries the dark-green amphibolite beds which are common in the Lee gneiss.

On the Hinsdale-Windsor road, along the east side of the schist area, the rock is greatly rotted in ledges by the roadside, and a little beyond, at the iron bridge, it contains beds of a curious white granulitic rock with coarse, distant hornblende blotches, while the same rock appears in picturesque ledges in the bluffs to the west.

In contrast with the broad area in the western limb of the anticline north of the Warner Mountain fault, south of this fault the Lee gneiss has a thickness of only 20 rods on the surface, and is concealed from this point south to the hill three-fourths of a mile southeast of Muddy Pond (see fig. 3, p. 36), where it is typically developed, and runs around south of Washington Station and the swampy ground, extending north therefrom in such a way as to render probable the presence of the Hinsdale limestone to the north.

TYRINGHAM GNEISS.

Along the west of the Hinsdale anticline the higher beds are faulted out of sight; along the east they are so covered that the Tyringham gneiss can not be mapped or found with certainty. At the south end of the area it comes in with great force and in most interesting and typical development.

At the deep cutting south of Washington Station the rock is a garnetiferous zircon-bearing biotite-gneiss of coarse fibrous or woody texture, rarely containing great blotches of a shining black hornblende. The biotite scales are wrapped around long quartz pencils, so that it is easy to note the dip and yet difficult to detect any planes of bedding. This peculiar structure of the rocks seems to be an extreme of the stretching common in the gneiss of the Cambrian series, especially east of the Connecticut. It was deformed under the influence of compressive forces which permitted flow in a single direction only. It weathers into a mass of quartz-feldspar rods, which are sometimes several inches long. This weathering is in itself quite exceptional. On the hillside above the cutting and along the road going south, large outcrops of the rock appear; it is crumbling into a mass of coarse granitic sand, and in the long cutting, which is in many places 10 to 12 feet deep, the decomposition extends everywhere below the bottom. This is a protected portion of the pre-Glacial weathering.

The wind blows the decomposed rock away like sand, exposing quartz veins and leaving large, rounded nuclei on the surface. The decomposition brings out in strong relief the peculiar structure of the rock as it falls apart into a pile of quartz-feldspar pencils, or long, flat rods—the expression of the perfect stretching of the fresh rock.

WASHINGTON GNEISS.

The broad outer zone of this large anticline is formed by a rusty graphitic blue-quartz gneiss. It is in the main a biotite-gneiss, rusty from the decomposition of pyrite, pyrrhotite, ankerite, and hornblende.

It has associated beds of a heavy, black hornblende-garnet-gneiss which have been taken for emery, and in the whole circuit graphite is a never-failing accessory, especially in the upper portion, and it is occasionally so abundant as to tempt mining.

Another equally persistent and very curious constituent of these gneisses is a blue quartz in flat laminæ, 1 to 2 millimeters in thickness, which has often a deep tint of rich, purplish blue. It is so abundant as to form more than three-fourths of the mass, and furnishes very attractive cabinet specimens. Allanite is also a characteristic and abundant constituent of the rock, especially in its upper portion, and the puckering surrounding its black or red cross sections constantly calls attention to its presence in the rock.

In every part of the circuit of this anticline, and along the broken crest of the Dalton anticline, I have never failed to find beneath the next succeeding Cambrian conglomerate-gneisses all these characteristics of the top of the older series. Especially down the eastern side, the area above the limestone is marked by several broad bands of the rusty rocks, with intervening bands of biotite-gneiss. The latter rock is often so crushed that it is with difficulty distinguished from the Becket gneiss above, but there is not such a complete transition from the older gneisses into the white gneiss[1] as that described in the Hoosac area. The rusty blue-quartz gneiss is generally a membranous ("flaserig") rock. Nearly continuous sheets of mica scales wind in and out and inclose the blue-quartz lenses and laminæ. When this rock is involved in a crushing later than the formation of the blue quartz, the latter becomes gradually disintegrated at the edges and at last changes to a mosaic of small grains, and the pale-blue tint is lost in the reflections from the many fissures. By a careful search one can usually detect nuclei which show the color, and in this search the pocket lens is a great aid, as the blue color is thus easily distinguished from the blue grays of the quartz from the granites and Cambrian gneisses.

The Washington graphite-gneiss is absent along the whole western side of the syncline, being concealed by the fault and by the westward thrust of the body of the syncline against the resistant mass of the Dalton syncline, until the south boundary of the latter—the Warner Mountain fault—is reached. South of this fault, at the Plunkett reservoir, the Washington gneiss appears, with a width of 2 miles, extending from the top of Warner Mountain, where the Becket conglomerate-gneiss can be seen dipping beneath it, to the top of the low hill which overlooks the great limestone bed 30 rods south of the bridge a mile south of Hinsdale. Its great width is attributable to its low dip eastward and its many undulations. It gradually narrows southward, and in the high hill three-fourths of a mile west of Washington Station it bends westward and forms the great loop which extends west past Washington Center, where it can be conveniently studied.

It is everywhere a coarse muscovite-gneiss, with some biotite, and so abounding in pyrite that it rots into a mass of rusty fragments, and is usually rusty externally. The content of graphite in clear crystalline

[1] Pumpelly and Wolff: Mon. U. S. Geol. Survey, Vol. XXIII, pp. 72, 85.

scales is nearly constant, and its amount increases with the increase in the rustiness. When not crushed it abounds in bands of blue quartz, sometimes 2 to 3 inches thick, which disappear with increasing granu lation. This granulation gives a peculiar sandy look to the rock, different parallel layers of crushed quartz being now white, now rusty, as the crushed mass was influenced by the rusting of the pyrite. Small bands of impure limestone, now mostly changed to a pale-green salite-actinolite rock, appear, and the graphite is often so concentrated in them that they have been mined.

Such a bed appears in the brook crossing the road a few rods west of the overhead bridge on the railroad a mile south of Hinsdale, and, as a line of big salite-actinolite bowlders, can be followed a mile farther south along the crest of the hill above the big limestone bed.

The contact on the Becket gneiss is very clear at the signal station on the apex of Warner Mountain, the highest point west of Hinsdale village, but across Washington and Becket to North Becket the Washington gneiss is much of the way wholly crushed and the blue quartz destroyed, and in many beds the content of pyrite is small. Where

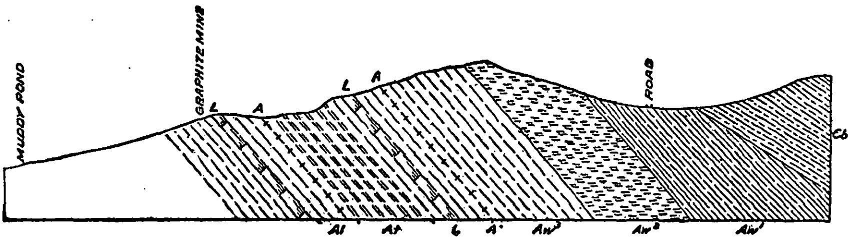


FIG. 3.—Section at lead mine east of Washington Station. Єb, white friable biotite-gneiss (Becket gneiss); Aw¹, white hornblende spotted gneiss (Washington gneiss); Aw², granulite (garnet-gneiss); Aw³, rusty graphite-gneiss; At, stretched biotite-gneiss (Tyringham gneiss); Al, light-gray biotite-gneiss (Lee gneiss); L, limestone; A, amphibolite.

this is the case the graphite is rare, for graphite and pyrite go together. Along this line the Becket gneiss is exceptionally crystalline and coarse grained, so that it is with difficulty distinguished from the Washington gneiss. The Becket gneiss is, however, a pure biotite-gneiss carrying many large garnets, which are absent in the Washington gneiss, and it is rare that a ledge of the latter will not furnish considerable graphite. Along the east side of the area the country is covered by surficial deposits, and the last place for study is east of Washington Station, where the outcrops are abundant.

Following the road from the station a mile east, to a point where it runs north and south, north of a small pond we find the road to be the boundary between the Becket on the east and the pre-Cambrian on the west. Going over the great bare hill we have the following section ending with the lead mine and giving the whole thickness of the Washington gneiss (Pl. I, fig. 3). The great beds of white gneiss are quite exceptional and are exceedingly like the Cambrian at first view. They are, however, more feldspathic, and their scanty black constituent is mainly hornblende.

Blue-quartz gneiss.—At Peru, near the residence of H. A. Messinger, a mile northeast of the bridge over Ashmere reservoir, there is a rusty, fine-grained gneiss (Pl. I, fig. 2), with little mica (biotite) in distant flat sheets of small scales, and with greasy blue quartz in grains and flat plates 1 to 3 millimeters thick, which often coalesce into parallel layers of considerable extent. These layers are plainly secondary infiltrations in a fine granular ground which has the aspect of a fine sandstone or quartzite, while they have much the position of the quartz blades in a graphic granite. In a plane at right angles to the dip they appear as rounded or slightly flattened ends of blades, which have their flat sides in the foliation plane and are often greatly elongated parallel to the dip. Under the microscope this ground proves to be an exceedingly fine-grained mixture of quartz, orthoclase, microcline, and abundant minute scales of muscovite; and it is such a structure as may have been produced by the crushing of granite and the change of most of its feldspar into muscovite. It is shown in three bands, of varying width, running across the slide. The darker shading in these bands represents a concentration of rust which permeates the whole layer.

The blue quartz, which crosses the slide in four bands, contains few minute broken rutile needles, rarely cavities containing small, rapidly moving bubbles, and many rudely parallel sheets of very fine cavities or grains of some unknown mineral. There are a few distant fissures. It shows strong undulose polarization, which appears in broad patches of deep shade elongated with the length of the bands and moving across them. This is indicated by the shading of the bands in the figure. The whole of each of the bands of the blue quartz polarizes as a single individual, however large it may be. The sections were cut at right angles to the foliation and about parallel with the dip or stretching of the rock. It is interesting that in each case they are cut at right angles to the optical axis, and the slide can be moved from one end to another of the blue quartz bands, 1 to 2 millimeters wide and 15 millimeters long, and the optical figure remains sharply defined, regular, and unchanged.

A fragment heated for a long time with the bellows blowpipe retained its color without perceptible change. Even in the thin section the quartz shows a rich blue, like a fluorescence, when examined by transmitted light and without a lens.

At Washington, on the north line of the road to Pittsfield, there is a coarse membranous biotite-muscovite-blue-quartz-gneiss (Pl. I, figs. 3–5). Broad continuous films or membranes of fine scales of biotite and muscovite, one of which runs through the middle of the figure (which represents a transverse section of the rock), wrap around layers or lenses, from a half inch to an inch wide, of a fine granular buff-colored mass, or around feldspar augen. This granular mass, which is shaded in the figure, is a quartz mosaic with very many regularly distributed muscovite crystals replacing most of the feldspar.

The blue quartz, in grains or flat lenses, shows a preference for a position between the membranes of mica and the fine granular groundmass, and seems to be a late addition to a crushed biotite-gneiss. In the figure the blue quartz separates the mica film from the granular mass on both sides. It contains broad sheets of small grains and pores, with moving refractile bubbles and few cracks. It shows undulose extinction, which is represented by the soft shading upon Pl. I, fig. 3. Each band is a single crystal, at least for a long distance, and in the broad band at the bottom of the figure the slide was moved 8 mm. without any movement of the axial cross.

The most striking and instructive things about the slide are, first, that the blue quartz shows, in spite of its great thinness, an opalescent blue color almost as clear as in the hand specimen, and, second, that the blue color is absent in irregular spaces, mostly along the borders, though the quartz does not show any other distinguishing feature and is only rarely separated from the rest by a visible fissure.

In fig. 4 of the plate, which is an enlargement of the lower portion of the upper quartz band in fig. 3, the colorless portions are distinguished from the rest by being dotted and by a dotted boundary. In fig. 5 of the plate the same is drawn with crossed nicols, and it is seen that the portions which were colorless appear, in polarized light, broken into a mosaic whose grains, being relieved from tension, polarize with sharp uniformity, while the blue portions show strong undulose extinction, as is indicated by the central shading. It is thus quite evident that the blue color is due to strain, which is effective in a very thin layer, and that the strain is relieved and the color discharged by the crushing ot the mass to a mosaic.

It is curious that a double series of rhombohedral cleavage lines runs through the broadly crushed portion figured and extends beyond it into the uncrushed portion without relieving the tension. The quartz is often crushed at the border and even clear into the center, but with the lens the blue color can be seen until the crushing is complete.

I first found these blue quartzes as grains in the gneissoid Upper Devonian conglomerates of the Bernardston series in West Northfield. Soon after beginning the study of the pre-Cambrian around Hinsdale I remarked the constancy of the blue quartz as a characteristic of the pre-Cambrian rocks of the region. On visiting Professor Wolff I found that he had noted the same thing and had made microscopical examinations of the rocks, and thought that the structure might be caused by strain; but he does not discuss the matter in the final report.[1]

Later, on examining crystalline rock from the southern Appalachians at the Survey office in Washington, I was struck by the prevalence of the same lavender color in the quartz; and finally, in a collection of rocks from Smiths Sound, in the Arctic region, obtained by Hayes and presented to Amherst College, I found a large specimen of the finest blue-quartz gneiss I have ever seen. It is a rich deep blue, like the

[1] Geology of the Green Mountains in Massachusetts, Mon. U. S. Geol. Survey, Vol. XXIII, p. 46.

finest cordierite, and is in a layer more than an inch thick extending across a large specimen. I have observed the same thing in the Archean gneiss at Gutwagen in Norway, in porphyries in Finland, and in the granites and quartz-porphyries which extend from Marlboro, Massachusetts, to Providence, Rhode Island.

It is a peculiarity of this coloring that it is best observed with a lens, which detects immediately if it is the true color of the quartz and not a grayish blue depending upon impurities or some fine corrugation of the surface.

The foregoing facts concerning the crystalline continuity of the blue quartz layers and lenses for considerable distances, their strained appearance, and their tendency to form on one side of the mica films, or, as in the center of Pl. I, fig. 4, on both sides, make it probable that they have entered into the composition of the rock at a somewhat late stage, and have since been only partly crushed and incorporated into the general mylonitic mosaic.

An antecedent state of many of these rocks may have been a well-crushed biotite-gneiss, and it is interesting to see how diverse the crushed masses are in the preceding examples.

In one case the rock is a large-grained plagioclase mass, regularly crowded with small sharp epidotes; in another it is almost all microcline, similarly but not so abundantly filled with epidote; in another case the epidotization is carried so far that little feldspar remains; in still another the crushing has changed the larger portion of the feldspar into a mass of small, stout, muscovite crystals.

Except when the large and strongly warped cleavage faces of the feldspar appear still uncrushed, this ground has a very clastic appearance and the blue quartz seems to be connecting thin bands of a firm quartz-sandstone.

This structure in the gneiss illustrates a tendency of the quartz to undergo torsion, or bending, rather than to become granulated under a pressure which would completely crush the other constituents.

DALTON ANTICLINE.

This is a normal flat arch with the Cambrian conglomerate-gneiss worn off from the crest, exposing the upper portions of the pre-Cambrian. (See fig. 4, p. 40.) The crest of the arch runs south from Dalton along the top of Warner Mountain, the north end of which is in Dalton called Day Mountain, and near the line between Dalton and Hinsdale.

The site of the Dalton clubhouse, a mountain house on the top of the high flat hill overlooking the Dalton railroad station, 1,840 feet above sea level and three-fourths of a mile south of Dalton, is a convenient landmark by which to find this most interesting contact of the conglomerate upon the older gneisses.[1] The clubhouse, locally called

[1] For description of the conglomerate contact see page 75.

"the Chalet," is now removed, but the foundations still remain, and the road can be followed from the station, the clearing making a notch in the woods at the top of the mountain visible from Dalton.

The pre-Cambrian, at the contact a few rods southeast of the clubhouse, is a fine-grained crushed granulitic gneiss, but abundant beds of the rusty blue-quartz gneiss come in just east of this. Farther south the blue quartz is everywhere abundant.

Along the boundary, going southwest to the brook which runs through the pasture south of the clubhouse, allanite is an exceedingly abundant accessory in the gneiss, a dozen crystals often appearing in a single hand specimen. It is especially abundant near a large tree at the middle outcrop of the brook bed, indicated in the figure.

A little farther up the brook bed is a very peculiar granular quartz rock containing considerable feldspar and calcite in large, rounded balls, often 3 to 4 inches across, which consist of one or a few crystals

FIG. 4.—Dalton anticline: The Dalton clubhouse section on Day Mountain south of Dalton. Cambrian conglomerate-gneisses arch over the pre-Cambrian uncomformably.

and show very large cleavage surfaces, presenting the finest twin striation. These balls are sometimes blended into masses of very coarse marble as large as a man's head. There is much pyrrhotite developed, especially along the borders between calcite and quartzite, and biotite also occurs in the calcite.

At the south end of the mountain ridge the pre-Cambrian terminates in a fine bluff overlooking the Warner Mountain or South Dalton fault. At the southwest corner it dips under well-marked Cambrian conglomerate-gneiss and shows heavy hornblende-gneiss beds in graphitic blue-quartz gneiss. The southeast corner is three-fourths of a mile N. 20° W. of the signal house on the top of Warner Mountain, and the sudden ending of the blue quartz gneiss against the fault is clearly exposed.

The schist upthrusts in the Stockbridge limestones, which are prominent farther north and disappear in the latitude of Pittsfield, opposite the Dalton anticline, the lesser folding of these limestones compensating for the Dalton anticline.

COLES BROOK LIMESTONE.

A remarkable linear outcrop of the Hinsdale limestone 7 miles long has cut through the Cambrian gneisses like a knife, from Factory Hollow, in Middlefield, to the south part of Becket. It is bounded everywhere by faults, is accompanied by only narrow selvages of the pre-Cambrian gneisses, and, unlike all the other outcrops of the limestone, forms a series of high, steep ridges. It is best exposed a mile northwest of Bancroft Station, in Middlefield, where the Boston and Albany Railroad cuts off a loop of the Westfield River and Coles Brook enters this loop from the north. The Cambrian gneiss overlaps the pre-Cambrian unconformably on either side.[1]

The white Cambrian conglomerate-gneiss in synclinal posture mounts unconformably on the older Lee gneiss, which consists of a great thickness of a wavy bedded gneiss of fine grain and almost black from the abundance of black biotite.

The Lee gneiss abuts, apparently by a fault, certainly by a wholly abrupt transition, upon a band of the coarse, white, almost micaless Hinsdale gneiss, with iridescent feldspar, which is 23 feet wide below but narrows above.

This is followed by a bed of white, thin-bedded, highly crystalline limestone 50 feet wide, with thin films of serpentine, which is separated, by 108 feet of the same dark Lee gneiss, from a second band of similar limestone, of which only 29½ feet are exposed. The partial serpentinization of the chondrodite has here produced a yellowish verdantique which furnishes very beautiful hand specimens and might be useful for ornamental work.

Following this, in the brook bed at bridge 142 and in the railroad cut, is a large mass of the dark gneiss-carrying beds of hornblende-schists, until we come to the fourth telegraph pole from bridge 142, upon the fine unconformity where the conglomerate-gneisses mount the dark pre-Cambrian gneiss.

Between this point and Middlefield Station the cuttings expose a long extent of contorted and twisted rocks, mostly of Cambrian age, the beds swinging round from horizontal to vertical within a few feet.

Gradually a low dip eastward predominates, which becomes steeper, and a band of hornblende-gneiss 10

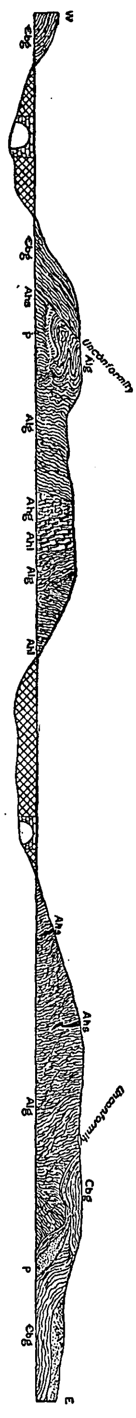


Fig. 5.—Section of pre-Cambrian rocks at Coles Brook, on the Boston and Albany Railroad, Middlefield. Ahg, Hinsdale gneiss; Ahl, Hinsdale limestone; Alg, Lee gneiss; Ahs, hornblende-schist; Cbg, Becket gneiss; P, pegmatite.

[1] The whole section is figured and described by the author in Mon. U. S. Geol. Survey, Vol. XXIX, pp. 21–24.

feet wide sets in, while at the signal house a boss of coarse Hinsdale gneiss and calcareous salite-actinolite-schist protrudes. East of the unconformity all is Becket gneiss, except the few hornblende-gneiss masses and the last-mentioned boss of Hinsdale gneiss, which are brought just above the railroad level by the undulations of the Becket gneiss.

The limestone can be followed a considerable distance north along the brook, and it gradually passes to the east bank. Its most northern outcrops are south of the schoolhouse at Factory Village, in Middlefield, and the long depression, occupied by the pond, which extends north from this point has been formed by its solution. To the west are heavy hornblende-gneiss beds (Lee gneiss).

South from Coles Brook the limestone rises in a great hill south of the Middlefield railroad station, where it is 330 feet thick and is inclosed in a fine granulite.

Westward, toward Becket Center, a ragged, castle-like ledge of calcareous actinolite-gneiss, much contorted, forms the bare crest of the hill south of the road, and just east of this ledge is a bed, 75 feet thick, of a

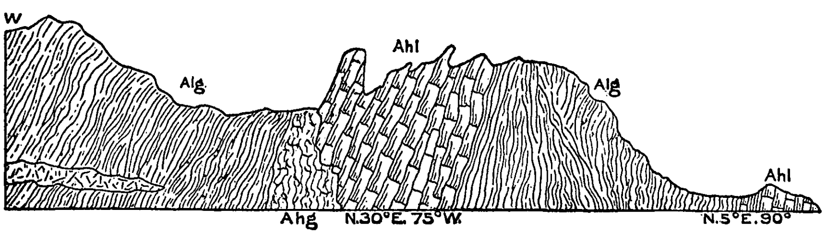


FIG. 6.—The Coles Brook limestone, enlarged from fig. 5.

coarse, well-bedded chondroditic limestone standing vertically. It is full of nodules, often 15 inches across, consisting of salite, tremolite, titanite, and chondrodite. Other nodules are wholly of pale-green bladed tremolite. On the south of this hill the limestone is exposed with a thickness of 250 feet, and farther south, where it crosses the road (at the house of Ellsworth and son), it is 660 feet wide. Where it crosses Walker Brook and the last road on the quadrangle, the limestone is exposed to a thickness of 100 feet, and can be followed south across a blind road, turning south from the main road to a house known locally as "the old Conn place." Just south of this house great masses of the blue-quartz graphite-gneiss accompany the limestone, which can be traced but a little way farther south, as the Becket gneiss closes in on it.

The limestones of this locality are first noted by President Hitchcock in his final report[1] as occurring in the west part of Middlefield on Pontoosuc turnpike, on the railroad at the mouth of Coles Brook, and 1 mile east, in the southeastern part of Becket. The first two localities are on the Coles Brook bed; the third was a line of great bowlders from this bed. The description of the Hinsdale Station limestones

[1] 1841, pp. 81, 85, and 567.

given on pages 27–28 will apply wholly to those of this locality, and the change of chrondrodite into serpentine may be better followed here. The former rock is, however, coarser, and the included minerals are in larger individuals and therefore better fitted for mineralogical study.

LIMESTONE ON THE ALDERMAN FARM IN BECKET.

A mile east of Center Pond, in Becket, a thick bed of pre-Cambrian limestone has been opened. It has a width of 82 feet, and is a coarse chondrodite-phlogopite marble. At its eastern contact is a selvage, 4 feet wide, of pale-green or partly olive-green actinolite-pyroxene rock, which consists for the most part of a loose network of coarse actinolite blades, with some large masses of pale-green pyroxene and pyrite. It contains amethyst, much titanite in the usual flat crystals, and orthoclase in small well-formed crystals with simple forms, rounded edges, and blue opalescence. The bed is bordered on the east by 3 to 4 feet of a dark-banded gneiss of the type of the Lee gneiss, and the whole is inclosed in the Becket gneiss. About 8 rods south (see lower section of fig. 7), in the line of the strike, appears a great bed of a black hornblende-schist, which rests against the vertical Becket gneiss on the east, while the same gneiss appears in its proper place on the west, the intervening space being low covered ground. This hornblende-schist seems clearly to be the continuation of the limestone. It was prospected quite extensively, first for copper and then for emery. A study of thin sections showed it to be a hornblende-biotite-garnet-gneiss, with little black ore and much leucoxene and plagioclase.

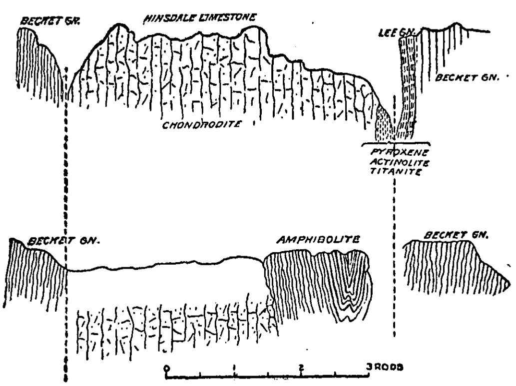


FIG. 7.—Hinsdale limestone at Alderman quarry, Becket. Lower section 10 rods south of upper one.

GULF ANTICLINE, DALTON.

North and northwest of Dalton the country rock seems to be entirely the massive quartzite, but going north by the second wood road, after passing the highest point on the "Gulf road," 30 rods from the highway, one finds outcrops of the gray Becket gneiss. Twenty-five rods above is the coarse, flesh-colored, pre-Cambrian biotite-gneiss, with blue quartz. This can be followed a long way up the brook, to the point where the main wood road crosses the brook, near an old cellar and 80 rods from the "Gulf road." The pre-Cambrian here extends west beyond the woods into the open pasture, and continues in that direction across 40 rods of Becket gneiss, to the long, bare ridge of quartzite which overlooks the railroad on the west. It can be followed still farther north, to its apex on the high, bare hill, at an altitude of 1,720 feet. Here is a broad, bare hilltop of the Becket gneiss, and at the southwest portion of the flat is the northern apex of the pre-Cambrian—a green, calcareous, highly feldspathic gneiss carrying dark-green fibrous hornblende, titanite, and blue quartz. The Becket gneiss wraps around it, and the contact is perfectly exposed. The Becket gneiss is conglomeratic at the south. A band of Becket gneiss about 40 rods wide surrounds the entire pre-Cambrian area, and the quartzite surrounds the whole. The axis of the anticline runs northeast, and the dips are all southeast, the anticline being overturned to the west. Mr. Benjamin Newell sent me specimens of the fresh rock from a point about 2 miles northeast of Dalton, and a specimen of coarse feldspathic pre-Cambrian gneiss, full of half-inch spots of a biotite-garnet aggregate. This is directly on the line of the axis of the gulf area of pre-Cambrian described above, and indicates a small pre-Cambrian area on the south border of the Greylock quadrangle.

LEE-TYRINGHAM AREA.

DISTRIBUTION.

This is the largest pre-Cambrian territory in western Massachusetts. It begins in a lobe overlooking Sackett Brook, in the south part of

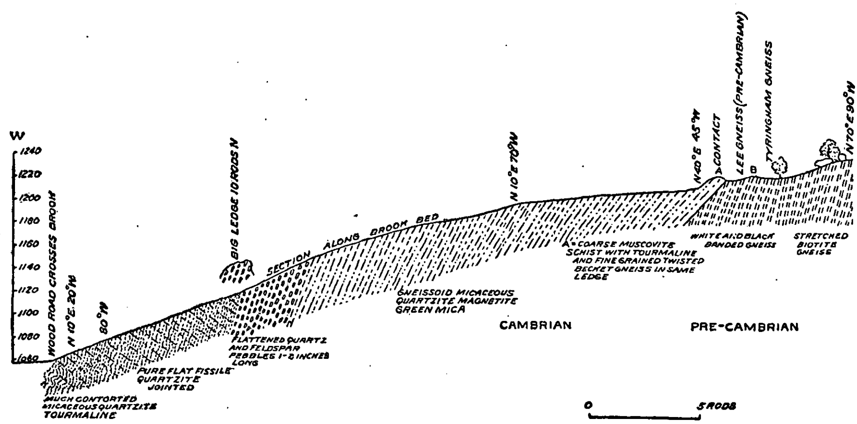


FIG. 8.—Section of contact of Cambrian on pre-Cambrian east of Lenox Furnace.

Dalton, where it is a slightly overturned anticline. It expands between Ashley Brook and Roaring Brook as a normal anticline, with axis running north and south. This is connected by a narrow isthmus with the larger and more important area, which begins on a fault in the high ground southwest of New Lenox, expands rapidly across Washington, occupies all the high ground in Lee and Tyringham, and ends in the great mass of Kingsbury Mountain, against the Tyringham fault.

It is convenient to treat separately the further extension south of this fault as the Sandisfield area (see page 55).

BOUNDARY.

The eastern boundary of this area is nearly everywhere normal, being formed by the Cambrian gneisses, which are often conglomeratic. It extends southeastward across Washington, with several great lobes running northward to a point south of Becket Center, where it turns southwestward, becomes an unconformable boundary, and, crossing into Otis, east of where the Tyringham River enters the town, extends southwestward to West Otis, where it meets the Tyringham fault.

Between New Lenox and East Lee the western boundary runs at the foot of the bluff overlooking the Housatonic Valley, and is a line of fault, with downthrow on the west and some westward overthrust. (See figs. 8 and 9.) Along this line the western half of the Lee-Tyringham pre-Cambrian dome is absent, and the Cambrian white gneiss and the lower part of the quartzite are carried down and concealed, the different beds of the pre-Cambrian on the east coming successively into contact with the quartzite on the west. (See Pl. VII, p. 86, and section D E.) East of East Lee the fault bends sharply, influenced by the northward thrust of the country to the south, and in the hill south of East Lee the boundary changes from an overturned and faulted contact to a normal contact, the Cambrian gneiss mounting unconformably over the pre-Cambrian gneisses.

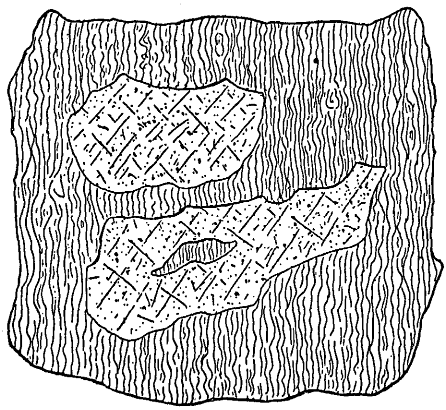


FIG. 9.—Layer of Cambrian slate on vertical Lee gneiss (at B, fig. 8), Lenox Furnace.

STRUCTURE.

Greenwater Pond anticline.—Along its northeastern border the Washington gneiss includes a wide band of Becket gneiss in a normal syncline which extends across Washington and Becket. West of this the Tyringham gneiss crops out over a broad area of great monotony. Still farther west is the curved axis of the important anticline of Greenwater Pond.

Limestones lie along the bottom of the deep valley. The steep walls are composed of the heavy black Lee gneiss, above which the barren Tyringham gneiss extends in low undulations a long way north and south, and finally sinks below the Washington blue-quartz gneiss. The axis of the Greenwater Pond anticline is continued beyond Shaw Pond and ends in the middle of the area, where it is covered by the uncomformable Cambrian gneisses.

East Lee anticline.—A mile east by south of East Lee another small but very interesting anticline, with eastward pitch, exposes the limestone bordered by the Lee gneiss.

Goose Pond anticline.—A mile farther on, Goose Pond lies in the bottom of a curved anticline, with axis pitching south and east at either end, which also exposes the pyroxenic limestones.

The deep valley in which lie Goose Pond, Long Pond, and its tributary brook has been formed by solution of the limestone. It overflowed for a long time into the Tyringham Valley, wearing a deep trench down the mountain side. This valley seems to have been tapped by the wearing back, along the axis, of the East Lee anticline.

The Goose Pond anticline is symmetrical with the Lee-Becket anticline in its Long Pond portion, and bends around in sympathy with the East Lee and Tyringham anticlines in its western portion. It has thus a curved shape like the Bear Mountain anticline (see p. 58).

The axes of these folds end abruptly on the west against the important fault that runs at the foot of the bluff from New Lenox to East Lee, which may be called the Lenox fault. The western prolongation of each of these anticlines was thus dropped below the level of the sea, in Cambrian times, and covered by the Cheshire quartzite and the Stockbridge limestone.

Foxden anticline.—The next interruption to the expanse of the Tyringham gneiss is a broad anticline of the banded Lee gneisses, which begins a mile and a half east of the outlet of Goose Pond, crosses the next road south, with a width of nearly a half mile, and ends unconformably a mile south of this road at a large ruined house, locally called Foxden, overlooking the Tyringham Valley.

The exposures here show perfectly the anticlinal position of the white-and-black banded gneisses in the stretched Tyringham gneiss, and the unconformable overlap of the white Becket gneiss upon the denuded anticline. Only a trace of limestone was found in the core of this anticline.

Hop Brook anticline.—The last interruption to the Tyringham gneiss before reaching the Tyringham fault is the Hop Brook anticline, at the foot of the Tyringham Valley. It is very interesting, both because of the abundance of fine minerals from the limestones of its core which have been found by Mr. Daniel Clark, of Tyringham, and from the light it throws upon the blocking out of the pre-Cambrian valley, into which the deep waters of the Cambro-Silurian sea penetrated, for the deposition of the calcareous beds now altered to the Stockbridge marble.

At the mouth of Hayes Pond, southeast of the valley, is a bed of green pyroxene-actinolite rock 40 feet wide, which, with the associated gneiss, represents the east end of the core of a long, narrow limestone anticline. The white-and-black banded gneisses wrap round the core and pitch steeply east, and can be followed across the pond and up the hill a half mile northwest, where they run under the Cambrian gneiss. They can be seen bending around from a south to a west strike at the house a little way south of the pond, and thence extend west to the

Tyringham fault. The last green actinolite beds of the core are near this house, and the deep erosion of Hop Brook has exposed the core, with many impure limestone beds, still farther west, to a point about 20 rods from the small settlement called Sodom, in Tyringham. They here go under the Cambrian gneiss, reappearing 4 miles down the valley at the Brookside mill, in the village of Tyringham, where, below the dam, the impure pre-Cambrian limestone, with chondrodite, wernerite, and titanite, appears beneath a low arch of Cambrian tourmaline-bearing gneiss, and is continued westward in a small isolated area of blue-quartz gneiss, which is exposed along the road running west down the Tyringham Valley from the mill to the town line. On the hillside above is a thin veneering of Becket gneiss, which has been worn off in the bottom of the valley. Blue quartz occurs in the striking cliffs by the roadside near the town line.

GENERAL PETROGRAPHICAL DISTINCTIONS.

Beneath the white Cambrian gneisses which border the area the Washington blue-quartz gneiss appears everywhere. Below this is a coarse biotite-gneiss, which is quite uniformly free from all accessory minerals and from beds of any different rock type. It is so highly stretched that it shows a ligniform, or small columnar, rather than a common foliated structure. I have called it the Tyringham gneiss.

It rests on a thick bed consisting of well-banded alternations of white granular gneiss and heavy black hornblende-gneiss or hornblende-biotite-gneiss, which I have called the Lee gneiss, and this rests upon the impure limestones which appear in the core of the anticlines.

The Lee gneiss is practically a calcareous facies of the gneiss in the neighborhood of the heavy limestone beds, and it sometimes seems to pass laterally into the Tyringham gneiss.

Hinsdale gneiss.—This rock is absent in the Sandisfield area, as the limestone is nowhere cut through to show the rocks which underlie it. On the road from Lenox Furnace to Washington occur bowlders of a coarse, zircon-bearing biotite-gneiss which closely resembles it but which could not be found in place.

Hinsdale limestone.—The fact, first suggested by Professor Dana,[1] that the removal of the limestone has formed many of the lake basins and valleys in this beautiful lake region, is of great value in the study of the distribution of this rock. The two valleys at East Lee, and the continuation of the more northern across the low col into the Farmington River Valley, Goose Pond, and several ponds in Sandisfield, are illustrations.

Observation is difficult, as the rock is covered by drift and water in bottoms of the valleys and must be studied mostly in bowlders. It is never exposed in beds so great as those in the Hinsdale area and is never so pure as there.

[1] The South Lee, the Hinsdale, and the Tyringham valleys are instanced as showing the influence on the outline of the Stockbridge limestone areas exerted by preexisting Archean channels or bays. J. D. Dana, Am. Jour. Sci., Vol. XXXIII, p. 276.

It is a coarse-grained, greatly gnarled and twisted rock, deeply weathered in the great bowlders which cover the surface where it occurs. It contains pyroxene and hornblende varying in color from deep green to white, phlogopite, muscovite, biotite, chondrodite, wernerite, titanite, chlinoclore, orthoclase, graphite, quartz, pyrite, and pyrrhotite.

Several of these minerals are always present in large amount, in varied and often quite characteristic groupings in different parts of the area. For instance, chondrodite is found most abundantly in masses larger than the two fists on the hill southeast of East Lee, wernerite north of Otis and in the bottom of the Tyringham Valley, and titanite in the northeast corner of Sandisfield, etc.

One mineral common in similar limestones is absent in this region. This is spinel, which is, however, found just south of this district, in Norfolk, Connecticut.

Lee black gneiss.—In the bluffs which border the East Lee Valley on the north and its continuation across Becket occur thick beds of a black, very heavy hornblende-magnetite-biotite-gneiss, which occupies a very constant position above the Hinsdale limestone and becomes a horizon of great value.

It represents a calcareous transition band above the limestone. A thin bed of a rusty graphite-pyrite quartzite seems to separate it from the limestone on both flanks of the East Lee Valley, but could not be found in place.

Along the south side of the valley and on both sides of the next valley to the south, by which runs the road to Goose Pond, the rock is still more strongly magnetitic, so that it is often prospected for iron, especially on the high hill a mile southeast of East Lee. It also abounds in large iron garnets, and this peculiarity can be traced along the north side of the East Lee Valley into Becket. Along both sides an upper bed is leek green and pyroxenic.

This rock also appears in considerable force in the crest of the high ridge north of East Lee, and may be studied by going up the hill road, starting 30 rods east of the East Lee Hotel. At the 1,400-foot contour the woods begin, and at the northwest corner of the clearing are two apparent ledges, which I assigned to the Becket gneiss but found to be great bowlders of the same. From this point a wood road runs up over the black hornblendic gneiss for 30 rods, and the rock ends where this road emerges in a clearing on the crest of a hill. Here it is a black, medium-grained rock, thin splitting and flat bedded. It is an anorthite-amphibolite, and a thin section (No. VI, 131*a*, National Museum Collection) of the black foliated rock cut transversely showed only a trace of quartz, little partly bleached biotite and magnetite, and no titanite. The green, moderately dichroic hornblende is not fibrous, but is in stout, ragged blades appearing in all directions in the slide. The centers of the blades contain many impurities.

The pleochroism is: a = yellow, b = yellow-green, c = blue.

The mosaic of anorthite occupies half the surface; about half shows multiple twinning with large angle of extinction; half the remainder shows concentric extinction, but no twinning. It incloses much hornblende in small plates and in minute straight needles.

The feldspars have very generally a common orientation, so that in the field they show a positive obtuse axis eccentric, with the axial plane about parallel to the twin striation.

There was nothing in the section that would lead one to think it an eruptive, and all its associations connect it with the calcareous gneisses.

A little west of the wood road before mentioned, the rock is white-and-black banded and is greatly twisted in its bedding. Farther west the quantity of hornblende diminishes, and north of the before-mentioned Becket gneiss bowlders it disappears and the rock graduates, with the strike, into the stretched Tyringham gneiss. It can be followed east as far as the limestone ledge, and here also it becomes a light-colored slightly hornblendic gneiss.

It is subordinate to the Tyringham gneiss, but as it borders the limestone areas in the different valleys for so long a distance it seemed well to maintain its distinctness within the area.

Where the band crosses the blind road on the mountain, a mile farther east, at the point where this road runs most northerly, it is a ribbon gneiss of many small hornblende bands interleaved with white gneiss bands.

On the southern side of the valley it can be best studied in the hill south of the hotel in East Lee, and is described in connection with the Hinsdale limestone. (See p. 33.)

It is well exposed along the desolate road which runs from Tyringham Valley over the mountain to West Becket as a series of markedly flat-bedded gneisses, of fine grain, which for nearly a mile across their strike present a continuous alternation of black and white beds from a fraction of an inch to 12 feet in thickness. The white beds have the appearance of quartzite, but are a compact quartz-feldspar mixture which looks as if it had been thoroughly crushed and recemented. The black layers are black from the great quantity of biotite and hornblende, and some beds are a heavy, black granular hornblende rock which resembles crushed tourmaline.

Tyringham ligniform gneiss.—This gneiss is, in perfect development, composed of bundles of quartz-feldspar pencils wrapped round with biotite. The dip is easily obtained but the strike often with difficulty. The rock is best developed across the center of Tyringham on both sides of Goose Pond. It is a coarse biotite-gneiss of very uniform character, barren of all accessories. Its biotite is gathered in elongate films more or less wrapped round the other constituents, and is generally rather dull black. The rock is very prone to decomposition.

Washington blue-quartz gneiss.—The peculiar lavender quartz so characteristic of the pre-Cambrian in the Appalachians is found in all the members except the limestone, but in the upper horizon it becomes extremely abundant and characteristic, so that it is the most constant guide to the settlement of the boundary between pre-Cambrian and Cambrian.

The rock is a coarse biotite- or biotite-muscovite-gneiss. Pyrite is a uniform and often abundant constituent, and the rock is always rusty. Graphite, so uniformly abundant and characteristic of the rock in the Hinsdale area, is found in quantities only part of the way across Washington, but reappears much farther south, in Sandisfield and New Marlboro.

Allanite, which is also abundant in Hinsdale, appears frequently in Becket and Tyringham.

The blue quartz appears in scattered nodular masses, often nearly an inch thick and fusing together into films on the foliation plane, and when the rock contains also large garnets and allanite, with the peculiar puckering around the crystals, it is beautiful and striking. The quartz is often granulated by crushing till only a small center remains, and the color is then wholly discharged. This crushing into a white sugary sand is very characteristic of the rock.

Where it crosses the road north of Ashley Brook it is a very coarse granite-gneiss, like that of Hoosac Mountain. The feldspars are often 4 inches across, at times resembling pebbles and having broad, curved cleavage faces. The blue quartz bands are sometimes 2 inches thick. Other beds are crushed to a fine granulitic rock, with flat, elongate, blue quartz seams.

The gradual granulation, by crushing, of the blue-quartz grains and bands, accompanied by an apparent discharge of the blue color, is very clearly exhibited here in all its stages.

The gneiss along the road from the outlet of Ashley Lake to New Lenox is a coarse to very coarse, granitoid, highly feldspathic, blue-quartz gneiss. Many layers are full of large manganesian garnets, often an inch across. The biotite is in distant membranes, branching out into masses an inch across. It winds in and out among feldspar or feldspar-quartz nodules 1 to 4 inches across. There is often much coarse tourmaline.

LIMESTONE AREAS.

East Lee limestone.—The deep valley which starts at East Lee and runs in a great curve southwest to Otis, containing Greenwater and Shaw ponds, is underlain by Hinsdale limestone and owes its position and shape mainly to the solution and removal of the same.

It is deeply covered by drift, which fills the valley, and can be best studied upon the high, bare hill between the two roads running east from East Lee. It is a coarse, white, highly crystalline limestone, coarser and of more translucent grain than the adjacent Stockbridge limestone, very impure, and coarsely warty upon the surface, from the solution of the purer parts.

It contains actinolite, pale-green and black pyroxene, phlogopite, and, most important, chondrodite, and in the hill above mentioned this mineral occurs in granular masses of the pure substance as large as one's fist and in rude crystals an inch long. Wernerite does not appear in this band, as it is not common in the limestone except near faults.

The mouth of the valley is greatly clogged by thick drift deposits, in which immense limestone bowlders are common, and by later post-Glacial sands, so that the relations of the Hinsdale limestones to the Cambrian deposits to the west can not be determined

The most westerly outcrop of the Hinsdale limestone is the great mass on the south side of the brook just east of the hotel. This is not certainly in place, but the great size of the outcrop and the direction of the glacial movements make it probable that it is in place here or still farther west.

Thirty rods farther west is an occurrence of the limestone in the foundation of a dam. Under the building and near the water wheel it is associated with great masses of the Stockbridge limestone, and this is probably the locality cited by Professor Dana[1] as a place where the two limestones could be seen in contact.

As the Stockbridge limestones dip in three different ways, they are probably bowlders, and from the outcrops to the west it is more probable that the Cheshire quartzite intervenes across the valley mouth, separating the two limestones from each other, as is represented upon the map.

Thirty rods east of the hotel a road runs north onto the mountain, and beyond the single house by the field road leading to the top of the clearing many outcrops appear in the wall at about the 1,400-foot contour. Above the northeastern corner of the east field is a cliff with a fine spring at its foot. For several feet from the base of the cliff the rock is the warty, impure limestone carrying chondrodite and green actinolite. It grades above into zigzagged strata of white, coarse, micaless, granitoid gneiss containing layers and wisps of green actinolite. These beds are together about 15 feet thick and grade upward into a fine-grained, flat-bedded gneiss much like the Cambrian gneiss. It is the transition to the Lee gneiss.

The great bowlders of the coarse limestone are very abundant for 2 miles up the East Lee Valley, to the point where the brook crosses the road to run north, but outcrops rarely appear.

The presence of these bowlders, the continuance of the bordering Lee gneiss in the hillside north and south, and the deep, continuous valley form the ground for believing that the limestone continues along the bottom of the valley.

Goose Pond limestone.—The limestone is almost wholly buried beneath the waters of the ponds, and the barren, stretched Tyringham gneiss appears in the heavily wooded and till-covered banks. In several

[1] On Taconic Rocks and Stratigraphy: Am. Jour. Sci., 3d series, Vol. XXIX, 1885, p. 205.

places the coarse chondrodite-limestones and the coarse pyroxene rock which replaces them form the shore, notably at Elwells Rocks, on the south side of Long Pond toward its eastern end. The superjacent hornblendic Lee gneisses appear in force at the end of the blind road south of Greenwater Pond.

Hop Brook limestone.—Starting 20 rods above the dam, at the small village of Sodom at the head of the Tyringham Valley, the bottom and steep banks of the brook show ledges and large bowlders of a coarse limestone which is more often a coarse-grained aggregate of silicates, both anhydrous and hydrous. Around the village of Sodom itself and at the foot of the steep cliffs farther east many large blocks of the same rock appear, which seem to have been brought down by the torrents of the brook, as they lie far north of the pre-Cambrian outcrops in a direction opposite to the trend of the ice in this region.

At the entrance to the road that leads to Sodom stands the house of Mr. Daniel Clark, whose splendid collection of minerals from the valley and large store of knowledge of the mineralogy of the country will be placed at the service of any student.

The outcrops are mostly concealed in the steep, moss-covered banks of the mountain brook, and they have been exploited at much expense by Mr. Clark. I spent several days studying his collections, and the special peculiarities of the minerals which occur here are described in the mineral lexicon appended (pp. 103–127).

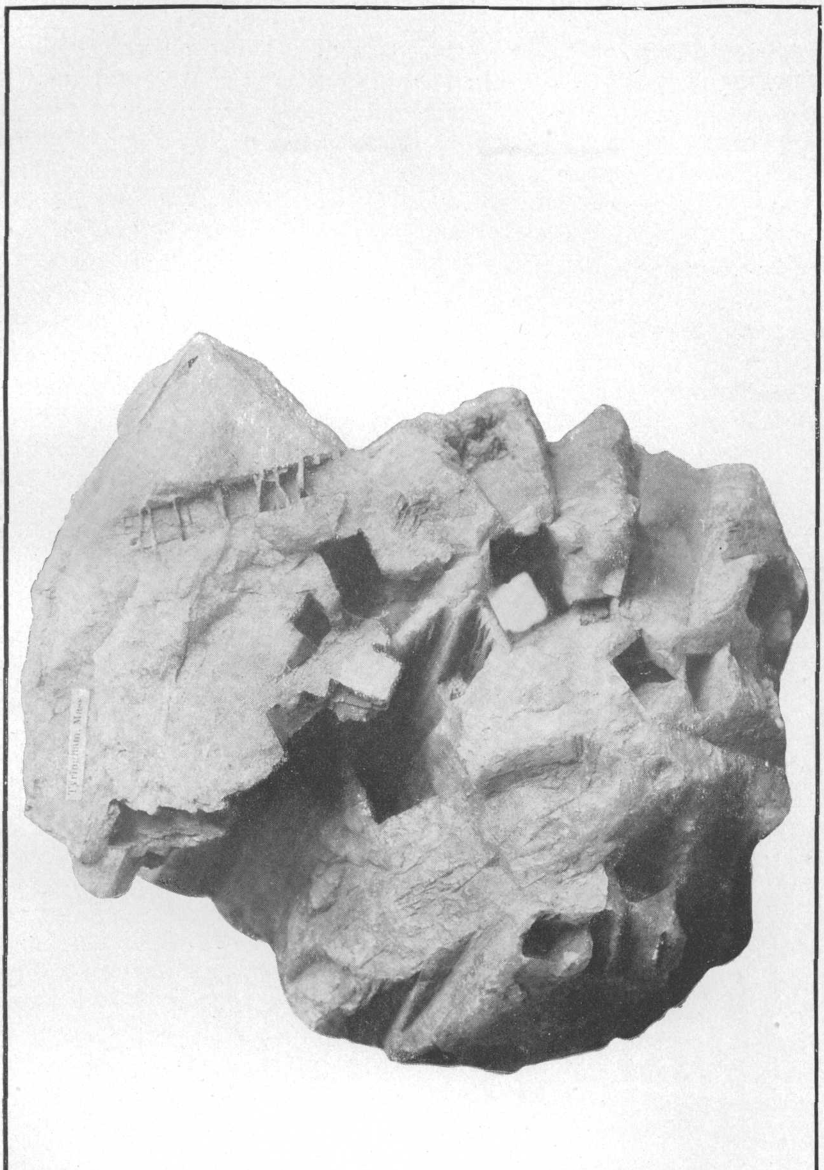
The masses of white, granular quartz-calcite mixture, with small amount of green pyroxene, titanite, and tourmaline from the altered limestone, are catalogued by President Hitchcock as "augitic gneiss from Lee and Washington," in catalogue of Massachusetts collection, under gneiss, 92 to 95.[1]

"Mortised rock" of Tyringham.—At Tyringham quartz pseudomorph after plagioclase is found, penetrated by square cavities from which salite has been removed. (See Pls. II, III.) In these most remarkable specimens great masses of clear vein quartz are penetrated by square cavities from which large crystals of salite have been dissolved, while the quartz proves to be pseudomorph after large masses of plagioclase, presumably albite.

The replacement is so delicately perfect that the twin structure is perfectly preserved, exactly as in cleavage surfaces of albite. This twin striation appears over large areas and is absent over other large areas, and the alternation occurs both in the direction of and at right angles to the striation.

Moreover, the pearly luster of the 0 (001) face is perfectly reproduced in the fractured surface of the quartz, showing that the replacement has preserved the structure of the albite, on which the pearly luster depends; that is, repeated separation along the cleavage planes and

[1] Rept. of Mass. Board of Agric., Appendix, 1856, p. 51.



MORTISED ROCK; QUARTZ PSEUDOMORPH AFTER ALBITE, CONTAINING CAVITIES OF SALITE CRYSTALS; TYRINGHAM.

MORTISED ROCK; QUARTZ PSEUDOMORPH AFTER ALBITE, SHOWING TWIN STRIATION AND PEARLY LUSTER, WITH CAVITIES FROM WHICH SALITE CRYSTALS HAVE BEEN REMOVED; TYRINGHAM.

the formation of air-filled interspaces which have the effect of Newton's rings.

Many of the quartz fragments split into large, acute, wedge-shaped pieces, which are aggregated in alternate arrangement of the separate wedges exactly like the Clevelandite variety of albite from the tourmaline-pegmatite veins.

The Tyringham specimens present an interesting and complete series, showing the alteration and disappearance of the pyroxene. There are, first, masses in which the long, white, four-sided prisms of salite, sometimes slightly truncated at the edge and distinctly striated on some faces, are from a half to a quarter inch in thickness and several inches long, loosely aggregated, and passing into a compact salite rock.

There are other specimens in which the same white prisms are inclosed in white or smoky quartz. They show the very strong basal parting of salite, and are often an inch across. They can be seen to be in some places wholly or partly replaced by a secondary tremolite or pale-green actinolite, and the quartz shows distinct traces of the tabular form and the twin striation of albite.

In other specimens the whole or almost the whole of the salite is dissolved, and the cavities take sharp casts of the longitudinal striation of the crystals as well as of the transverse partings which cross the cavity with the proper obliquity of the basal section of salite.

These specimens were found at Sodom, in the upper end of the Tyringham Valley, in the pre-Cambrian limestone. I was therefore greatly surprised to receive from a student a large specimen of the same cavernous quartz, which was found by his father, Mr. Charles T. Barker, during the digging of the cellar under the Berkshire Life Insurance Building in Pittsfield. It is a wholly unworn block 6 inches on a side. The angular faces look as if they might have been broken artificially, and the weathered surface of the block suggested that it had been buried many years. It is full of cavities, some of which are an inch across and 6 inches long. A 6-inch surface shows over half its area a fine representation of the albite cleavage, and half the rest has the appearance of the pearly feldspar cleavage; yet the whole is a clear, translucent quartz, from colorless to smoky, and splinters broken off from the surface showing striation displayed the perfect optical figure of quartz very obliquely placed. I can not imagine that the specimen was brought to its present place by ice, for the proof of its pre-Cambrian origin is quite complete and there is no pre-Cambrian limestone area to the northwest.

From the interest which these mortised stones have created in the past I imagine that the specimen may have come from the Tyringham Valley and have been at some time a part of a collection in Pittsfield, as the place where it was found adjoins the former habitation of the Berkshire Historical Society. This is the specimen figured in Pl. III. Mr. Daniel Clark, who has collected most of the specimens upon which the foregoing description was based, has written me as follows concerning the Pittsfield specimen:

The specimens have never been found except as drift. I have never seen any ledge, but they occur in numerous specimens from small size to several tons. They could not have drifted far, for they were angular and showed no signs of erosion, and were found on a few acres in Sodom.

The specimen which Mr. Barker found in Pittsfield I believe to be from this locality. Over forty years ago Mr. Stephen Reed, of Pittsfield, who was interested in minerals, visited my place, and I gave him several specimens of what we then called mortised rock, and I believe your specimen from Pittsfield is one of those Mr. Reed carried from here at that time. I have never known of any specimens being found in Berkshire County except in this locality.

Metamorphosis of the pre-Cambrian limestone and paragenesis of the limestone minerals.—The following tabular statement, derived from study of the Hop Brook and Otis limestones, may make clear the probable steps by which the rich mineral beds along Hop Brook have been formed. That this has been along a line of faulting has had much to do with the complexity of the result. A detailed description of all the minerals mentioned is given later:

First stage: A fragmental limestone.

Result of vital forces and transportation. The bed was at first presumably an accumulation of animal remains .... First calcite

Second stage: A crystalline limestone.

Result of circulating carbonated waters with heat and pressure. In its least-changed state the bed is now always highly crystalline—has recrystallized many times in every part .... Second calcite

Third stage:

(*a*) East Lee facies. Chondrodite-phlogopite-limestone, with much clinochlore, coccolite, and graphite.

Result of circulation of heated waters carrying silica and fluorine. Characterized by very basic magnesian fluosilicates.

(*b*) Otis facies. Pyroxene-wernerite-titanite limestone.

Result of more intense dynamic and thermal activity along fault planes and the circulation through the limestone of heated waters containing fluorine, chlorine, and titanium compounds.

Characterized by graphite, green and white pyroxene, stout black hornblende, great blocks of wernerite and chalcedony, opalescent orthoclase (loxoclase), albite in great masses inclosing salite and calcite, and pink, white, and gray calcite in coarse crystals .... Third calcite

(*c*) New Marlboro-Norfolk facies. A limestone containing the minerals of *b* with wernerite replaced by spinel and nickeliferous pyrrhotite.

Characterized by abundant aluminous silicates, which may perhaps be derived from clayey limestones, while the chlorine may come from the ancient sea in which the sediments gathered, and the graphite from the organic remains. The abundant titanite was probably brought into the limestone from without, and this makes it possible that the same may be true of the alumina silicates.

Fourth stage: The mortised rock (*a*).

Extensive pseudomorphic replacement of albite by quartz (see Pls. II, III) without affecting the inclosed salite; resorption of salite for the formation of actinolite, which incrusts the remnant of the salite.

Result of continued action of silica solutions under changing conditions of heat and préssure.

Fifth stage: Quartz inclosing actinolite.

Extensive development of large biotite crystals in veins in which the crystals are greatly crumpled by later movements on the fault. Result of silica solutions at lower temperature.

Sixth stage: Zeolitization.

Formation of scolecite by the decomposition of wernerite. The formation of actinolite continues.

Seventh stage: Zeolitization, continued.

Development on the earlier scolecite of heulandite, stilbite, scolecite, laumontite, and calcite. Formation of jasper inclosing fragments of earlier silicates. Result of warm waters and long time........................Fourth calcite

Eighth stage: Decomposition and hydration.

Jefferisite from biotite, kaolin from feldspar; solution of calcite and etching of crystal faces. Formation of chalcedony inclosing jasper. Effect of atmospheric waters and moderate temperature.

SANDISFIELD AREA.

The long and peculiarly shaped area of pre-Cambrian rocks lying south of the Otis area and the extension of the Tyringham fault down the valley of Clam River and across Sandisfield and Colebrook, is composed almost wholly of the upper member of the series—the Washington gneiss.

In the center of the southern lobe only, where it is widest, is there a trace of the green pyroxene-hornblende rocks, usually associated with the Hinsdale limestone. The most striking occurrence within the area defined above is found at the northwest corner, in the pasture opposite the house of the mineralogist, Mr. D. Clark, at the head of the Tyringham Valley. In the western part of the pasture the white Cambrian gneiss abuts unconformably against the pre-Cambrian gneiss. The blue-quartz gneiss near the house is so full of allanite and its decomposition products that often a dozen crystals appear in a single hand specimen. In tracing these gneisses down from the north this has been found to be characteristic for a long distance. Allanite does not appear much farther south, but is replaced by fibrolite.

Along the west boundary, 2 miles south of Mr. D. Clark's, at a point a mile west of West Otis, just where the boundary line cuts the line of long. 73° 10′, is a beautiful unconformable contact of the Becket gneiss on heavy beds of chondrodite-clinochlore-limestone, which is very pyroxenic and has a broad border of green pyroxenite. It is a medium-grained white marble, banded in places by black ore, and occurs in sufficient quantity to suggest a possible quarry stone.

The hill 1½ miles south by west of Sandisfield, which forms the apex of the pre-Cambrian lobe extending northwest from South Sandisfield, presents peculiar conditions. In the hollow of the north foot of the hill (south of the road) is a typical Cambrian quartzite, at first massive, then, three rods south, banded granular, with magnetite grains, which further south grades into typical Becket gneiss. Two or three rods south of this, in the north foot of the hill, is a 6-foot band of white fibrolite-gneiss, which is continuous with the coarse, crushed Washington gneiss and impregnated with a coarse feldspathic pegmatite in veins and irregular masses.

All along the tortuous boundary the limit of the Washington gneiss can be fixed by the presence of graphite and fibrolite in a two-mica rusty gneiss, and over the whole area the same characteristics exist, although there are many bands from which pieces much like the Becket gneiss can be taken.

A mile south of South Sandisfield, near a watering trough, a black pyritous quartzite occurs, which is like that above the limestone in the East Lee Valley.

At the southern apex of this area a pale-pink garnet is abundant and of large size. The regular intergrowth of muscovite and biotite is quite characteristic.

Bands of black hornblende-gneiss and green pyroxenite occur just north of the State line in Sandisfield, south of A. Ducharne's house. This rock is rather bright-green, finely granular, and passes into a light granular quartzite made up almost wholly of cuboidal grains of bright-green pyroxene, with distinct dichroism to pale-brown in basal sections and with very coarse prismatic or pinacoidal cleavage. Some grains are centrally darker in color and full of dark ore grains. There are a few grains of orthoclase, plagioclase, biotite, a green mineral like epidote, and a deep-green actinolite. This rock contains no calcite, but it is clearly one of the derivatives of the limestone and is changing into an amphibolite.

In one instance, in the neck that connects Seymour Mountain with a rocky spur projecting southwest, distinct pseudoconglomerate structure appears in the graphitic gneiss. The same rock composes the whole top of the hill west of Seymour Mountain.

Above the 1,600-foot contour the entire hill is composed of coarse, warty, very micaceous gneiss, with rusty, coarse, sandy grained mass. The nodules are about the size and shape of pecan nuts and consist of coarse blades of overlapping muscovite and biotite, often with more or less dark gray from spots of radiated fibrolite. They are first orthoclase, then muscovite, then fibrolite.

The contacts can be well seen at the bridge over Buck River, a mile above West New Boston. The first reefs below the bridge are of Washington graphitic gneiss. Six rods farther is the contact with the thin-banded Cambrian gneiss. The contact is exposed again where the rock crosses the two roads northwest of Seymour Mountain, on the mountain itself and on its southeast spur, as given above, and where it crosses the brook east of Mount Pisgah, on the south line of the quadrangle.

OTIS AREA.

This area is cut off on the south side by the Tyringham Valley fault, which is continued down the valley of Clam River; on the north side it is bounded by the East Lee Valley fault, which follows the bed of

Farmington River. Between these two faults there is a central band of Hinsdale limestone and its derivatives, flanked on either side by the rusty blue-quartz gneiss.

On the west, at the north foot of Filley Mountain, fibrolite begins to appear, and ultimately replaces the blue quartz farther south. On the top of the mountain the two occur together, but the blue quartz can not be traced much farther south as an important constituent.

The eastern boundary seems to coincide with the Farmington River, and the first outcrops to the east, in the high banks, are of the Cambrian white gneiss, until, in the bluffs across the brook south of the blind road at P. Davison's, there is, at an old mine said to have been worked to a depth of 10 to 15 feet, an apparent outcrop of a pyritous wernerite rock of pre-Cambrian age. It seems to lie a little west of the bluffs of white gneiss.

The boundary then runs southwest into Sandisfield, and at the south foot of the hill, 40 rods west of H. S. Hawley's, the last house before turning off to Cold Spring, is another old mine. A deep trench runs into the hill where the white gneiss on the east and the rusty, graphitic, pyritous gneiss full of garnets and black hornblende (this is the ore) on the west are closely approximated.

The next point where the two can be seen to approach each other is on the hill west of the south end of Spectacle Pond, in Sandisfield. The apex of the hill north of an abandoned house is of the white gneiss, standing nearly vertical, with the strike shifting from north around to west, in great folds, from the influence of the fault to the south.

The western boundary is normal. The rusty gneiss rests against the white gneiss and is overturned to the west.

The boundary of the pre-Cambrian on the Cambrian is carried, both on the northwest and on the southeast, directly across the strike of the two, while whenever the two are found in immediate contact they are squeezed into superficial conformity. This is because of the lack of sufficient outcrop. If one could trace the whole boundary, I have no doubt it would run northeast in general direction, but with many sharp serratures directed northwest and southeast.

The bottom of the Farmington River Valley in Otis abounds in large bowlders containing, in great abundance and often in very fine crystallization, the following minerals: wernerite in white stout crystals and large lavender masses, pale-green pyroxene in cleavage masses several inches across, titanite, hornblende, emerald-green actinolite, pyrite, and graphite.

On the hill a half mile south of the hotel is an outcrop of coarse, granular, scarcely cemented limestone, carrying red-brown titanite and grains of wernerite and coccolite, deeply excavated by weathering, from which, tradition says, two cart loads were once blown out by a mysterious explosion while the owner of the farm was in close proximity to the place.

Along the river in Otis Center there are also found many large bowlders of a fine chalcedony, a very characteristic fault rock which gives evidence of the special activity of circulating solutions along the fault plane. There are, among others, very large masses of fine, white to pale sky-blue bowlders, which are drusy and botryoidal in cavities. They represent the last stage of deposition, since they inclose many angular fragments of a deep-yellow jasper, showing that this jasper had been an earlier filling of the fissure, made, doubtless, by waters at a higher temperature, which were able to dissolve iron as well as silica from the gneiss.

Both these chalcedonies contain fragments of the wernerite, proving that still earlier movements had shattered the wernerite limestone, that a solution of the calcite had followed, and that, later, a cementation of the residual silicates by silica had taken place.

"SNOWPLOW" ANTICLINE OF BEAR[1] MOUNTAIN.

"Beartown Mountain. The vast pile of mountains that bears this frightful name lies southeast of Stockbridge." (Hitchcock's Final Report, p. 235.)

The great anticline of Sky Hill and Bear Mountain has been closely folded, with north-south axis, has been strongly overturned to the westward, and has then been bent around into a sharp V (with apex directed northwesterly), by the movement of the north limb of the anticline around through the east quadrant so as to point southeast. It is, of course, not intimated that these events happened successively, though it does not seem to me wholly impossible that such may have been to some extent the case. It is certainly most probable that they were nearly contemporaneous.

As a result of this posture of the rocks, the high ground, consisting of older rocks, encroaches on the limestone valley to the west by exactly the full width of this anticline. The general structure of the anticline can well be compared to one of the large double railroad snowplows formed of two vertical concave surfaces which diverge from a central prow. If the Cambrian gneiss on the north and west of the pre-Cambrian could be removed, the north and west surface of the pre-Cambrian would have the shape of such a snowplow. In other words, northeast and southwest sections across the mass present a gradually widening fan-structure as they are drawn along lines more and more distant from the apex at the northwest.

The same structure is continued for many miles to the southeast, and 1 mile south of Monterey the Cambrian conglomerate-gneiss mounts over the Stockbridge limestone in a similar snowplow anticline and is itself surmounted in the same way by the pre-Cambrian of Morley Hill.

The area of exposure of the pre-Cambrian in Bear Mountain is lunate; a narrow band extends from the apex down the crest of the

[1] See footnote on p. 13.

mountain from its northern end for 4 miles south, bends east, with an easy sickle-shape, and ends just across the road north of Livermore Hill.

The west lobe has an average width of less than a half mile. From its northern part it sends a broad lobe, a mile wide, east for 3 miles into the Sandisfield quadrangle. The western lobe is composed of the Washington blue-quartz gneiss, often strongly banded, graphitic, and very rusty. The eastern lobe, excepting its eastern end on Sky Hill, which is described below, is composed of the coarse, white, liguiform Tyringham gneiss.

A band of black amphibolite, of fine grain and well bedded, which occurs at or near the contact but within the Becket gneiss, aids in fixing the limits of the older bed.

The structure of the western lobe is that of a closely compressed anticline overturned to the west. Its axial plane strikes a little west of north for three-fourths of its length and bends around to strike southeast in its southern fourth; it dips 75° to 80° E. The best places to study the beds are where the road crosses Bear Mountain on its south end a mile north of Livermore Hill, and on the top of Sky Hill. At the former place the axis of the fold is exposed in a heavy bluff on the east of the road south of a coal-burner's hut, and is a coarse, very quartzose biotite-gneiss, quite rusty and well banded, and composed almost wholly of blue quartz.

Fifty rods to the south the amphibolite crosses the road and fixes the boundary. Fifty rods north, at the highest ground south of the last bridge over the brook, the white Cambrian gneiss can be seen in contact with the blue-quartz gneiss, dipping away from it, with many convolutions, to the northeast.

The bed of amphibolite crosses the brook opposite the schoolhouse a mile east of Bear Mountain peak, and appears in great force three-fourths of a mile southwest of that point and 100 rods southeast of the peak, where it has a width of 40 rods. From the schoolhouse it bends east and runs down the Monterey road to the boundary of that town. The boundary of the bed continues along near the road, often marked by small hornblendic bands.

At the isolated home of Mr. Beebe, the well-known weather prophet of the mountain, the amphibolite again appears, while south of that point, in a section a mile long crossing the whole band from north to south and emerging near the beginning of the Monterey road, only the monotonous Tyringham gneiss is visible.

At the east end of the syncline is Sky Hill, rising above the former settlement of the Shakers, at Fernside, and noted as the burial place of Mother Ann, queen of the Shakers.

An area nearly a mile long and a third of a mile wide, upon the crest of the hill, is occupied by the rusty graphitic Washington gneiss, while the white Cambrian gneiss wraps round the two kinds of pre-Cambrian rocks, showing unconformity.

A bed of coarse gneiss, with a band rich in hornblende and titanite, is the southeastern apex of the pre-Cambrian rocks. Everything indicates an overturned anticline of the older rocks included in the Cambrian Becket gneiss.

The Becket gneiss is abundantly exposed over broad areas to the east and north, and strikes N. 20 to 30° W. and dips 30 to 40° W. under the pre-Cambrian. On the eastern slope of the east spur of Sky Hill the Becket gneiss rests, wavy and irregular, on the older rock, which is a stretched gneiss of light color with large grains of magnetite.

At the top and at the east aspect of this hill the typical rusty, blue-quartz, graphitic gneiss is in great force—a ragged-surfaced, well-banded, rusty-brown rock.

The bedding is expressed by bands almost an inch apart, which, being more quartzose, stand at a regular uniform level, while the intervening micaceous layers are deeply excavated by weathering, making a very rough surface. The rock is always very rusty, and at times shows an abundance of lavender quartz, but is usually so crushed that only a blue core can be seen here and there.

The boundary is beautifully exposed around the north slope of this east spur, and runs 5 rods south of two great dead trees which are visible from the whole length of Tyringham Valley below. It then runs northwest, past a large cellar of the abandoned Shaker settlement at the 1,700-foot contour northwest of the summit of Sky Hill.

All of Sky Hill for 100 feet down is of the same rusty rock. A great band of black, heavy, hornblende rock runs across the crest of the hill, and west of it is a micaless gneiss with the aspect of a quartzite. A hundred feet down the slope on the west is a very rusty, extremely graphitic schistose gneiss. All these beds are pre-Cambrian.

Going down the mountain to Fernside we pass over the whole Cambrian and Silurian series inverted, and then over the Silurian and Cambrian in normal order, and come upon the pre-Cambrian in the bottom of the valley. In order to understand this complex syncline one should consult the sections of Bear Mountain in the Housatonic folio.

MONTEREY AREA.

As a result of strong overthrusts to the west a small pre-Cambrian area appears on the south line of Monterey, between two brooks. Its south end is in New Marlboro, at the brook which crosses near the house formerly occupied by E. R. Smith, 2½ miles south of Monterey.

Here the section in fig. 10 is exposed. Beneath the dam the Becket gneiss is in place, with traces of pebbles 1 to 5 inches long. This gneiss is continuous in the field northeast of the house, and contains the beds of amphibolite which mark the neighborhood of the Cambrian contact. The rock dips northeast and seems conformable with graphitic gneiss, which appears in the yard of the house and can be traced into the great hill of pre-Cambrian rocks to the north. It is overthrust onto the Stockbridge limestone, which appears in great force west of the house and to the south grades into mica-schist.

On the hill to the north the blue-quartz gneiss is abundant, associated with coarse graphitic gneiss. Coarse black hornblende in large cleavage pieces, rusting to red in the center, and a dark-green pyroxenic rock with remnant of limestone, also occur here.

All along the northwestern border is a sugary crushed rock, almost wholly fine granular plagioclase, with a uniform small amount of magnetite, and at times minute garnets, a little biotite, and films of muscovite. It carries also lenses of deep-green to black coarse hornblende, with centers of the coarse calcite from which the silicate has been derived. The whole is a crushed facies of the pre-Cambrian limestone on the fault.

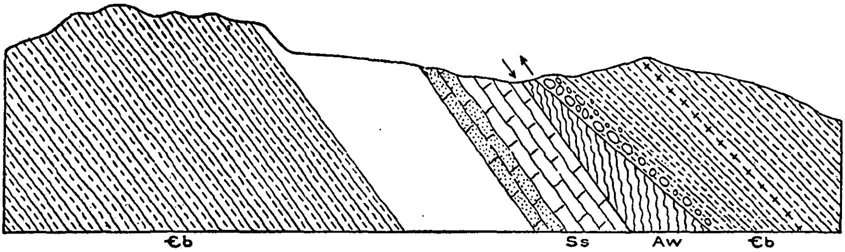


FIG. 10.—Overthrust of pre-Cambrian on Stockbridge limestone; north line of New Marlboro. €b, Becket gneiss; Ss, Stockbridge limestone; Aw, Washington gneiss.

SOUTHERN AREAS.

The small pre-Cambrian outcrops which run south from New Marlboro village to the southern line of the town are everywhere very rusty and have often tempted the landowners to unremunerative mining, as at the Cleveland, Hotchkiss, and Wadsworth mines. Bands of impure limestone are abundant and have often been changed, more or less, to silicates. Calcareous amphibolites and pyroxenites are as a result common, and often carry a nickeliferous pyrrhotite, which at the Hotchkiss mine has furnished fine crystals.

The limestones are characterized by the abundance of sulphides of iron and by the absence of the finely crystallized silicates, of wernerite, and of various forms of chalcedony, which appear farther north, where the beds are cut by great faults.

The pre-Cambrian rocks lie in whole or in part in deep landlocked depressions, which seem to have been formed by the removal of the limestone by solution, the sinking in of the thin, flat Cambrian cover and the later removal of its fragments. The last stages of this work of removal we may ascribe to the action of the Glacial ice.

NEW MARLBORO AREA.

A mile southwest by south of Southfield, at the house of G. Lawrence, the Becket gneiss, with a band of black hornblende-gneiss, crosses the road.

A few rods north are large cliffs of the rusty, very graphitic gneiss, with pale-green hornblende, and the boundary can be followed from there N. 60° W., making a sharp loop where it crosses the border of the quadrangle and then going northwest over the north flank of the hill, passing thus into the Sheffield quadrangle. It again enters the Sandisfield quadrangle on Collins Hill, where the Cambrian gneiss is beautifully conglomeratic,[1] and runs along just south of the road into New Marlboro and through the village to a point near a small dam east of the town.

On Collins Hill the pre-Cambrian gneiss contains the blue quartz which is so characteristic farther north.

AREA SOUTHEAST OF SOUTHFIELD.

High bluffs of the light Becket gneiss rise north of the house of J. Wade and occupy the hill to the south of it, and between emerges a small pre-Cambrian area, mainly in the valley bottom, but rising a little above it a short distance west of the house. This area is a flat triangle about 100 rods long and 40 rods wide, and along its northeast border rises a band of coarse, impure limestone and pale-green hornblende-gneiss.

HARMON PÖND AREA.

The banks on the east side of this pond descend almost vertically into deep water, and 3 feet above the water's edge the pre-Cambrian emerges from beneath the Becket gneiss as a band of green amphibolite with a thin band of coarse, loose, granular, coccolite-chondrodite-limestone, and a micaless gneiss with titanite and chlorite pseudomorph, apparently after titanite. Bowlders of the pre-Cambrian rocks are found around the pond, but the first outcrops in the bluffs back from the water are Cambrian. (See section of Cleveland Mountain shown in fig. 11, p. 64.)

SOUTHFIELD CEMETERY AREA.

A little way up the hill from the Southfield cemetery, a mile south of the village, is a ledge by the roadside where the extremely rusty character of the rock has tempted somebody to waste time in blasting, and the ledge has been so undermined that the rock can be seen to form a low dome. Outcrops of the Becket gneiss are near at hand on all sides, showing that it is a very limited area domed up through the newer rock, which is an exceedingly rusty dark-green pyroxenite, largely hornblendic.

HOTCHKISS AREA.

Northwest of East Pond in New Marlboro, a few rods north of the house of Mr. I. Hotchkiss, a bed of massive, white, coarse limestone emerges from beneath the Becket gneiss, which is at this point a fine quarry granite, and a limekiln has been erected here. The limestone dips 25° N. on the north side of the quarry and 20° S. on the south side.

[1] My attention was called to the locality by Prof. William H. Hobbs.

It is exposed with a thickness of 10 feet, and no bottom appears. It is exceptionally pure; a few small chrondrodite grains and pale-green chlorite flakes occur.

At the edge of the brook, a half mile below the house, a shaft has been sunk about 12 feet upon a group of small pyrite veins in the coarse, rusty, dark-green pyroxenite. Crystals of pyroxene an inch across can be found, generally eight-sided prisms, terminated by imperfect and rounded O faces. A coarse-bladed green hornblende also occurs. Two veins of the pyrite are 3 to 4 inches wide, bunching to a foot and showing rude cubes of pyrite 1 to 1½ inches across, and pyrrhotite in cubical masses up to an inch on a side and in fine crystals an inch long—three-sided, slightly tapering prisms with edges truncated. These crystals weather to a liver-brown; a basal cleavage develops, and the layers warp apart and spoil the crystals.

Albite occurs in druses of many-faced crystals, with beautiful play of color on the $\infty P \infty$ (010) faces. On the dumps everything is coated with a crust of a colorless sulphate.

CLEVELAND AREA.

This is a triangular area 1 mile long from east to west, a half mile wide from north to south, half on the Sheffield quadrangle and half on the Sandisfield quadrangle.

At its northern apex is the Cleveland iron mine, about 100 rods northeast of the house of J. Cleveland. The Becket gneiss, somewhat granitoid, rests nearly horizontally upon the Hinsdale limestone, which is 4 or 5 feet thick, and below this, in the hillside, is a great thickness of the coarse, light-colored Hinsdale gneiss, in which is an irregular vein of magnetite, bunching in places to a foot in width.

The limestone is a white, firm, coarse-grained rock, in most of its thickness showing only a few pale-green mica scales. Some layers are filled with green mica, buff phlogopite, deep-red chondrodite, and colorless tremolite in fine needles.

Commencing about 10 feet below the limestone the gneiss is extensively trenched to open the iron ore. The most abundant variety is a clear gray gneiss, much resembling at first sight the Becket gneiss above the limestone. It is darker gray, firmer, and the black mineral is sometimes wholly black granular hornblende in rounded separate grains with fused surfaces, very different from the same mineral in the black Cambrian gneisses. In other places the black mineral is wholly magnetite. Much of the gneiss is highly stretched, the very scanty dark mineral being a dark-green hornblende, or epidote and hornblende.

Along the magnetite vein the rock is greatly crushed. The purest magnetite is mixed with hornblende, and the folia of the white gneiss inclose rows of large hornblende nodules and masses of epidote and contain druses of albite crystals in cavities.

Coarse, friable, granular limestone, containing many small grains of dark-green hornblende and pistachio-green pyroxene, are caught up in the crumpled rock (see fig. 11) or intergrown with the white hornblendic gneiss. This is very different in texture and accessories from the compact thick-bedded chondrodite-limestone above. It can best be looked upon as a calcareous vein stone derived from the normal interbedded chondrodite-limestone.

The contact may be seen in the edge of the woods north of the house of J. Canfield, nearly 1 mile southeast of the Cleveland house, just at the west edge of the long bluffs of contorted Becket gneiss which border the road on the north for a long way east of this house. The biotite-gneiss changes suddenly into the coarse hornblendic gneiss. The boundary turns sharply west at this point and must closely follow the road west, as the outcrops of the biotite-gneiss are abundant on the south side of the road past the southern end of the Cleveland road to the vicinity of the Wadsworth mine, 100 rods north and 10° east of the house of Mrs. J. P. Wadsworth. Here are two openings, 10 feet deep, upon a rusting bed of calcareous actinolite-schist. A former limestone bed has been almost wholly changed into balls of a granular grass-green hornblende-biotite mixture. The limestone is pinched into the gneiss in a remarkable way, and where it is changed into hornblende rock it could be mistaken for an altered dike.

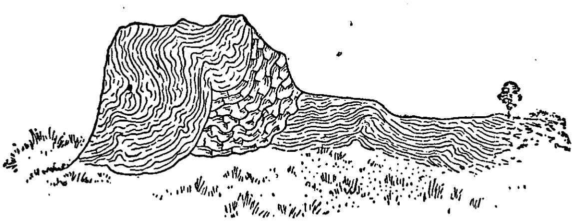


FIG. 11.—Limestone pinched into pre-Cambrian gneiss, Cleveland mine, New Marlboro.

In the center of the area is the Cleveland mine proper—a shaft about 20 feet deep. The rock is a deep-green massive pyroxene-hornblende, carrying much pyrrhotite and a little chalcopyrite, considerable coarse granular calcite, and graphite. The mine was first opened as a gold mine, and I was shown a nugget of gold half as large as a pea and one of silver as large as a dollar, which were said by the owner of the mine to have been obtained from a barrel of the ore (500 pounds). The assay was made by a Boston firm. An assay made by Arno & Co., Cedar street, New York, gave $5.50 gold and $0.75 in silver for 500 pounds. Later assays have shown no precious metals but varying quantities of nickel from 3 to 26 per cent. This information was given me by Mr. Cleveland. The bed was being worked in 1891 by a New York firm as a nickel mine.

The structure of the Cleveland area is anticlinal. The axis is N. 35° W., and the whole is overturned to the west, so that at the northern end, where the overturn is complete, the Becket gneiss rests almost horizontally on the Hinsdale limestone and gneiss. On the southern end they stand almost vertically. Along the southwestern side the

Becket gneiss dips low beneath the older rock and is inverted. Still farther west and lower down the Cheshire quartzite rests on the Stockbridge limestone in the beautiful dome cited by Professor Dana;[1] so that going west from the Cleveland mine one has the whole series, from the pre-Cambrian to the limestone inverted, as indicated by fig. 12, showing section through the Cleveland mine and through Harmon Pond.

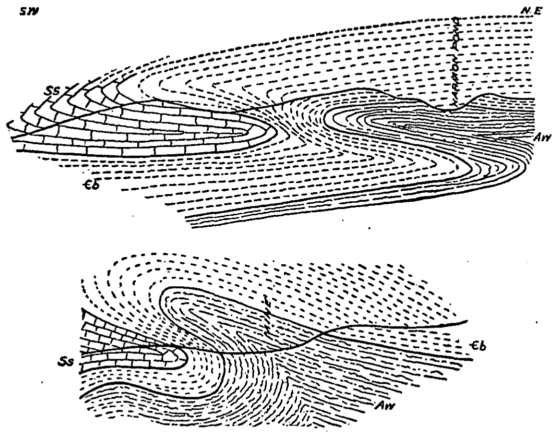


FIG. 12.—Overturned anticline in Cleveland Mountain, west of Harmon Pond, New Marlboro. Єb, Becket gneiss; Aw, Washington gneiss; Ss, Stockbridge limestone.

NORTH CANAAN AND WEST NORFOLK AREAS.

Limestone.—On the road from Norfolk that enters North Canaan at its extreme northeast corner are fine ledges of the white Cambrian gneiss. Crossing the brook and going southwest up the hill we find a small wooded knoll just southeast of the road, which consists of the characteristic schistose nodular gneiss of the region, and shows on its eastern aspect the single outcrop of limestone which is found in the pre-Cambrian of this area. It is in the east edge of the woods and 10 rods from the road, and is exposed only 30 feet from north to south and a few feet in width. Prof. William H. Hobbs blasted into it for 8 feet and found it a true outcrop. The limestone dips 50° W. underneath the nodular gneiss, while a few feet to the east the Cambrian gneiss outcrops in the pasture, striking N. 20° E. and dipping 70° W. It is a coarse granular limestone of translucent grains, with rotted chondrodite, phlogopite, and large blue orthoclase nodules.

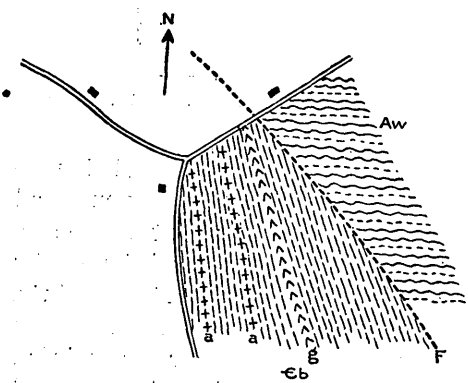


FIG. 13.—Fault contact of pre-Cambrian (Aw) on Cambrian Becket gneiss (Єb) containing granite (g) and amphibolite (a); northwest corner of North Canaan.

Nodular gneiss.—The coarse, rusty, highly micaceous muscovite-biotite-gneiss adjacent to the limestone described above is full of large pebble-like nodules, which represent ancient porphyritic feldspars, now

[1] On Taconic Rocks, etc.: Am. Jour. Sci., 3d series, Vol. XXIX, p. 222. (Locality 14 on Dana's map.)

largely changed to matted masses of coarse muscovite which is filled in varying degrees with fibrolite. It also contains large garnets, and weathers to a very rough surface.

The rock contains graphite regularly, and is exactly like the rock of Seymour Mountain in Sandisfield, into which I have traced the pre-Cambrian blue-quartz gneiss of Tyringham and Otis. (See p. 56.)

Following the road a half mile southwest, to near its end on Tobey Hill, we find, south of the red house at the end of the road, the best exposure for the study of these nodular gneisses and their posture against the fault by which they touch the Cambrian on the south (see fig. 13).

The white gneiss (Єb), with beds of amphibolite and garnets, abuts against the nodular gneiss, and this rock continues with a monotonous regularity for a mile southeast, to the west foot of Ball Mountain, where it often carries a little tourmaline.

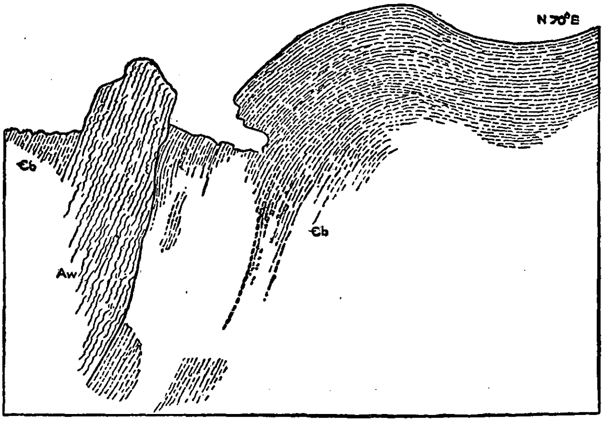
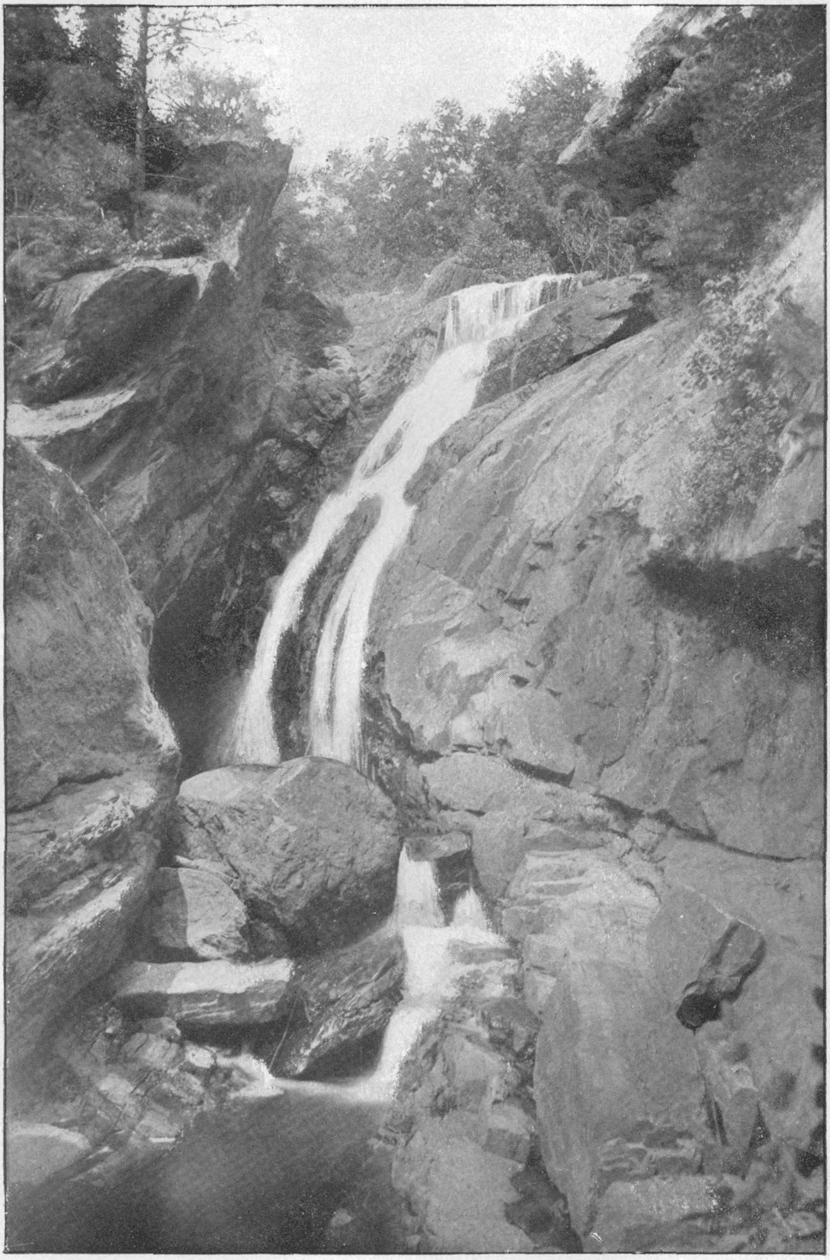


FIG. 14.—Campbell Falls section (central part given in Pl. IV), New Marlboro. Єb, Becket gneiss; Aw, Washington gneiss.

Campbell Falls section.—Following the schistose gneiss a half mile northwest from the limestone, to the point where the next road north crosses Whiting River (the brook coming from East Pond) at a fine waterfall, we find clearly shown the contact of the Cambrian gneiss on the east with the older gneiss. Fig. 14 gives the relations of the two rocks and Pl. IV shows them represented in the central portion of the diagram. All to the right or east of the water is Cambrian gneiss, which continues a little way to the left, to the foot of the vertical bluff of the older nodular gneiss which rises above the upper level of the water. The strong shear planes run in the white gneiss parallel with the falling waters, and west of the pool, at the bottom, the white gneiss can be seen dipping beneath the older rock.

South of the fault the same nodular gneisses appear in force, and one of the best places to study them is south of the road running northwest onto Tobey Hill from the point mapped in fig. 13 (p. 65) and south of the western house in the figure. Specimens from this place have



CAMPBELL FALLS, NEW MARLBORO; LOOKING NORTH.

been described by Professor Hobbs[1] as illustrations of the change of orthoclase to muscovite.

These rocks cross the railroad at the west end of the long West Norfolk cut. (See Pl. V, p. 76.) Here there is first a rusty, spangled muscovite-gneiss, containing graphite, pyrite, and fibrolite, dipping east beneath a light actinolite-garnet-gneiss, which also dips east against a granite-filled fault plane near the third telegraph pole from the entrance of the cut. It abuts against the black quartzite common at the base of the Cambrian.

The same nodular schist makes up the high ground south of the river at West Norfolk and is well represented in the ledges south of the hotel in Norfolk.

On the brow of the hill in West Norfolk, near the south line of the Sandisfield quadrangle, iron ore is found around the house of H. M. Jones, near the upper end of Lake Wungum.

Nodules in the gneiss.—The rock at Campbell Falls is a coarse muscovite-biotite-gneiss, very micaceous, with nodules, about an inch long, of coarse pegmatitic feldspar, bordered by a band of black biotite and brown hornblende. Another form is in its central part made up of a single crystalline grain of quartz, with a partial border of coarse, much-twisted muscovite, both full of fibrolite. Another form is composed of a single large crystalline grain of muscovite, full of fibrolite; and still another is of coarse granular microcline, without fibrolite.

The groundmass of the rock is a finely foliated mixture of muscovite and biotite, often intergrown, often much twisted by pressure and finely foliated, but without fibrolite.

The rock, as found in the ledge west of the limestone on Tobey Hill and in bowlders southeast of Ball Mountain, coming from the same area contains nodules of muscovite full of tufted fibrolite, and large grains of orthoclase also containing fibrolite. The nodules are separated by a finer grained, confused muscovite-biotite groundmass. A quartz-feldspar mosaic often surrounds the nodules, being formed by their partial crushing.

The fibrolite is found in quartz, feldspar, and muscovite, and not in biotite. It is often in a sort of sagenitic network on the C face of the mica, arranged parallel to its prism faces.

Prof. William H. Hobbs has described these nodules from the bowlders and found the cleavage and Carlsbad twinning suture of the feldspar retained in the mica.[1] He gives the following analysis made by Dr. W. F. Hillebrand, of the United States Geological Survey.

[1] Pseudomorphs after feldspar from Norfolk Township, Connecticut: Am. Geologist, Vol. X, p. 46.

Analysis of nodules from Norfolk Township, Connecticut.

	Per cent.
SiO_2	76.32
Al_2O_3	15.87
Fe_2O_3	.53
FeO	.36
CaO	.26
K_2O	4.55
Na_2O	.24
H_2O at 100°	.20
H_2O above 100°	2.01
TiO_2	Trace.
SrO	Trace.
Li_2O	Trace.
P_2O_5	Trace.
Total	100.00

We examined the locality together and then considered the nodules to have been pebbles, as mentioned in his article, an opinion which I have since abandoned.

SOUTHEASTERN AREA.

Above Riverton, on the Farmington River below the Sandisfield quadrangle, is a large outcrop of the Hinsdale limestone and the associated hornblendic and pyroxenic rocks, rising in the center of a broad area which may be associated with the Washington gneiss through the Sandisfield area just described, though the blue quartz is absent, being replaced by fibrolite, while the presence of graphite and of both micas, the rustiness, and the coarse, ragged, somewhat schistose texture of the gneisses distinguish them from the Cambrian above.

A characteristic rock in this area is a dull-black biotite-gneiss, highly fibrolitic and rusty, spangled with large flakes of muscovite and often abounding in large, irregular garnets. The band extends far northeast and southwest, but nearly its full width is found in the Sandisfield quadrangle. Where it enters the quadrangle, east of Mount Pisgah, it is a sugary-crushed, rusty, graphitic hornblende-gneiss.

PYROXENITES AND AMPHIBOLITES.

The passage of the limestone into a coarse-granular leek-green pyroxenite is very common; a large bed of this kind appears at A. Ducharne's, at the south apex of the Sandisfield pre-Cambrian area. (See p. 56.)

A knob of a similar rock projects above the level of the track at the signal house west of the Middlefield station. It is a calcareous diopside rock derived from the pre-Cambrian limestone and projecting into the Becket gneiss. Other similar projections appear in the cut nearer the limestone. It has disseminated crystals of a black hornblende, luster-mottled (poikilitic) by the earlier diopside, and changes into a green amphibolite which contains little plagioclase and no ore.

Because of the interest which attaches to the origin of amphibolites, special attention is called to the change of the limestone in Hinsdale into black, massive amphibolite and hornblendic gneiss, both by the formation of interstratified beds of various dimensions, and by an alteration progressing from both the top and the bottom until only a few feet of limestone remain at the center, and also to the Cleveland area, where the limestone is pinched into the gneiss like a dike and then partly changed to amphibolite (fig. 11).

The amphibolite which occurs in continuation of the limestone at the Alderman farm at Becket Center and which has been quarried as emery and copper ore, and the exactly similar rock found adjacent to the Coles Brook limestone 1 mile east of the Alderman farm, are more difficult of assignment. This is a black, massive, granular rock quite like the altered Cambrian dikes described below. It carries garnet, and the black ore which it contains is associated with titanite (leucoxene); the colorless ground is largely quartz. The rock is much like the Lee gneiss above East Lee, described on page 33, and I have associated it with the Lee gneiss, as a derivative of the calcareous transition beds above the Hinsdale limestone.

ANALYSES OF PRE-CAMBRIAN LIMESTONES.

The following analyses of pre-Cambrian limestones are taken from Hitchcock's Final Report of the Geology of Massachusetts, page 80. The other Berkshire analyses in this table are of the Stockbridge limestone:

Analyses of pre-Cambrian limestones.

	1.	2.	3.	4.
$CaCO_3$	54.80	56.25	51.66	58.31
$MgCO_3$	44.98	31.56	39.48	28.61
Fe_2O_3	.22	1.12	.91	1.24
Impurities	....	11.07	7.96	11.84
Total	100.00	100.00	100.01	100.00
Sp. gr.	2.77	2.78	2.77	2.84

1. Lee, 1 mile east of village; burned for lime. This is from the hill above East Lee.
2. Middlefield; Coles Brook; white.
3. Blandford; white. This is a great bowlder from the Coles Brook bed, found south of the village of North Blandford.
4. Becket, southeast part; magnesian.

CAMBRIAN SYSTEM.

An inspection of the map will show that the Cambrian gneisses and quartzites cover more of the surface than do the rocks of any other system.

In the area between the pre-Cambrian and the Stockbridge limestone it is helpful to carry out the distinction between the lower portion of the system—the Becket gneiss, which was originally largely conglomeratic and is now chiefly a muscovite-gneiss with some quartzite—and an upper portion which was originally largely a quartz sand and is now changed to a more or less micaceous quartzite—the Cheshire quartzite, very generally characterized by the presence of minute crystals of dark-brown tourmaline, although the quartzite sometimes extends to the base of the system.

This quartzite is locally replaced by a mica-schist, which is often greatly corrugated. On the east side of the pre-Cambrian the Cambrian is largely a biotite-gneiss and is completely gneissoid up to the hydromica-schists and lacking in tourmaline.

UNCONFORMITY AT THE BASE OF THE CAMBRIAN CONGLOMERATE.

Five rods east from the mountain cottage on the hill high above Dalton Station the conglomerates, themselves nearly horizontal, can be seen resting upon the vertical beds of the older gneisses which strike N. 80° E. One can follow the junction in the cliffs south and then for a mile southwest down the mountain side, to the brook above J. S. Barton's, with excellent exposure, as indicated in fig. 4, page 40. It continues up the side of Warner (or Day) Mountain, and on south through the woods for 2 miles to the great fault described hereafter (p. 92). On the opposite side of the anticline, along the east slope of the same hill, the same unconformity can be seen, though the outcrops are poorer. Everywhere the old gneisses strike N. 80° E. and are nearly or quite vertical, while the conglomerates, nearly horizontal at the top, take a low dip westward down the west side and eastward down the east side of the long hill, and before it was cut through along the crest of the hill they mounted over it symmetrically.

The unconformity is thus striking, abundantly exposed, and extends for a long distance. The same unconformity clearly exists along the west flank of the West Washington anticline (shown well at P. Conroy's house), a mile northwest of the Becket reservoir.

Around the great Hinsdale anticline there is everywhere a general apparent conformity, but there is very commonly a discrepancy of 10° to 30° in the strike, while the dips uniformly agree in being low to the east; but the whole anticline is so forcibly pushed over westwardly and flattened, and the outcrops on the exact junction are so few, that it gives little important evidence on the subject.

The pre-Cambrian at the Coles Brook anticline is thrust very irregularly through the Cambrian, and the unconformity is well shown in the description of the section at the mouth of the brook (see p. 41), and is apparent in the whole length of the band from the contact of the Cambrian gneisses with the different members of the older series. It is more beautifully shown a mile north of the railroad cutting, where the road comes down off the mountain and crosses the limestone near the site of the burned house of H. Hawes. As seen in the figure (fig. 15), the Cambrian gneiss wraps in easy folds over the vertical pre-Cambrian limestone, which is accompanied by a rusty biotite-muscovite-gneiss, with tourmaline and coarse graphite, and on the top of the hill, where the gneiss is worn through, the limestone appears.

A nearly vertical secondary schistose structure is present in much of the gneiss. It is a typical Becket gneiss, with many striated octahedra of magnetite, and at the sharp bend in the road it contains an 8-foot bed of a fissile black amphibolite with films of biotite. This makes a very beautiful slide under the microscope. Around the many grains of magnetite an abundant growth of titanite (leucoxene) appears, swelling into larger crystals in a limpid ground of untwinned plagioclase grains. It is probably an altered eruptive rock.

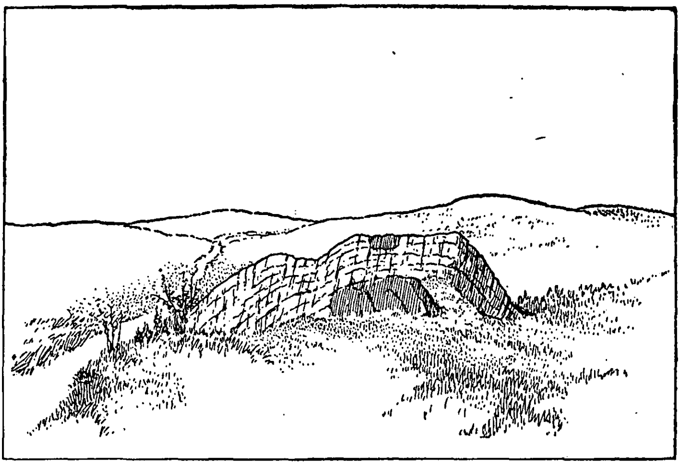


FIG. 15.—Cambrian gneiss folding over pre-Cambrian limestone unconformably; Middlefield.

CONGLOMERATE-GNEISS (BECKET GNEISS).

In the northwestern part of the area the broad band of light-colored gneisses which encircle the old blue-quartz gneiss of the Dalton anticline is as uniformly characterized by the abundance of muscovite as the older series is by that of biotite. The latter mineral is not always absent in the newer rock, but when it does occur it is in small, scattered flakes, not in connected films.

All the other characteristics of the older series are conspicuously absent, except that the blue quartz occurs in grains and pebbles, plainly secondary. It passes gradually upward into the Cheshire tourmaline-bearing quartzite.

The base of these gneisses is often a heavy bed of the most clearly developed conglomerate of quartz pebbles—white, black, and blue, commonly white, with rarely a pebble of feldspar or gneiss—from 5 mm. to 100 mm. in length, uniformly well rounded, and all arranged parallel to a common plane. They are sometimes apparently flattened parallel to that plane to quite broad sheets, in one case to round-edged plates of quartz 150 mm. by 100 mm. by 10 mm. These pebbles are generally inclosed in a large quantity of groundmass, which is changed into a mica-schist or a micaceous quartzite by the development of more or less muscovite, and many tourmaline crystals encrust the surface of the pebbles, often in radiating groups.

This conglomerate bed is continuous and can be traced for miles across Hinsdale and into Washington. It is best studied at the Dalton clubhouse and across to the south in the open pasture, represented in fig. 4 on page 40. The conglomerate is here so beautifully distinct, the ground so completely changed to a muscovite-schist, and the complete unconformity to the underlying pre-Cambrian so well exposed, that this is the best locality in Massachusetts for the study of all the relations of the two formations.

The growth of rosettes of tourmaline on the pebbles and the shearing of the conglomerate into a complete gneiss along narrow bands, 6 inches wide and at right angles to the bedding, on either side of which the pebbles are but slightly flattened, is especially notable. From the clubhouse flat one will do well to follow the contact down the slope to the brook (see fig. 4), where the Cambrian and the pre-Cambrian can be seen in contact, and also to go across to the east of the pasture, to the point indicated in the right-hand part of the figure, where the gneissoid development is more complete, although the pebbles are in places quite distinct.

From the Hinsdale station one may go a mile north along the railroad, to the long rock cutting, and see the same gneiss entangled in a warped and overturned syncline and more highly metamorphosed and contorted.

One of the best places to study the series from the blue-quartz gneiss up to the Cheshire quartzite, and especially the relations of the conglomerate to the pre-Cambrian gneiss and the transition of the conglomerate gneiss into the sugary tourmaline-quartzite, is in the northwest corner of Washington, where a blind road, not on the Survey map, runs north from a schoolhouse to the house of H. C. Congdon.

The blue quartz is extremely abundant and of rich color. Allanite is present, and parts of the ledges near the barn and spring are crushed into a granulite, which can only be distinguished as pre-Cambrian by its association with other pre-Cambrian rocks and by its position below the Cambrian. On the west it is covered unconformably by a fine muscovitic conglomerate-gneiss, which is more gneissoid farther up from the base, and where a wood road crosses the brook it becomes a tourmaline-bearing quartzite, slightly muscovitic. Next west, and thus higher up in the series, it is a fine, white, massive quartzite, forming the first range of hills and becoming schistose as one goes down into the limestone valley.

It is in places a very feldspathic quartzite, and by the decomposition of the feldspar becomes quite regularly porous, having formerly found some use as a buhrstone.

While through all the western half of the Becket quadrangle the lower part of the Cambrian is everywhere more or less conglomeratic near the older rocks and more or less a quartzite in its upper part, in the broad eastern band the metamorphism is more severe, and this division can not be carried out.

Down the east border of the area across Windsor and Peru half-obliterated traces of pebbles occur here and there in the lower half, but the whole upper portion is mainly muscovite-gneiss. The gneisses are marked by a deficiency of feldspar, by the friable, granular character of the mass, and by the absence of all accessories except tourmaline and magnetite.

A mile northwest of Peru Center the true dip is marked by sandy layers an inch thick interposed between 2-inch schist layers, though in much of the area the structure is probably secondary. Around Peru Center the rock is a gneiss in thin flaggy beds, with the mica mostly biotite. The degree of metamorphosis increases steadily southward.

Across Becket the rock is a friable, well-banded but often thick-bedded biotite-gneiss, like that of the Monson quarries but even more massive and granitoid, and this quarry granite borders the Coles Brook and the Alderman pre-Cambrian limestone beds, the regular granitic texture seeming to depend on greater dynamic metamorphism accompanying the sharp upfolding of the limestone. Where it occurs along the railroad from North Becket to Coles Brook it is a good building stone, and in the quarries by the railroad the passage from the flaggy to the massive varieties can be clearly seen. Just west of the Coles Brook crossing the rock beside the railroad is flaggy and in flat undulations. In the quarry above, it is massive, thick-bedded, and granitoid, and is somewhat mixed with pegmatite in small veins.

In the south part of Becket the gneiss becomes a thick-banked, completely granitoid, light-gray gneiss, which furnishes the fine quarry stone of the Chester Company's quarries in the extreme southeast corner of the town, and the same rock extends south into Otis. A thin section of the rock appeared highly crystalline, very fresh, and of completely gneissoid structure. The large plagioclases were full of small crystals of biotite and of black rods—some stout and straight, some minute and curved. The quartz grains were full of sheets of cavities with large moving bubbles. The biotite was everywhere intergrown with muscovite, though to the eye the rock seemed purely biotitic. It gave no indications of strain, but rather showed signs of complete recrystallization.

In Monterey and in the area south of New Marlboro bordering the pre-Cambrian the Becket gneiss is quite normal across the whole length of the quadrangle to the south. It is much of the way a massive, white, granitoid quarry gneiss; the biotite is jet black. Very small garnets are numerous, and the rock is characterized by minute magnetite octahedra. These seem to be dissolved through the influence of lichens, and the rock then weathers white. After rains they accumulate by the roadside as iron sands.

One or two bands of a jet-black, fine-grained biotite-hornblende-gneiss occur about one-fourth of a mile east of the boundary with the older rocks. There is rarely any trace of pebbles in the gneiss along the boundary or elsewhere.

The amount of quarry gneiss is inexhaustible, and the rock from the large quarry on Ball Mountain, Norfolk, can not be distinguished from the Becket and Monson quarry rock. In Otis the white gneiss branches on the pre-Cambrian, and its western lobe runs down west of Filley Mountain to the Tyringham fault, while its border portion continues down the eastern part of the quadrangle inclosing Great Pond and the Otis reservoir. It is a very uniform biotite-gneiss. The jet-black biotite is generally disseminated through the rock, at times concentrated in rounded or elongated blotches or in distinct banding. It generally bleaches at the surface to a dead white, but always contains much magnetite in minute octahedra. At times it is strongly muscovitic, as where the East Granville road crosses the east line of the quadrangle, and at the northeast slope of Noyes Mountain. Where it enters the Sandisfield quadrangle it is largely garnetiferous, but this characteristic disappears to the south. Only one small hornblendic bed occurs in it. This is east of D. Goddard's, a mile east of Otis Center.

Considerable excavation for iron has been made west of T. Fay's, a mile farther east, beginning more than fifty years ago. The gray gneiss is here a little more impregnated with magnetite than usual and carries hornblende.

In Otis the rock generally occurs in smooth, white ledges, with a fine-grained granitoid structure, very free from fissures, and breaking in large blocks, or, while breaking in equally large and firm blocks, showing a flat or wavy contorted banding from the arrangement of the biotite. It at times weathers into a ragged and deeply pitted and seamed rock, as in the remarkable bare ledge which starts from the southeast lobe of Otis reservoir and runs over the top of Noyes Mountain, a famous fox run. It nowhere shows any trace of conglomerate structure, and I have at times tried to refer portions of it to a certain wholly crushed facies of the Washington gneiss, but on comparison, especially under the microscope, it seemed plainly not to belong to that type. The Becket gneiss at its junction with the pre-Cambrian across Sandisfield and Tolland has been quite fully described in tracing the upper boundary of the latter (see p. 55) from the apex of this South Sandisfield lobe, to the north of which it is greatly corrugated, around to that village. Typical quartzite and a black pyritous quartzite accompany the boundary and lie well down toward the base of the Cambrian, where the rock is usually gneissoid, so that in the southern part of this area I have not tried to carry out the distinction between the basal gneiss and the quartzite above, which is so well developed in the Becket region. All across Sandisfield the Becket gneiss is very generally a fine-grained, gray, quarry gneiss, of good quality for building purposes.

AMPHIBOLITES IN BECKET GNEISS.

On page 68 reference is made to pyroxenites and amphibolites derived from pre-Cambrian limestones.

East of the Connecticut the Becket gneiss is often black, from excess of the shining black biotite and fine granular hornblende, assuming the aspect and relations of a crystalline schist, and seeming to have the same origin as the conglomerate-gneiss itself, into which it passes and of which it is, in my opinion, a mere ferruginous and calcareous variant.

In tracing the Becket gneiss of the western region south from Hoosac Mountain I did not find any hornblendic beds until the locality at H. Hawes's, in Middlefield (see p. 70), and the Chester Company's quarry in Becket were reached.

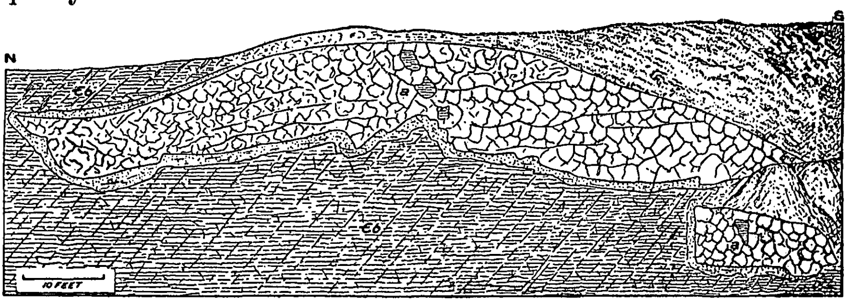


FIG. 16.—Amphibolite dike (a) in white granitoid Becket gneiss (Єb) with pegmatite contact rim (p); quarry, Becket.

At the latter place a great mass of a fine, jet-black, massive and friable biotite-amphibolite extends, with a width of 12 to 15 feet, across the east wall of the great quarry (see fig. 16). It tapers to a point at the north end, and a separate or faulted portion of the main dike appears at the south end. It contains blocks of the white gneiss and, what is very peculiar, is separated from the inclosing white, massive biotite-gneiss by a quite continuous band of a coarse muscovite granite or pegmatite a foot wide, a phenomenon which is repeated several times farther south, as at the Ball Mountain quarry and at the West Norfolk cut.

Under the microscope the rock shows in a fresh, limpid ground of granular quartz and plagioclase-feldspar (the latter gave in plates parallel to M, the optical figure of oligoclase), and abundant grains of hornblende, biotite, and magnetite. In many of the occurrences farther south the grains of each mineral have nearly a common size, giving the slide a very regular look. Here many smaller flakes of the same minerals are inclosed in the feldspars.

Some of the black ore grains are surrounded by titanite (leucoxene). It is not, however, nearly so abundant as in the Middlefield bed described on page 70. Titanite generally characterizes the amphibolites in the Cambrian beds, which I have considered to be derived from gabbros or diabases, and is absent in the similar beds which I have supposed to be altered calcareous deposits.

From this point on, going south, the hornblendic beds grow more abundant in the white gneiss and come to be quite characteristic of the basal beds of the Cambrian near the contact with the underlying pre-Cambrian. This is so uniformly the case in the region surrounding the Bear Mountain anticline that it gives a safe indication of the position of the boundary where it is concealed. The beds are generally without structural indications of eruptive origin, are often more biotitic than hornblendic, and, as they are always interbedded with the gneisses, have probably had a similar sedimentary origin. They are too small to be represented on the map.

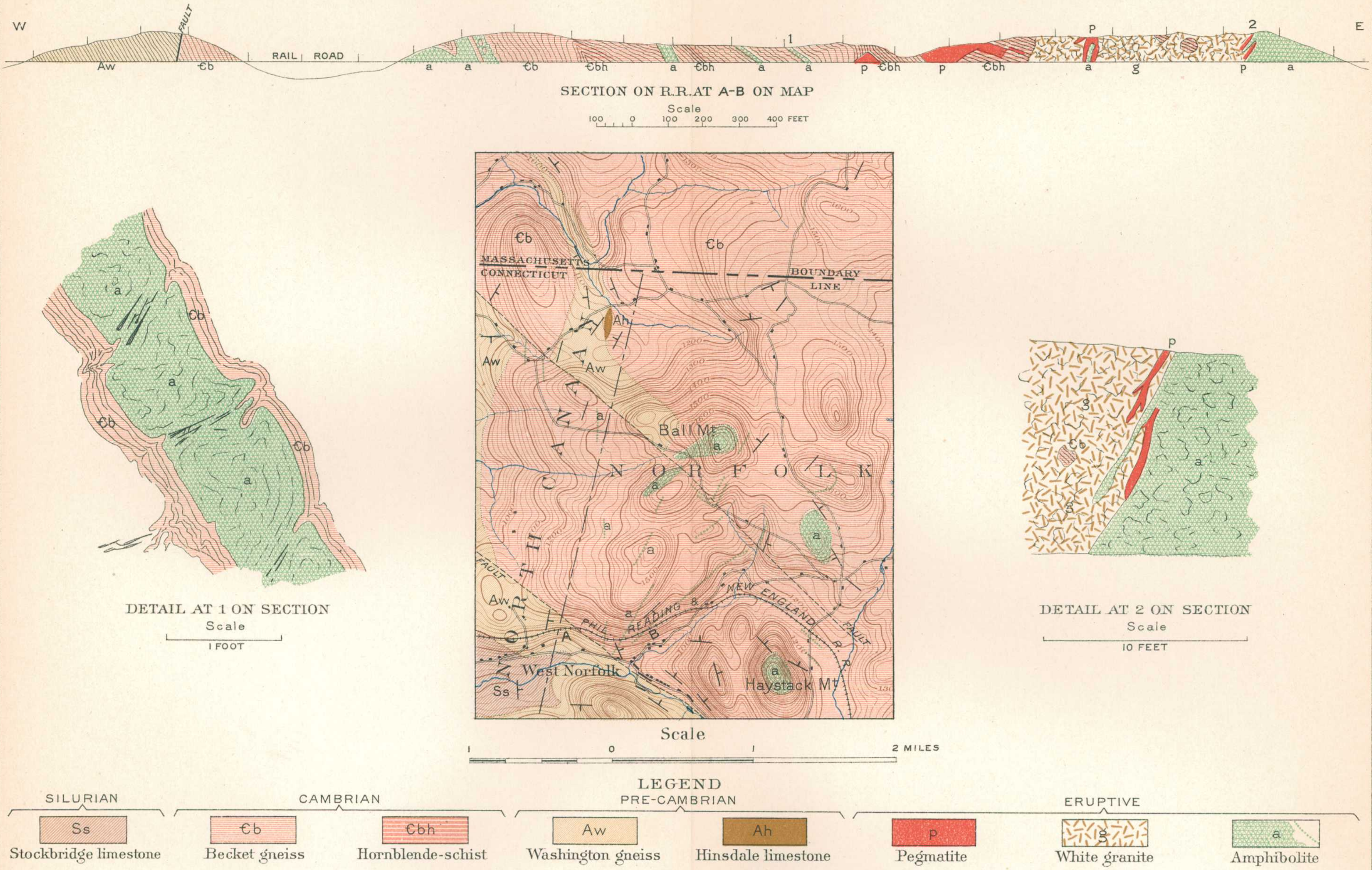
The hornblendic rocks are even more abundant in Norfolk, and both the sedimentary and the intrusive kinds are represented. Haystack Mountain, Ball Mountain, and the high hill to the east are largely composed of amphibolite and seem to owe their height to its durability. In the quarry on the east face of Ball Mountain is a black dike exactly like the Becket dike previously mentioned. The country rock is the granitoid white Becket muscovite biotite-gneiss. It contains inclusions of a black rock much like the dike. The dike is wholly inclosed in the gneiss, is 8 feet wide, and extends 5 rods south before being covered. It is cut by a dike of pegmatite a foot wide—a clear, gray rock with idiomorphic quartz, much plagioclase, and shining, black biotite which is coarser than the biotite of the gneiss.

The rock is the same black granular rock, suggesting fine-granular tourmaline, but slides cut from different parts of the mass vary materially, while the hornblende and the black ore surrounded by titanite are the same. In one slide the biotite is of even size with the hornblende grains and free from inclusions, and the abundant colorless ground is largely granular quartz; in the other slide the large porphyritic biotite scales inclose all constituents except hornblende, and the ground is a fresh, granular, mostly untwinned feldspar, with the border of each grain differing sharply from the center.

The whole top and west slope of Ball Mountain are composed of the same black, massive, hornblende-biotite rock.

In the southeast wall of Ball Mountain the light gray gneiss wraps round the rectangular south end of the black, massive amphibolite exactly as if that had been a more massive foreign body in the conglomerate-gneiss at the time of the folding. This is like a diabase dike, but it is also like a displaced limestone bed, and either one may be changed into an amphibolite. (See p. 64.)

Haystack Mountain, on the contrary, is made up of a highly contorted hornblendic gneiss, generally biotitic, pyritous, or garnetiferous, thin foliated and carrying intervening thin bands of a white gneiss a foot or so in width, which look like dikes in the black rock.



NORFOLK RAILROAD CUT AND MAP SHOWING LOCATION, WITH DETAILS.

A. Hoen & Co. Lith. Baltimore.

The great railroad cut west of West Norfolk Station shows all the relations of these rocks to the best advantage. It is illustrated by the section on Pl. V. Entering the cut from the west the rusty pre-Cambrian gneisses (Aw) occupy the first 28 rods. At first they are granitoid and carry graphite. They are succeeded by light actinolite-gneisses carrying garnet. Both minerals are indicative of the near presence of limestone in the rock. These are all characteristic pre-Cambrian peculiarities. Then comes a fault marked by a pegmatite (p) layer, and this is followed by the light biotite-gneisses (Ꞓb), which carry near the base a heavy band of thin-bedded micaceous quartzite.

On passing an interruption in the cut we again come to the same gneisses, in which is a great dike-like mass of amphibolite (a), or what may be taken to be a wholly altered basic eruptive.

This is immediately followed by another entirely similar bed, which includes great masses of the gneiss and has a sharp but irregular boundary against the inclosing hornblende-gneiss (Ꞓbh), which latter, from the analogy of the similar bed described below, seems to be older than the two dikes described above and to be of sedimentary origin. Then follows the foliated and finely twisted amphibolite bed (at 1 in the section), which is given in detail on Pl. V. The contorted foliation of the inclosing schist runs parallel with the walls of the black bed; and both are partially sheared asunder and quartz veins occupy the distant shear planes.

Near the east end of the cut is a broad bed of a fine-grained white granite (g), which on the east abuts against the foliated amphibolite (at 2; see detail figure) and includes great angular blocks of it, together with the common gneiss, thus showing that both these rocks are older than the granite. At the east end this granite is cut by two dikes of the black massive amphibolite, into which it sends tongues, thus showing that this massive amphibolite is newer than the foliated amphibolite. The granite has produced a marked metamorphic effect upon the black rock. An outer layer of the latter a half inch wide has lost its banding and is of much coarser grain.

In both cases a selvage of pegmatite separates the amphibolite from the white granite. These foliated amphibolites lack some of the peculiarities of the amphibolites derived from eruptives and resemble those derived from limestone described on page 69.

The two dikes just mentioned share all the properties of those described above from near the west end of the cut, but differ considerably in minor matters.

The dike, with inclosures, at the twenty-first telegraph pole from the west end of the cut is the normal type of the Cambrian eruptive amphibolites or metadiabases. It is a blackish gray, massive, fine-grained rock, made of shining hornblende needles, biotite scales, and a small amount of white interstitial matter just visible to the eye.

Under the microscope plagioclase appears, rarely twinned and with small angle of extinction. Many large grains, which seem exactly like quartz, are biaxial and positive, and so are plagioclase. The hornblende is in jagged angular cuboidal grains, with strong absorption and deep colors—*a*, bright yellow; *b*, yellow to greenish yellow; *c*, blue green; $b>c>a$ Ex. 23°—29°. Menaccanite occurs and leucoxene is abundant.

The garnet-amphibolite from the dike at the east end of the railroad cut is with the lens not distinguishable from the other metadiabases of the region. It is a massive, fresh-black, fine-grained rock, mostly black granular hornblende and white granular plagioclase.

Under the microscope it is quite peculiar. The hornblende has rather less absorption and is composed of large aggregations of small scales, sometimes polarizing together and grading into large grains which are centrally filled with large needles placed parallel to the cleavage.

The garnet grains are free from inclosures and are surrounded by a beautiful radiated aggregate of plagioclase blades which expels all the colored constituents and has exactly the aspect of the secondary water-deposited albite filling cavities in the Triassic diabase from Greenfield.[1] The resemblance is so exact that one may feel sure that this limpid plagioclase is also water deposited. The plagioclase molds the garnet grains and radiates from them. The two minerals occupy angular spaces, as if they replaced a porphyritic mineral.

The magnetite is surrounded by a very ferruginous biotite, but never by titanite (leucoxene). There is a little quartz present.

CHESHIRE QUARTZITE.

The basal conglomerate of the Cambrian originally passed up into a sandstone which is now represented by a white quartzite, often largely muscovitic, always deficient in feldspar, and quite regularly characterized by small black or dark-brown tourmalines. It is at times simply a white friable quartz-sandstone, often dug for glass making; at times a thin fissile muscovite-quartzite, which can be seen to change along the strike into muscovite-schists or white gneiss; and at times a tough, massive quartzite.

In the high ground north of Dalton village the quartzites are present in great force, are at times calcareous and at times muscovitic, but are not developed as distinct gneisses upon the Becket quadrangle. They are hard, massive quartzites where crossed by the roads. At the southwestern corner of the high ground, as represented on the map, they are white, sugary, glass sands, which were entered to a depth of 180 feet in digging for a well on Mr. Thomas Allen's farm, Grasmere, just south of Coltsville Station.

They are at times metamorphosed into distinct gneisses. Of such a character is the fine long exposure in the railroad cutting which extends from the railroad crossing of the Hinsdale-Dalton road, near the Cath-

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[1] Bull. Geol. Soc. Am., Vol. VIII, 1897, p. 59.

olic cemetery, north to the line between those towns. The beds sweep in a broad curve, with strike northeast to northwest, and represent the center of the overturned syncline between the two anticlines, and thus the top of the series.

The rock is a muscovite-schist, at times a sericite-schist, highly contorted. It dips eastward, as forming the east flank of the Dalton anticline; and entirely similar but less altered beds occupy the other (western) slope of Warner Hill, dipping westwardly on the other slope of the anticline. Here, in the brook bed above J. S. Barton's, the rocks above the conglomerates are white mica-gneisses or quartzites, and certain beds are a pure quartzite full of quite large drusy cavities, now partly filled with kaolin from the alteration of feldspar. The rock rarely contains small tourmalines and magnetites.

The metamorphosis of these beds plainly decreases toward the north and west in the region under discussion, so that the minimum of change appears in the northwest corner, on the brook last mentioned.

The quartzite along the west slope of the Dalton anticline is very thin bedded, and the greatly corrugated and discordant layer of the mica-schists upon it makes it probable that part of its thickness may be concealed by a fault.

South of the South Dalton fault, on the high ground southeast of Pittsfield, the quartzite widens into a broad area. It lies nearly horizontally and rises eastwardly in soft undulations. Where the Pittsfield-Washington road crosses the corner of Dalton and makes a large bend to the east the rock carries so much muscovite that it deserves the name of a schist, but it does not approach in type the higher schists and has all the characteristics of the quartzites (tourmaline, sandy structure). The same is true on the next road south, south of S. Hines's, where mica-schist is shown on Professor Dana's map. These quartzites pass around the north end of the Washington anticline in a broad flat syncline in the conglomerate-gneiss, which extends far out over the high ground in a very unusual position for such soft and slightly metamorphosed rocks. Just where they are cut by the line of latitude 42° 25′ they overhang Sackett Brook in bluffs more than 100 feet high.

They are dug as glass sands at the extreme southeast end of this syncline south of Ashley Lake, in the middle of Washington. They are everywhere characterized by fine tourmaline needles and are generally muscovitic in greater or less degree.

KAOLIN FROM THE QUARTZITE.

Professor Dana has called attention to the decay of the quartzite south of Ashley Lake, in Washington, and to the formation of sand therefrom, and explains this decay as due to the decomposition of the feldspar in the feldspathic portions of the sandstone.

The quartzite, which varies from the hardest to the most friable and from massive to thin bedded, has at times quartzose layers alternating with thin seams of soft kaolinized feldspar.

Many kaolin beds of western New England occur in quartzite, and are washed out from the decomposed quartzite. This is true of the largest of these deposits, that in the southwest corner of New Marlboro, near the Canaan boundary. The kaolin is sandy and contains quartzite fragments.

Feldspathic quartzite occurs near the line between Lenox and Washington. Large cavernous blocks lie over the fields, with cavities an inch or more long.

Dr. C. Dewey says it is wrought into millstones after the manner of the Paris buhrstones, and is known as the Pittsfield buhrstone.[1]

Feldspar still exists in some of the cavities. Prof. E. Hitchcock recognizes the feldspathic character of the rock in his Massachusetts Geological Report of 1842, saying (page 587) that the buhrstone is "a variety of gneiss rock whose feldspar has decomposed and disappeared, and in which quartz was greatly the predominant ingredient." The name "gneiss," which has been given it, is not so far out of the way as might at first seem, for some of the rock contains, besides feldspar and quartz, a little mica.

The hearthstone quartzite quarried less than a half mile south of this locality, which affords the best hearthstones of western New England, contains black mica, in very minute scales disseminated through it, like much of the quartzite elsewhere.

Professor Hitchcock mentions another locality, 4 or 5 miles south of the spot where millstones are prepared, at which the rock "may be seen in all stages of the process between gneiss and buhrstone."[2]

QUARTZITE BRECCIA.

I have mentioned the breccia found along the South Dalton fault. The massive quartzite is shattered, the fragments being often moved on one another and cemented by limonite. It was first described by Dr. Chester Dewey in 1824,[3] and is mentioned by President Hitchcock in his report of 1841 (p. 588). He enumerates it in his catalogue of the State collection in 1841 (Nos. 604–606) and 1856 (quartzite, Nos. 59, 60, and 107, 108) as brecciated quartz; cement hematite. It is attributed by Professor Dana to the wedging open of the fragments by "the extremely slow action of the depositing limonite."[4]

I have found it so closely associated with faults that I have no doubt that it is a fault breccia, produced by friction along the great transverse faults, the fragments being afterwards cemented by infiltrating iron solutions at so low a temperature that the cement is limonite.

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[1] Am. Jour. Sci., 1st series, Vol. VIII, p. 17.

[2] J. D. Dana: Am. Jour. Sci., 3d series, Vol. XXVIII, p. 448.

[3] Am. Jour. Sci., 1st series, Vol. VIII, p. 18.

[4] Pseudobreccia, by J. D. Dana: Am. Jour. Sci., 2d series; Vol. XXVIII, p. 451; Vol. XXIX, p. 57.

TRANSITION OF LIMESTONE INTO SANDSTONE.

In the single spur which projects into Lake Garfield, in Monterey, from the middle of its southern shore is a ridge of the white limestone resting upon a highly calcareous sandstone and dipping 50° S.

At the south end of the Monterey pre-Cambrian (see p. 60), south of the brook opposite the E. R. Smith place, the pure white limestone is full of white pyroxene crystals and quartz veins and grades into a rusty biotite-schist. It is sandy in some places and black and flinty in others.

A few rods north of the village of New Marlboro, and west of the north road, is a white, friable, micaceous sandstone, which is pounded to a white sand by the feet of cattle. It is very calcareous and lies almost horizontal in the Becket gneiss, into which it passes.

Along the south slope of Dry Hill, northwest of New Marlboro, 80 rods northwest of D. S. Powell's house, is a row of outcrops, 125 rods long, of the Stockbridge limestone, resting as a thin layer upon the banded micaceous quartzite. It wraps round projections of the schist, dipping away from them on all sides, and passes gradually into the schists below.

SILURIAN SYSTEM.

HOOSAC SCHISTS.

Windsor mica-schist bed.—The anticlines of pre-Cambrian gneiss along the eastern side of Berkshire County are flanked east and west by light-colored conglomerate-gneisses, and these are followed on the east side by a series of mica-schists, at first garnetiferous, then feldspathetic (porphyritic), and still higher up sericitic.

The careful studies of Professor Wolff[1] have traced these schists around the north end of the Hoosac anticline and down its western flank to where they run out onto the gneiss as a narrow band which finally disappears just northwest of Savoy Hollow. In this passage out onto the gneiss the mica-schist lies in a syncline in the gneiss running southwardly, and it is probable that the mica-schist described below is the continuation of the same bed.

The boundaries of the bed can be rudely defined by bowlders west of Windsor Hill, nearly 3 miles south of the above-mentioned terminus of the Hoosac schists in Savoy, and abundant outcrops of the rock soon appear and continue in a high, narrow ridge to the Hinsdale line, just east of the reservoir.

It can be best studied at A. W. Warren's. It seems to lie in a westwardly overturned syncline in the Cheshire quartzite, which lies in the newer gneiss, but with only a narrow seam of the latter separating it from the old pre-Cambrian graphite-gneiss.

It strikes N. 10° to 20° E. and has high dips to the east, but is for the

[1] Mon. U. S. Geol. Survey, Vol. XXIII, p. 80.

most part so twisted and contorted that no prevailing directions appear. It is a coarse, black, garnetiferous mica-(biotite) schist, highly graphitic or coaly, causing the black color. The garnets are of the form 110 and small. Quartz veins with sulphides occur.

Coltsville mica-schist bed.—The whole hill east of and overlooking Coltsville and forming the western foothill of Davis Hill, northeast of Dalton, is composed of a dark lead-gray mica-schist or phyllite, greatly contorted and abounding in fine quartz veins with large quartz nodules which look like pebbles. The rock is plainly graphitic and contains a few garnets. It dips southeast beneath limestone.

Dalton bed.—Following west down Barton Brook, on the west slope of Day Mountain, from the contact of the older gneiss and the conglomerate-gneiss at the clubhouse (see fig. 4, p. 40), one passes over the whole of the latter and a great thickness of the white quartzite-gneiss lying stratigraphically above the conglomerate, all having a strike N. 40° E. and dipping 30° W. beneath another bed of these schists. The nearest outcrops of the quartzite to the schist are at the road-crossing of the next brook south, so that only a small thickness of intervening strata remains concealed.

The schists are here greatly contorted, strike irregularly N. 70° E., have high dips to the west, and are plainly discordant to the gneisses below.

These schists advance westwardly to the railroad, and at the foot of its embankment runs the Housatonic River. At the Carson & Brown Company's paper mill on this stream, just opposite the schist, the boring of an artesian well went down 135 feet through limestone containing a 20-foot bed of quartzite, and at that depth the drill dropped 3 feet, in a water seam said to have been full of worn pebbles, onto a surface of the same black schists, in which the boring was continued 9 feet. I have compared fragments of the schist from this boring with the adjacent ledges and they are identical. This brings these schists into the same position as the schists previously mentioned at Savoy and Windsor. On the other hand, these Dalton schists differ from the schists which succeed the white gneisses on the east in Middlefield and Becket.

Mica-schist of Dry Hill in New Marlboro.—The mica-schist which wraps around the quartzite of Dry Hill in New Marlboro and grades into the Stockbridge limestone occupies precisely the same stratigraphical position as the Dalton schist. It is composed of thin bands of a white, sugary quartzite, one-fourth of an inch to 1 inch wide, with equally thick intervening layers which are quite micaceous. The mica is fine grained and generally muscovite, though sometimes much biotite is present. High up the hillside the rock is a dark mica-schist, its dark color due to excess of biotite and hornblende.

Eastern band.—At the base of this formation a dark, highly garnetiferous mica-schist forms the passage bed from the Becket gneiss to the main portion of the series.

The latter has the habit of a mica-schist, although it is generally quite feldspathic. Small rounded crystals of albite, scattered porphyritically in the mass, have in crystallizing often cemented several grains of quartz together.

Both micas are present and the rock is generally quite dark, from the abundant biotite. It shares with the following formation the greasy feel from the hydration of its muscovite.

The base of the bed is exposed on the road lying east of Peru Center, at D. E. Ingalls's, the second house to the south after leaving the village. It is here a coarse and corrugated feldspathic mica-schist, full of garnets as large as raisins.

Two miles northwest of Peru Hill, at the stone schoolhouse, the upper boundary of the Hoosac schist upon the Rowe schist is exposed for a long distance on the bare hill 50 rods east of the schoolhouse. The rock is a gray porphyritic gneiss—a rock with the habit of a coarse sericite-schist but abundantly porphyritic and with small oval spots of white feldspar. It is well exposed east of Bancroft station on the Boston and Albany Road, beginning with the mouth of Factory Brook and extending a half mile east. At the base it is a coarse sericite-schist, full of garnets one-third of an inch across, and the same bed extends north to Middlefield Center and beyond. In the upper part the garnets are absent, and sandy layers alternate with the more micaceous bands. This continues to the bridge east of the station.

The next accessible section of the series is along the road west from Chester station, just within the limits of Becket. Where, at the southeast corner of the Becket quadrangle, the road goes south from Walker Brook to the Chester Company's quarry the brook cuts a contorted, light-gray, thin-bedded biotite-gneiss, with layers two-thirds of an inch thick, strike N. 15° W., dip 70° E. It has muscovite on foliation faces and much of it is soaked with pegmatite.

A little east, halfway to the next house, a highly muscovitic saccharoidal gneiss is kneaded in with a highly garnetiferous, rusty mica-schist, of quite coarse grain, which forms the basal layer of the terrane under discussion. Strong, coarse mica-schists follow, mainly coarse films of muscovite scales and an arenaceous quartz ground with no bands or nodules of infiltrated quartz, few garnets, and rarely blotches with feldspar aggregates. A thin section of the rock from the east of Becket (E. B. Richards's) shows a gray, rusty, muscovitic gneiss; raveled and ragged intergrowths of muscovite and biotite and a mosaic of quartz grains wrap round porphyritic "augen" of albite, which in places shows extinction according to two laws and the granophyric structure in every variety and of great beauty. The garnets are centrally filled with brightly polarizing black rods and long blades of biotite.

ROWE SCHIST.

Only a narrow band of the Rowe schist runs down the eastern border of the sheet for half its length. The small porphyritic albites disappear and the rock becomes a softer sericite-schist blotched with green, due to chlorite spots derived from altered garnets. Going east from Bancroft station to the third bridge one finds the boundary and a sudden transition from the albitic schist below. Along the railroad two bands of amphibolite occur in this formation before the edge of the quadrangle is reached. Along the east line of Becket, east of the Chester Company's quarries, it contains a gray cyanite, which includes small garnets with the centers filled with black grains. The cyanite is often changing into muscovite. (See Pl. I, fig. 6.)

Where the schist enters the Sandisfield quadrangle it is a hard, ragged, contorted muscovite-biotite-schist barren of accessories, slightly rusty and quartz veined; the zigzagged bedding goes N. 40° W., the cleavage N. 50° W. Higher up it has small hornblende-schist layers and is in places garnetiferous and of greasy feel.

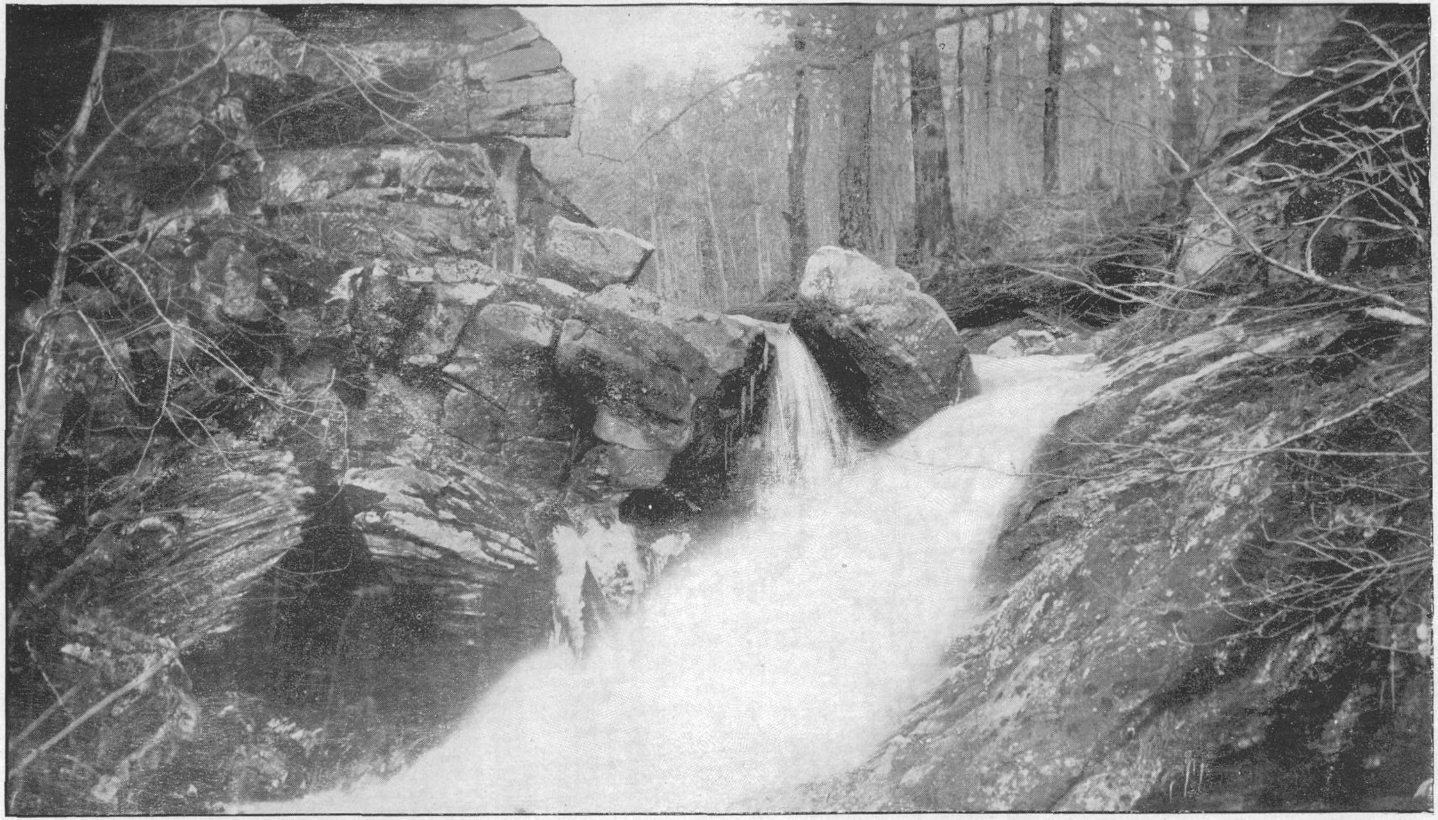
STOCKBRIDGE LIMESTONE.

Only a narrow portion of the white crystalline limestone which underlies and has conditioned the broad Housatonic Valley, enters the area on its western borders and extends far east into broad depressions in the older rocks in Dalton and Tyringham and into smaller recesses south of the fault on the south line of Dalton and at East Lee. Its boundary is thus for 10 miles a straight line parallel with and near the western edge of the Becket quadrangle, while the broad sands of the Housatonic conceal nearly every portion of the limestone in the low valley bottom.

The scarp of the older rocks, which looks down on the limestone valley, is offset to the west in Bear Mountain, and on the southern half of the area the eastern boundary of the valley limestone lies far west of the territory covered by the map. The rock also extends eastward in a great lobe far out over the highlands in Monterey, and two smaller lobes enter the area at New Marlboro and at West Norfolk. In its northern portion it is mainly a calcareous carbonate and is for the most part free from accessory minerals. I have collected rutile and brown tourmaline in the quarry at Coltsville. It is a white-to-gray marble, everywhere quarried locally and furnishing good building stone in inexhaustible quantity, so that the location of quarries is mainly dependent upon the proximity to railroads. Much has been written about a flexible variety of the marble (see Calcite in lexicon, p. 107) occurring near Pittsfield.

Farther south the extensive quarries at Lee are within the limits of the area considered, and from these quarries much marble has been shipped to Washington, Philadelphia, New York, and Albany. Here some beds of the rock are filled with a white-bladed tremolite, which is represented in every mineral cabinet.

This limestone is thickly covered in the bottom of the Tyringham



HYDES FALLS.

Valley. For a long distance north of the fault it is absent, and in this distance the springs and wells on the north of the fault give soft water and those on the south of the fault give hard water. At Mr. D. Clark's and eastward the limestone is preserved on both sides of the fault, but is very thin. All the springs are of soft water.

The limestone that runs horizontally high up on the south side of the Tyringham Valley at Fernside is the common, gray, barren Stockbridge marble. On the hillside across the strike the pure limestones grade into gneiss, through a large series of calcareous schists, often very rusty. The series is thus inverted and is the upper limb of a small fold overturned to the north, its axial plane dipping south into the mountain.

On the other side of Bear Mountain the limestones dip northeast into the mountain; they can not go under it, as its nucleus is pre-Cambrian. There is thus some form of fan structure present here, as was suggested to me by Prof. T. Nelson Dale. (See section on the Bear anticline, p. 58.)

The Monterey limestone grades in every direction into a sugary calcareous quartzite, and this, with the exceptionally heavy cover of till, makes it impossible to put accurate boundaries on the map. At the branch in the road south of the outlet of Lake Garfield is a broad area of a white, sugary limestone with much white pyroxene overlain by a rusty jointed, black, pyritous quartzite. The accompanying plate (Pl. VI) shows a beautiful anticline in this limestone at Hydes Falls, 1½ miles south of Monterey.

Farther south other remnants of the marble exist on the surface northwest of New Marlboro, and several instances of its passage into the Cambrian gneisses and quartzites are given.

Of 25 analyses of the Stockbridge limestones given by President Hitchcock,[1] 12 show it to be pure calcium carbonate. The remaining samples are strongly magnesian but quite free from silicious impurity, while in 5 analyses of pre-Cambrian carbonates the rocks are nearly pure dolomites with an average of 11 per cent of silicious impurities.

GEOLOGY OF FERNCLIFF RIDGE IN LEE.

CAMBRIAN QUARTZITE.

The geology of the prominent ridges which rise within and just east of the village of Lee (see map, Pl. VII) is complicated by the unexpected appearance of an outlier of the Cambrian tourmaline-bearing quartzite in the midst of the normal Silurian series.

This quartzite forms a peculiar ridge, which starts with Ferncliff, in the middle of Lee, and is a picturesque steep-sided mass of native rock, in whose eastern side an interesting cave has been formed by the falling of the jointed quartzite from the vertical face of the cliff.

[1] E. Hitchcock: Geol. Report of Mass., 1841, passim.

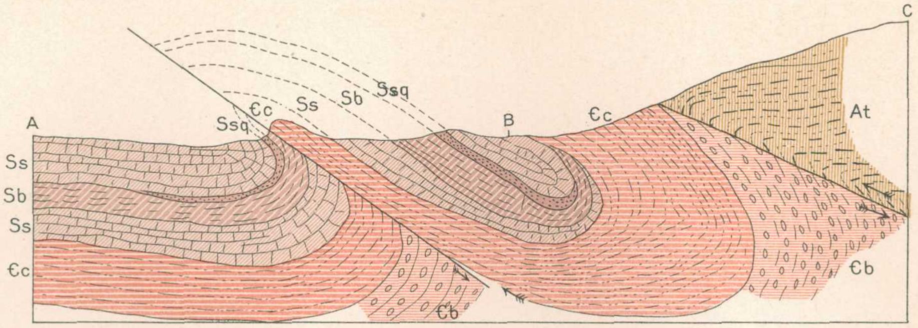
The ridge has been cut through by the river, but rises immediately on the north side and runs a mile farther northwest, presenting vertical cliffs to the east and lower bluffs to the west, where its shape is masked by a thick coating of drift. It ends abruptly at the south end of Laurel Lake, its northern and western faces showing 100 feet or more of vertical or overhanging cliff.

Lithology.—In Ferncliff the Cambrian series is represented by a thin-bedded micaceous quartzite, quite gneissoid in its granular texture and its irregularly disseminated biotite scales, and although it is slightly feldspathic it is not sufficiently so to be called a gneiss. It is uniformly fine sandy granular, and abounds in minute well-formed brown tourmalines in six-sided prisms. It is full of small lenses and pockets of quartz, and the tourmaline, in irregular aggregates, is much concentrated in and around these small veins and in their prolongations, being here much larger, some prisms reaching fully an inch in length.

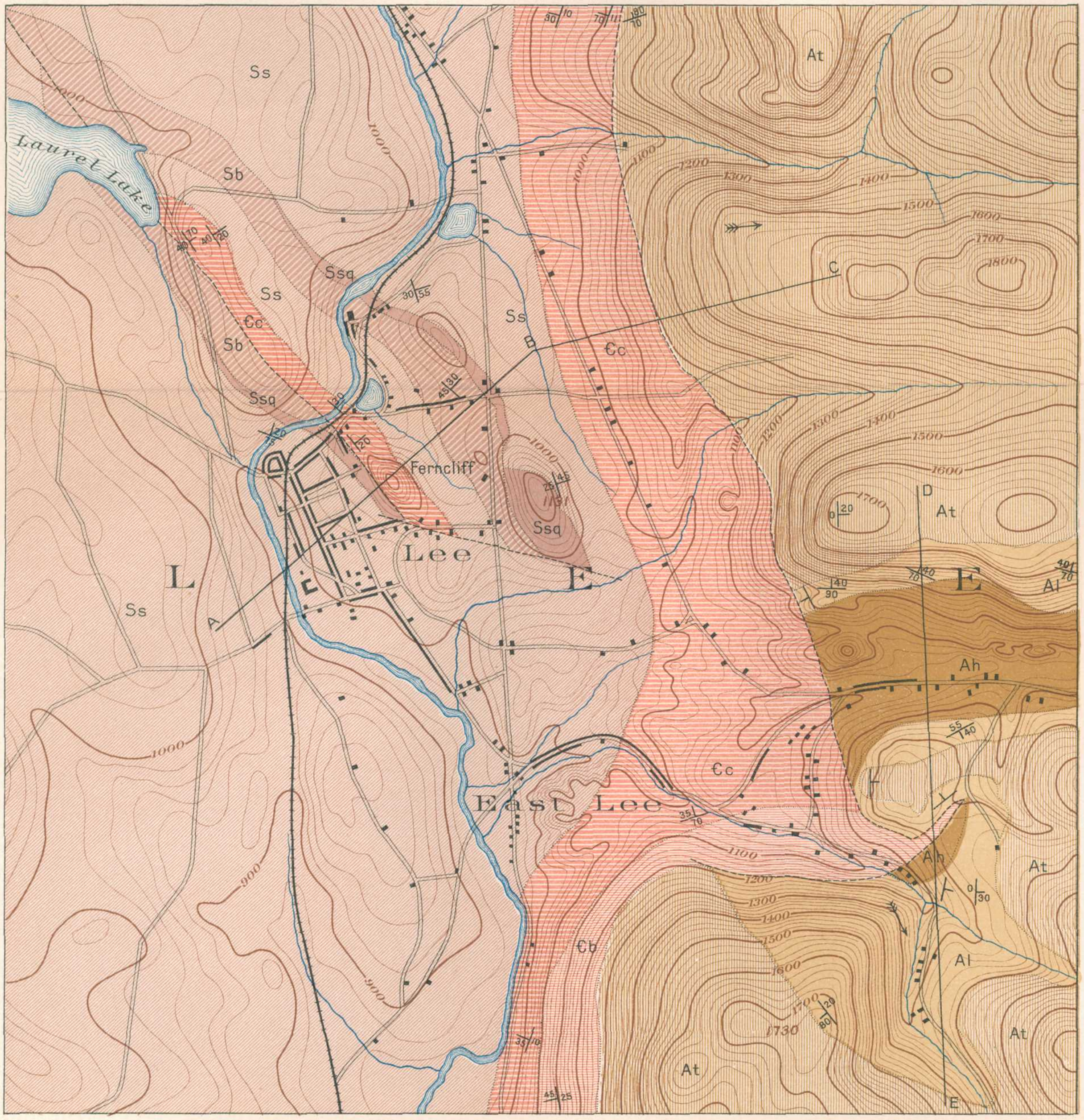
This bed, 40 or 50 feet thick, makes the crest of the ridge, and beneath it is a more micaceous quartzite or arenaceous mica-schist, always having a sandy quartz base, but often dark gray in color, owing to the abundance of biotite mixed with the muscovite. This also regularly contains tourmaline, in shapeless groups of needles, clear down to the edge of the river at the north foot of the hill. The same conditions exist in the ridge to the northwest. The rock is tourmaline-bearing from top to bottom, except in the middle of the east face of the steep hill which forms its north end, where there is, in considerable force, a pure white quartzite containing only a few minute pyrite cubes. It is, however, more granular than the Silurian quartzite to the east and more regularly banded, and layers immediately above and continuous with it contain much mica and tourmaline.

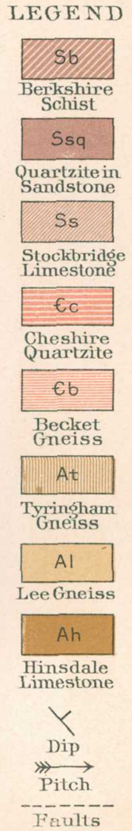
Structure.—In Ferncliff the rock is much contorted in the west face of the ridge; its beds dip east into the hill, with high angle, and emerge in the same direction, with low dip to the east as a whole but with large low undulations of the beds to north and south and with low dips to the west in some places, as at the cave.

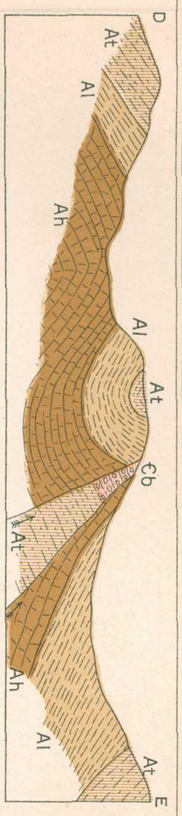
On the north face of the Ferncliff hill the beds dip first 20° E., then 30° E., where they are on a level with the Silurian quartzite to the west; 60 feet lower, at the river bank, they are nearly horizontal, with low dip south. At the north end, in the same way, the dip is 70° to 80° E. all the way up the west face, with low easterly dips on the east side. In the high ground of the valley border, several miles to the east, the equivalent of these rocks appears as the Cheshire quartzite, which graduates into the Becket gneiss, and they are here, for a long distance north and south, characterized by an abundance of minute stout tourmaline prisms. They are much more highly metamorphosed than the Silurian rocks with which they are here associated.



FERNCLIFF SECTION A-B-C ON MAP







EAST LEE SECTION D-E ON MAP

A. Hoen & Co. Lith. Baltimore.

GEOLOGICAL MAP OF FERNCLIFF AND EAST LEE

Scale of miles

1 ½ 0 1

1898

SILURIAN SERIES.

LOWER LIMESTONE.

The lower band of the Stockbridge limestone which appears in this area is deeply buried in the low valley bottom and rarely exposed at all. At the railroad crossing in the north edge of Lee village, opposite the Columbia mills, where on the map the eastern quartzite band crosses the road and railroad, is a section which shows all the remaining rocks of the area in excellent exposure, all dipping eastward in apparent conformity, and just south, along the railroad, the lower limestone is also well exposed in the cutting. It is full of phlogopite in bands, especially at the top, of altered pyrite in pentagonal dodecahedrons, of granular colorless muscovite, and of quartz grains. Its calcite grains are much twinned.

It folds around a large lens of a very coarsely crystalline and limpid marble, and is as a whole so much more crystalline, translucent, and filled with minerals than the soft, fine, sugary limestone of the upper bed as to strongly suggest that it may belong to the pre-Cambrian limestone, like that of the East Lee Valley. I could not find chondrodite or pyroxene in it, and consider it a Stockbridge limestone rendered more highly crystalline than usual, perhaps by the influence of faulting.

The accompanying analysis of a specimen of this limestone, from the railroad cut in Lee, also goes far to prove that the rock is to be associated with the Stockbridge limestone. The analysis was made by Mr. George Steiger in the laboratory of the United States Geological Survey.

Analysis of limestone from cut west side of railroad, north of Lee village.

	Per cent.
SiO_2	0.95
TiO_2	None.
Al_2O_3	.09
Fe_2O_3	None.
FeO	.10
CaO	54.75
BaO	None.
MgO	.56
K_2O	.15
Na_2O	.02
Si_2O	None.
Water 100°—	.08
Water 100°+	None.
SO_3	.05
P_2O_5	.03
CO_2	43.38
Total	100.16

I have elsewhere brought together (see p. 69) four analyses of the pre-Cambrian limestones of western Massachusetts. They are all nearly pure dolomites and contain an average of 11 per cent of siliceous impurities.

In a list of 25 analyses of the Stockbridge limestones 12 are nearly pure calcium carbonate, and those which contain magnesia are nearly always free from siliceous impurity.

BERKSHIRE SCHIST.

This mica-schist, which is well exposed just east of the railroad crossing on the foregoing section and in many places to the south as well as along the southwest shore of Laurel Lake, is a felted mass of warped red-brown biotite scales, generally of quite ragged appearance, rusting readily, and without accessories.

SILURIAN QUARTZITE.

The quartzite which appears near the schoolhouse just west of Ferncliff, and which has been recently opened for road material across the river to the northwest, agrees exactly in composition with that of the ridge a mile east of Ferncliff. It is the usual pure, massive, pale-yellow, vitreous quartzite.

It diminishes rapidly in thickness toward the west and north. At the south end of the east band it composes the whole of the massive hill just east of Lee (1,131 feet high), while where it crosses the railroad it is less than 50 feet thick. Farther north the rocks are everywhere covered, but all the indications of topography point to its entire disappearance, as at the north end the mica-schist ridge slopes down gradually into the low limestone plain, whereas a strong ridge would rise to the east if the quartzite were present. The quartzite west of Ferncliff is also only about 50 feet thick, and seems to thin out to the northwest so that it ceases to have influence upon the topography.

UPPER LIMESTONE.

This is the common Stockbridge limestone, white or pale gray, friable, generally pure in this vicinity, except that tremolite is abundant in the quarries to the south of the town.

FAULTS.

The representation of a north-south Ferncliff fault is justified by the close approximation of the Silurian quartzite to the Cambrian quartzite in Ferncliff, followed by the similar approximation of the Silurian mica-schist at the north end. It is drawn parallel and symmetrical with the main Lenox fault, which runs at the foot of the mountain to the east, as an overthrust subordinate to the main one, and most simply explains the structure of the region.

Justification for the hypothesis of an east-west fault is found in the fact that on reaching this line the two strong quartzite ridges suddenly stop and the whole area before them lies at the low level of the limestones, so deep indeed that over a square mile there are no outcrops at all. It is thus much more probable that these resistant beds are faulted down than that they form the surface across to the edge of the mountains, where they appear again in undiminished thickness.

This fault, prolonged easterly, runs up the East Lee Valley, where it or another fault south of and parallel to it, which is given with query on the map, terminates the Lenox fault and is marked by the overthrust of the pre-Cambrian on the Cambrian. It also runs parallel to the great Tyringham Valley fault to the south.

SIGNIFICATION OF THE NORTHWESTERN THINNING OF THE SILURIAN QUARTZITE.

I have elsewhere shown that the Tyringham and East Lee valleys were early blocked out because of the solubility of the Hinsdale limestone, and this thinning out of the coarse sediments, represented by the two quartzite bands (see Ssq, Pl. VII), along lines radiating from the mouth of the East Lee Valley, may mark a time of exceptional elevation of the Berkshire Valley border and of strong drainage through the long East Lee-Otis depression. In other words, the quartzite and associated band of Berkshire schist represent the remains of the delta deposit of a stream flowing west down the East Lee-Otis Valley during Lower Silurian time.

FAULTS.

HINSDALE FAULT.

This fault runs north and south through the village of Hinsdale. Along the whole western border of the Hinsdale anticline north of the Plunkett reservoir the Washington graphitic gneiss is absent and the Lee gneiss comes successively into contact with the Cambrian Becket gneiss, the Washington gneiss of the Dalton anticline, and the Stockbridge limestone.

A mile south of Hinsdale, at the top of the hill just west of the large outcrop of limestone near the bridge over the railroad, and again 90 rods west of the last inhabited house (C. D. Barrett's) on the blind road running north from the cemetery, the Lee gneiss can be seen in immediate proximity to the Becket gneiss. The fine-grained micaceous quartzite (Cambrian) has a strike N. 10° W. and a dip 65° W. The amphibolite and banded gneisses (Lee gneiss) adjacent on the east have a strike N. 50° W. and a dip 80° W.

Farther north, at J. Hanrahan's, south of the road running east from Dalton, the Lee gneiss carrying allanite is for a long distance in immediate proximity to the great outcrops of Stockbridge limestone, showing that the fault is one of great importance and concealing the whole Cambrian and Upper pre-Cambrian beds.

DALTON FAULT.

From the high iron bridge near the Dalton railway station the crumbling white Stockbridge limestone can be seen to form the north bank of the Housatonic for a long way west, while the fluted surface of the massive Cheshire quartzite forms the steep south bank.

At the ruined pier of a proposed bridge this fluted surface dips 80°

N. in the upper portion of the bluff, 50° and 40° in the lower part, and represents the fault surface, being horizontally ground and slickensided by the horizontal thrust of the fault. The limestone appears in the northern bank of the narrow stream to the next iron bridge, where it includes quartzite beds and forms the bed of the stream, with a constant strike N. 20° E. and a low westerly dip of 20°, as at the Carson and Brown paper mill, just west. Here the adjoining rock on the south of the fault is a dark, corrugated mica-schist, abundant in the hills to the south, and in boring an artesian well at this mill and 2 or 3 rods north of the stream the auger went through the limestone for 135 feet and then dropped 3 feet onto the surface of the mica-schist, which was bored 9 feet. I found chips from this boring identical with the schist in the hill to the south. This gives the fault here a hade to the north about the same as the quartzite plane mentioned above. The well record is interesting and is given below.

The faults on the north and south of the Dalton anticline were formed by the crushing together and the uplifting of this anticline, and an inspection of the map will suggest that the two areas of mica-schist north and south of the fault may once have been continuous, and the part to the north have been pushed eastward by the throw of the fault.

It may have been a muddy band sent out over the bottom of water where for the most part limestone was forming, and have been continuous eastwardly with the remnant in Windsor and the Hoosac schists farther east.

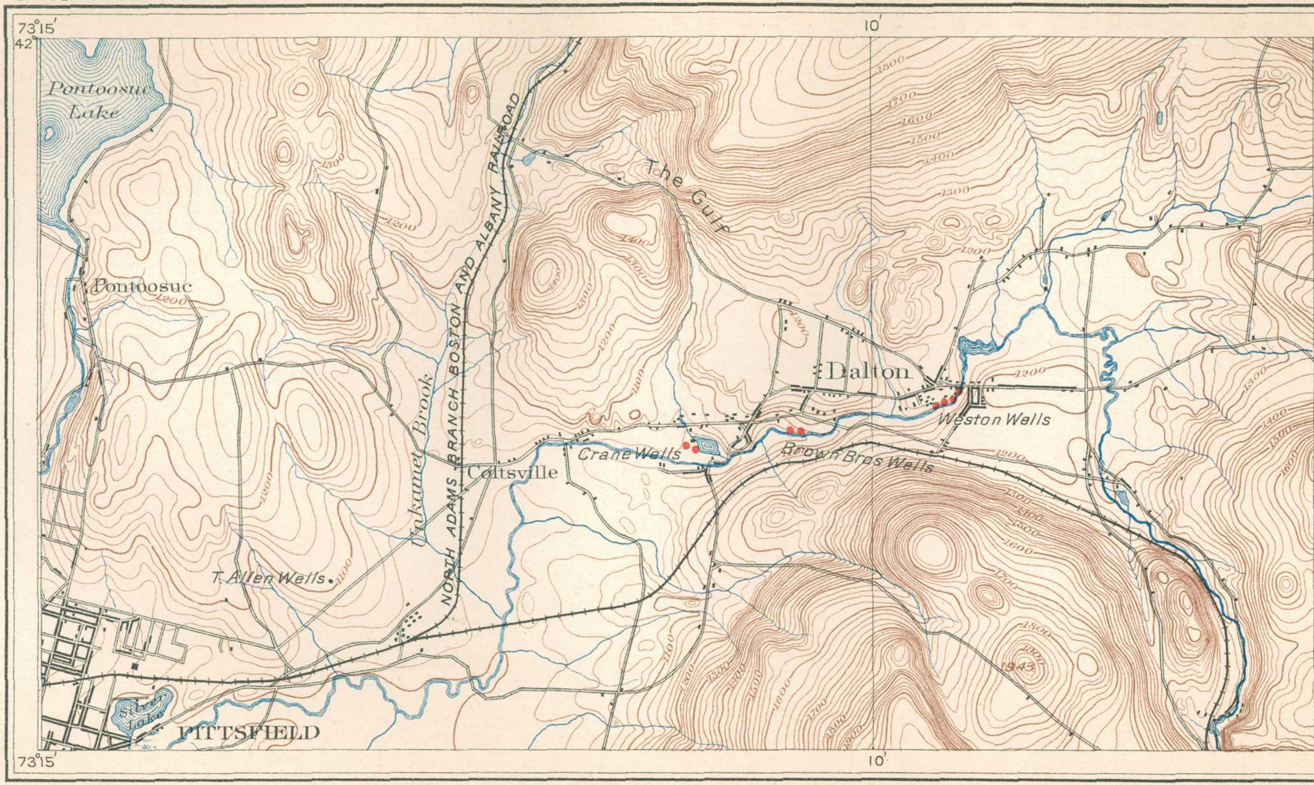
ARTESIAN WELLS UPON THE DALTON FAULT.

The great paper-making mills at Dalton owe much of their high reputation to the abundant artesian water, of excellent quality, obtained from very shallow wells bored upon the Dalton fault. (See Pl. VIII.)

At the Carson and Brown mill, beside the Housatonic River, in the west part of Dalton village, two interesting artesian wells have been bored. One was commenced March 7, 1884, by D. Dull, of New York. The following record was given me by Mr. Brown:

Record of well borings at the Carson and Brown mill in Dalton in 1884.

	Feet.
Soft rock	25
Hard rock	84
All way hard rock	98
Little water ran over	99
Soft rock	101
Soft rock	102
Very soft rock	104
Very soft rock	109
Very soft rock	114½
Very soft rock	117
Very soft rock; first water run	122
Very soft rock; increased water run	126
Very hard rock	131½
Broke through to soft rock and gravel 3 feet deep; water doubled.	135
Solid rock again	138
Continued 9 feet in the same solid rock	147



A. Hoen & Co. Lith. Baltimore.

ARTESIAN WELLS ON DALTON FAULT

Scale

1 0 1 2 MILES

The well supplied 740 gallons a minute of the purest water. The upper rock was limestone. The drill fell in a cavity formed by solution of the base of the limestone by water circulating along the plane of the fault. The lower rock was the corrugated mica-schist, as shown by samples preserved.

In 1855 a well was bored on the west side of the mill near the river by S. S. Gilman, of Springfield. The following record was preserved:

Record of well boring at the Carson and Brown mill in Dalton in 1855.

	Feet.
Rock blue lime	24
Rock blue lime	24–37
Gray band; first water	37–40
Gray lime	40–67
White belt; large water vein, flowing well	67–71
Increase of water	71–100

"The rock is soft lime mixed with soapstone." The soapstone was probably the decomposed micaceous portion of the limestone.

An analysis of the water gave the following results:

Analysis of water from artesian well in Dalton.

[Parts in 1,000,000=140.3 solid.]

	Parts.
SiO_2	8.80
Al_2O_3	12.80
CaO	33.15
MgO	23.06
K_2O+Na_2O	22.54
FeO	Trace.
Cl	3.55
CO_2	36.40
$CaCO_3$	59.15
$MgCO_3$	35.06
NaCl	5.85
SiO_2	8.80
Al_2O_3	12.80
K_2O	18.64

The wells in the village of Dalton to the north and east lost their water when the first well was opened. Other wells have been bored along the same fault, at Mr. Byron Weston's mills farther east, but the wells bored at the Crane mills to the west were unsuccessful and were plainly not along the line of the fault. The following report on the wells at the Weston mills, 250 rods east along the same fault, has been prepared for me by Mr. W. L. Tower, civil engineer in Dalton:

Number of wells, 5, of which 4 are in use:

No. 1, the Bonanza, is 239 feet deep and was bored in winter of 1883–84. First flow of water tested January 24, 1884, showed 366 gallons per minute. After further boring more water was obtained, and the flow has perceptibly increased since the well was completed. The latest test shows a flow of 550 gallons per minute with a pump lifting the water 18 feet out of well. The boring drills and part of the apparatus were lost in this well, and it is thought that this fact diminishes the flow of water.[1] The rock is reported to have been principally very soft limestone. Operations in boring this well were very much delayed and hindered by caving. It was bored by Daniel Dull, of New York City, who saved samples of the rock passed through in boring the Bonanza and Deep wells.

No. 2, Deep well; 511 feet deep; bored in fall of 1883. Flow, 260 gallons per minute. Bored by Daniel Dull. Rock passed through medium to hard limestone and a vein of very flinty rock at a depth of about 300 feet.

No. 3, Chamberlin well; 150 feet deep; bored 1856-57. Flow, 120 gallons per minute. Bored by Mr. Gilman.

No. 4, Defiance well; 76 feet deep. Flow, 28 gallons per minute. This well is about 400 feet northeast of the Bonanza well. Surface rock in the immediate vicinity, as uncovered in summer of 1895, soft seamy limestone. Bored by Jesse Button, Springfield, Massachusetts. An analysis, made at Yale College, of the water of the Bonanza, Deep, and Chamberlin wells, determined that it is very hard, contains carbonates, is unfit for use in boilers or laundry.

There is a fifth well at Weston's mills, near the Deep well bored by Jesse Button, but it is now abandoned. The well has a temperature of 48° for summer and winter.

SOUTH DALTON OR WARNER MOUNTAIN FAULT.

The west end of this fault can be well studied a hundred rods north of where the road from Pittsfield to Washington Station first crosses Sackett Brook, in a narrow gorge running east and west and forming the gathering ground of a small brook, shown on the map, that runs west, crosses the north and south road, and joins Sackett Brook.

The north wall of this narrow valley is composed of the dark Becket gneiss, the south wall of the pure Cheshire quartzite, and they both strike north and south and dip west.

Going west to the next point where Sackett Brook crosses the road, one may take a wood road north from the western house (J. Sweeney's) of the small settlement 100 rods up the mountain side and 100 feet above the main road to a group of logging huts near a bridge.

Five rods up the brook, above this bridge, one finds the white quartzite on the south abutting against the dark Becket tourmaline-bearing gneiss in a well-marked vertical east-west fault, which can be traced in the bluff a long way east to a point where, north of the eastern house of the village (W. Kirschner's), the quartzite begins to come in contact with the older gneiss, and where the junction of the two gneisses is also well exposed a long distance in a steep bluff.

The fault limits the Dalton normal anticline on the south. South of the fault the quartzite extends a mile farther east than on its northern side. All along the roadside, south of the great southward-facing scarp caused by this fault, are numerous great bowlders of a coarse quartzite breccia cemented by much limonite—a friction breccia derived from this great fault. (See p. 80.)

At a point a half mile north of the top of Warner Mountain the

[1] This was probably because the fault plane was struck at this point and the tools fell into the cavity, as in the case of the Brown Brothers' well, before mentioned.

corner of the pre-Cambrian area can be clearly mapped in the bare hilltop. From this point east the country is covered, but the formations that come up to it on the north and on the south are so diverse that the prolongation of the fault is certain, and its exact position can not be anywhere far from the line given on the map. It is, however, not certain that it cuts off the pre-Cambrian limestone at the overhead bridge south of Hinsdale village, although this is by far the most probable representation of this badly covered area.

LENOX FAULT.

A half mile south from New Lenox Roaring Brook comes down from the mountain. Following it up 100 rods from the road over the distinctly bedded quartzite, which strikes 45° E. and dips 50° W., increasing near the contact to 60° W., the contact above can be seen in the side of the wood road which follows the brook on the north side, and below in the bank at a fine waterfall. The quartzite is here thick bedded and much contorted, especially a little farther south, and its posture is constant. It is vertically jointed for several feet west from the contact and a few scales of muscovite appear on the foliation faces. The gneiss rises in a great bluff above the quartzite, and this bluff extends a hundred rods north and several miles south to the East Lee Valley. The gneiss is highly stretched, with strong pitch south. It is much crushed and agrees in type with the Tyringham rock. Many bowlders of the coarse Washington blue-quartz gneiss, blotched with great masses of biotite, have fallen down, and the contact of the two formations is in the bluff above.

A still more interesting exposure of the same contact is found a mile east of Lenox Furnace (fig. 8, p. 44). A wood road runs east from a sharp bend in the main road, and the section shown in the figure begins where this road crosses a brook and continues along its side.

The contorted quartzite at the brook crossing seems to have a rather low dip west, but the finer, flaggy quartzites higher up dip steeply to the west, which seems to be the posture in the beds; flattened pebbles are found higher up. These beds and the thick, granitoid quartzite which follows (and which, as in the Dalton clubhouse section, is characterized by a pale-green muscovite) are full of small tourmalines and connect with the Cambrian.

At the contact, which occurs in a great white ledge south of the brook just before reaching the thick woods, only a rod of a true Becket gneiss intervenes between the micaceous quartzite and the black-and-white pre-Cambrian gneiss. There is a conformity of foliation at the junction, but while the quartzites strike north the older gneisses strike nearly east, and the extent and character of the fault can not be determined. It depends upon the thickness of the gneissoid lower member of the Cambrian, and this is variable; at times the Cambrian seems to be a quartzite to its base.

Five rods east of the contact of the section shown in fig. 9 on page 45, at the point where the road from Lenox Furnace if prolonged east would cut the 1,400 contour line, is the contact of the white-and-black banded Lee gneiss and a stretched gray Tyringham gneiss. The wood road runs over bare rock at this point, and there is, resting unconformably upon the vertical edges of the Lee gneiss, a thin veneering of a dark jointed Cambrian slate containing small pebbles.

The complex series of faults near East Lee can be only partially deciphered, and their connection with the Lee faults is not clear. The matter is discussed under the sections describing the East Lee limestone (p. 50) and the Ferncliff faults (p. 88).

TYRINGHAM FAULT.

The Tyringham fault has had much to do with the formation of the deep Tyringham Valley. How much it has been assisted by the solution of the pre-Cambrian limestones can not be determined.

It brings the pre-Cambrian up against the Cambrian in the mouth of the valley, probably hades north, and is upthrown on the north side. Lower down the valley it has brought Cambrian and pre-Cambrian together, and in its continuation has formed the upper valley of Clam River, as the Otis fault has fixed the upper course of the Farmington River.

INTRUSIVE ROCKS.

Intrusive rocks, both basic and acid, are almost absent from the Becket and Sandisfield quadrangles, except so far as the pre-Cambrian rocks are altered eruptives. West of the great granite stocks which look down on the Connecticut Valley and their broad fringe of dikes, the isolated dike of porphyritic granitite in Middlefield is almost the only acid intrusive which approaches this territory. The greatly altered black massive hornblendic rocks of Becket and of Ball Mountain and vicinity, associated with the Cambrian gneisses in the extreme southwest corner of the area, are the only exception among the basic rocks. The same is true of the extension of this area to the north across the State. Two small, much-altered dikes of basic rock are indicated by Professor Wolff in the Hoosac Mountain map as northeast and southeast of the village of Berkshire, and a third pre-Cambrian dike is described from Oak Hill, on the north border of the area. The same seems also true of Greylock Mountain and of the Taconic Range for a considerable distance to the west. The basic rocks of the Cambrian are described on page 69, in order to compare them with the amphibolites formed from sedimentary beds.

Pegmatite.—A well-characterized graphic granite is represented in Mr. D. Clark's collection, which was obtained from the roadside in West Otis village. The granite 50 rods below Windsor Falls, in Dalton, south of the brook, contains good crystals of orthoclase and a little actinolite in biotite, and is soaked full of a lemon-yellow iron salt due to change of biotite and actinolite. In the southwest part of the Sandisfield quadrangle small pegmatite veins and impregnations are quite frequent, but not extensive enough for mapping. They present no peculiar characteristics except at the occurrence north of Town Hill, in Sandisfield, where the crushing has sheared the large tourmalines in a remarkable way into a series of echeloned plates. The small pegmatite dikes bordering the amphibolite at the Becket quarry are described on page 75, and those at the West Norfolk cut on page 77.

GLACIAL DEPOSITS.

The whole upland country is covered by drift, often very heavily, especially in the south of Becket and the north of Otis, but presents little of special interest.

POST-GLACIAL DEPOSITS.

The Hoosac limestone valley is continued south over a low pass in Lanesboro into the broader Housatonic Valley at Pittsfield by way of Unkamet Brook. The Hoosac Mountain Range from the north line of the State to the north of Dalton presents so steep and uniform a slope to the west that it forms an unbroken line of division between the Champlain deposits on both sides of the range. When, however, the limestone expands eastward in the center of Dalton a partial union occurs.

This Dalton bay is deep, being underlain by the Stockbridge marble, which is easily removed by erosion. It is, moreover, continued southeast across Hinsdale and Washington by a curious transverse depression in the Berkshire Hills, which, although at a much higher level than the Pittsfield Plain, is yet much below the crest of the ridge. It begins narrow, at its southeast corner, and extends as a broad depression across Hinsdale, where it drains west as the Housatonic, and is continued beyond the Washington station, where it expands into a deep amphitheater and suddenly narrows into a canyon, which continues into Becket and contains the head waters of the Westfield River—a tributary of the Connecticut.

When the boundaries of the complex overthrown Hinsdale anticline were made out, the lowest easily decomposing beds of the pre-Cambrian nucleus of this anticline were seen to have conditioned this depression, which is divided at the Washington station by a dam of the decomposing gneisses about 1,550 feet above the sea. These furnished the barrier which fixed the level of the Hinsdale lake in Glacial time, and which forms the watershed of the present topography.

WASHINGTON BASIN.

As the ice melted up the Westfield River Valley it at last set free the canyon already mentioned, between Becket and Washington stations, and the deep amphitheater into which the canyon expands just before reaching the latter station. As the waters escaped from the ice and passed through the gorge, they left a great body of sand in the basin, and this at a time which slightly antedated the formation of the Hinsdale lake described below.

For nearly a square mile north of Washington Station the broad, flat-topped sands stand 80 feet above the bottom of the Hinsdale lake. Recent extensive excavations by the railroad along this plain showed that for long distances it is composed of broad, undulating sheets of nearly horizontal sands and gravels, bending down on the south, with delta front structure. They were probably laid down when the ice still occupied most of the Hinsdale Basin to the north and had just begun to send its waters down the newly opened gorge to the south.

HINSDALE LAKE.

A description of the heavy gravel and fine sand deposits which fill the basin back (north) of the Washington sand plain across Hinsdale and which end abruptly in a terrace scarp on the east edge of Dalton, high above the level of the sands in the Pittsfield-Dalton Valley, will be best appreciated if given in the terms of the theory which seems to explain them.

The sands seem to have been deposited while the ice, having just abandoned the Hoosac Range to the east, still filled the limestone valley to a point south of Pittsfield and projected into the Dalton bay, completing the boundary of the lake near the present western boundary of Hinsdale Township, and about a mile north of Hinsdale village.

The Washington gneiss barrier determined the height of the waters, and heavy floods from the north and northwest swept across the ice and into the lake, carrying great masses of sand and gravel which, exactly as in the filling of a mill pond, were deposited in the upper part of this lake, filling the narrow northern portion from the point where the ice stood, across the area where is now the Catholic cemetery, extending southward, and expanding with the widening of the basin to a broadly curved line just south of Hinsdale village.

The great plains to the north and east of the village (the level of Maple street), about 1,520 feet above the sea, are a remnant of this extensive deposit, and the magnificent terrace scarp which starts from the road running southeast from the town library and about 50 rods from that building and runs a half mile east to the next road, is the terrace front of the great delta that was advancing into the lake when a period was put to the lake itself.

On the recession of the ice northward into the Dalton bay, the lake drained, forming the present Housatonic River and cutting away much of the old delta. The sand which had rested against the ice caved to a terrace scarp sloping north toward the Dalton bay, traces of which scarp can be seen just north of the Catholic cemetery.

In Hinsdale one must mentally restore the level of Maple street, the broad plain east of the village, and carry it across to the hillside on the west of the village, in order to understand the great sand deposit, for brooks and temporary washouts have carried forward the destruction begun by the breaking away of the lake.

From the foot of the great delta front below the library a broad, flat plain of fine sand extends south, the whole width of the basin, to the foot of the transverse sand plain in the Washington Basin which bounds the lake on the south.

The plain descends slightly to the south and the river meanders slowly across its flat surface. The fine sands were being spread over the bottom while the great gravel delta was advancing into the basin and gradually covering them. The high delta flats at Hinsdale and at Washington Station and the lake bottom bed between them can be clearly made out from the contours on the inch-scale map.

DALTON KAMES.

A great kame starts high up on the Wakonah Falls Brook in southwest Windsor. The broad, open valley is in its northern part and for a long way south bottomed by till, and is then suddenly covered by gravels which gain great thickness southwardly before they reach the reservoir 3 miles northeast of Dalton. Southeast of the latter place, in the northwest of Hinsdale, similar sands expand in a broad basin. These join the Windsor sands and extend west down the Wakonah Brook Valley into Dalton as a well-sorted gravel kame of large dimensions (a long sand plain abounding in deep pits) which winds strangely across Dalton and is finally submerged beneath the broad sand stretches which expand westward from the Pittsfield plains.

It is clear that these gravels began to be deposited when the ice still filled the Dalton depression, and that the waters that brought them had then an outlet south across Ashmere reservoir into the Hinsdale lake; that, as the ice lowered, the drainage of West Windsor and North Hinsdale ran southwest across the ice, by Wakonah Brook, into the Housatonic Valley. Later the horizontally stratified gravels were let down by the ice remnants on which they partly rested and sank to such a level that they were in places wholly, and in places only partially, submerged by the sands which were afterwards swept south through the Hoosac Valley and spread on the Pittsfield-Dalton Plain.

HIGH TERRACES IN BECKET.

A high mountain ridge extends northwest from Becket Mountain, and for several miles is flanked by two great terraces, at 2,080 and 2,000 feet, which seem to be the remnants of a glacial lake whose waters finally drained into Basin Pond Brook. These terraces can be reached by the blind road west of the reservoir. They have not been made the subject of special study.

HIGH SANDS AT ENTRANCE TO EAST LEE VALLEY.

Standing on the hill south of Lee and looking across to the entrance of the East Lee Valley one sees that the whole broad mouth of the valley is clogged by exceptionally high, flat-topped sands, which project into the valley in great lobes. They have been notched by the cutting for a railroad that was never finished, and, as usual, have a cemetery on their flat surface. They represent the filling of a temporary lake, held up by the Berkshire Valley ice and drained southeast down the East Lee Valley.

DEFLECTED GLACIAL DRAINAGE DOWN THE HINSDALE, EAST LEE, AND TYRINGHAM VALLEYS.

Each of these long valleys has been greatly affected by the movement of the ice out of the Berkshire Valley, and by the deflection of the flood waters during the meeting of the ice.

From Hinsdale down the Westfield River, from East Lee down the Farmington River, and from Tyringham down the Clam River, this influence is felt the whole length of the valleys and out across the Connecticut Valley in Massachusetts and Connecticut. Bowlders of blue-quartz gneiss are not rare here, while the "hardheads" of the Cambrian quartzite from the Housatonic Valley are everywhere very common.

MINERAL RESOURCES.

LIMESTONES.

Pre-Cambrian.—The time has long past when the Hinsdale limestone was burned for quicklime. Most of it is too impure for architectural purposes. The limestone at the mouth of Coles Brook, in which the chondrodite grains have changed to pale yellow-green serpentine, is adapted to ornamental purposes, and the heavy bed, crossed by the Housatonic branch, southwest of Hinsdale is very pure and of even grain, firm and of good luster, and ought to be considered as a source of marble.

Silurian.—The Stockbridge limestone or dolomite is quarried extensively for local uses in the deep bays which penetrate the Hoosac Range in Dalton and Tyringham, and the important quarries south of Lee village have furnished large quantities of high-grade marble, from which the Washington Monument, the Capitol extension, Girard College, the new city hall in Philadelphia, and St. Patrick's Cathedral in New York City were built. It is a white, durable, but rather coarse marble, and cubes 20 feet on a side can be furnished from the quarries. It sustains the highest tests for crushing strength.

Analysis of white dolomite from Lee, Massachusetts.

[G. P. Merrill: Cat. Nat. Mus., 1889, p. 505.]

	Per cent.
Carbonate of lime	54.621
Carbonate of magnesia	43.932
Oxides, iron and aluminum	.365
Loss	.610

Tests of strength of dolomite (marble) from Lee, Massachusetts, at Watertown Arsenal.

[G. P. Merrill: Cat. Nat. Mus., 1889, p. 497.]

Size of cube.	Position.	Strength per square inch.	Remarks.
5.91+ 5.92+ 5.92	End	22.860	Sustained maximum load of testing machine without apparent injury.
5.91+ 5.91+ 5.90	Bed	22.900	Flaked off along one edge.
5.89+ 6.00+ 5.90	Bed	21.700	Crushed suddenly with report.
5.9+ 5.91+ 5.90½	End	20.504	Burst into fragments suddenly.
5.93+ 5.93+ 5.93	Bed	22.370	Effect of loading, slight flaking of one face of block; did not break.
5.92+ 5.92+ 5.91	End	22.820	Sustained maximum load of testing machine without perceptible injury.

GRANITE.

Pre-Cambrian.—The coarse gneisses of the pre-Cambrian series have been quarried for common work, like bridge building and underpinning, but have been used only locally. They rust badly, and may crumble.

Cambrian.—The conglomerate-gneisses are often so strongly metamorphosed that they become complete granites. This seems often to depend on their proximity to sharp upfolding of the pre-Cambrian rocks. The best quarry is that of the Chester Granite Company, in the southeast corner of the Becket quadrangle. This granite is fine-grained and clear gray, a little too dark for polished work but taking a fine surface and furnishing large blocks of even grain and color, suitable for the best monumental work. A similar stone has been much worked in the Clark quarry, beside the railroad west of Coles Brook. Here the passage of the massive quarry stone into the common flaggy gneiss can be clearly seen. A promising quarry has been opened on N. Alderman's land, in the center of Becket, and in Otis the quantity of good granite is inexhaustible. In the south part of the area in New Marlboro and Norfolk a rock of the same age and character has been much quarried, especially on the east slope of Ball Mountain.

FLAGSTONES.

The Cheshire quartzite is mentioned by Hitchcock as furnishing the most perfect flagstones in the State. The best quarries were in the west part of Washington, 5 miles southeast of Pittsfield. Other quarries occur in Tyringham and Lee. Little work, however, seems to be done on these beds now.

BUHRSTONES.

In the same hill in Washington in which the flagstones occur buhrstones were formerly quarried which sold for $70 to $80 each. This industry also has passed away.

GLASS SAND.

Where the Cheshire quartzite extends far up into the mountains in Washington much glass sand is dug and carted down to the railroad. In the western part of Washington also and in the Gulf at Dalton much of the quartzite is pure enough for use in glass making.

ROAD MATERIAL.

In Hitchcock's Final Report on the Geology of Massachusetts (p. 211) is perhaps the first suggestion of a rock for road building in the State. The harder varieties of the Cheshire quartzite are thought to be well fitted for this purpose. It will certainly be the best local rock for this use, but the pure quartzite found in the Stockbridge limestone will be nearly as good. The Gulf in Dalton, the country in Washington south of Sackett Brook and east of New Lenox, the western ridge at Fernside in Lee, and the quarry just north of the river, together with the great hill nearly a mile east of Lee, will furnish material in abundance.

SOAPSTONE.

A large amount of soapstane has been taken out at the quarry beside the brook above Wakonah Falls in the south of Windsor, and recently the bed has been opened west of the old quarry and good, soft, slaty soapstone obtained. Along the same bed, a mile southwest, some work has been done on the hard, green, massive chlorite associated with serpentine. A pale-green, fine-grained steatite occurs in large amount as a selvage on the east of the great limestone bed cut by the east branch of the Housatonic in the southeast of Hinsdale. This would form a beautiful rock for inside work.

IRON ORES.

The pre-Cambrian rocks are very rusty, especially in their upper strata, and have everywhere tempted mining. As this rustiness depends largely upon the decomposition of pyrite it is not a good indication of valuable ore. Considerable digging has been done just east of Hinsdale Center, at N. Alderman's in Becket, and at the Hotchkiss and Cleveland mines at New Marlboro. The principal ore is pyrrhotite. Nothing has been found to justify expenditure. The Cleveland mine was first opened as a gold mine but latterly has been worked as a nickel mine.

GRAPHITE.

Considerable excavation has been made at the "lead mine" east of Washington Station, on the Lyman place, and openings have been made along the same band at several places to the north and at the creamery near Hinsdale. Graphite occurs in considerable amount on Sky Hill in Tyringham and across New Marlboro, but nowhere in sufficient quantity for mining.

GOLD AND COAL.

The Cleveland mine in New Marlboro was first opened as a gold mine. Buttons of gold and silver *received from the assayers* are shown by the owners. There is no probability that gold in paying quantity will be found within the limits of the area covered by the map. In my notebook are the printed-out answers to the questions of a deaf old man living in the south part of Windsor, the sides of whose house were heaped with great blocks of rock full of rotted yellow mica, which he fondly believed to be gold. The rock had been quarried and brought down by him from the mountain to the east. I tried in vain to persuade him to waste no more labor on the search.

The following items appeared in the Springfield Republican:

1895. Yellow Metal at Hinsdale.—Work of mining gold at the Primrose farm at Hinsdale will begin in the spring. Assays have varied considerably, but all find gold in paying quantities. Ricket and Banks, of New York, have made three fire assays; Professor Suthphen, of Gloversville, New York, has made numerous assays, the last being of sand that yielded $56.33 per ton. A large syndicate in New York City is trying to buy a part of the Primrose farm. The interested capitalists live in Pittsfield. The Fleming farm, owned by George Duncan, of Middlefield, will soon pass into the hands of a syndicate of Springfield men if proper terms can be made.

August 15, 1896.—George M. French has a number of men excavating on his "gold find" preparatory to the final examination by Professor Suthphen, of Albany. Despite the contradictory statements made by different assayers Mr. French still has some hopes and flattering offers as well. The numerous assays made by reliable authorities do not agree. While some find gold in large quantities, others find little or no trace.

I have not visited the farm since the new mine was opened. My earlier study of all the ledges of the region had not led me to expect important gold deposits there. The following similar account is quoted for the interesting legend and note concerning the custom of selling mineral rights in the hill towns.

Long ago there was mining for gold done in that wild region known as "the Gulf," in Dalton, in a very desultory way, however, without capital and with no thoroughness, and by those not expert in prospecting.

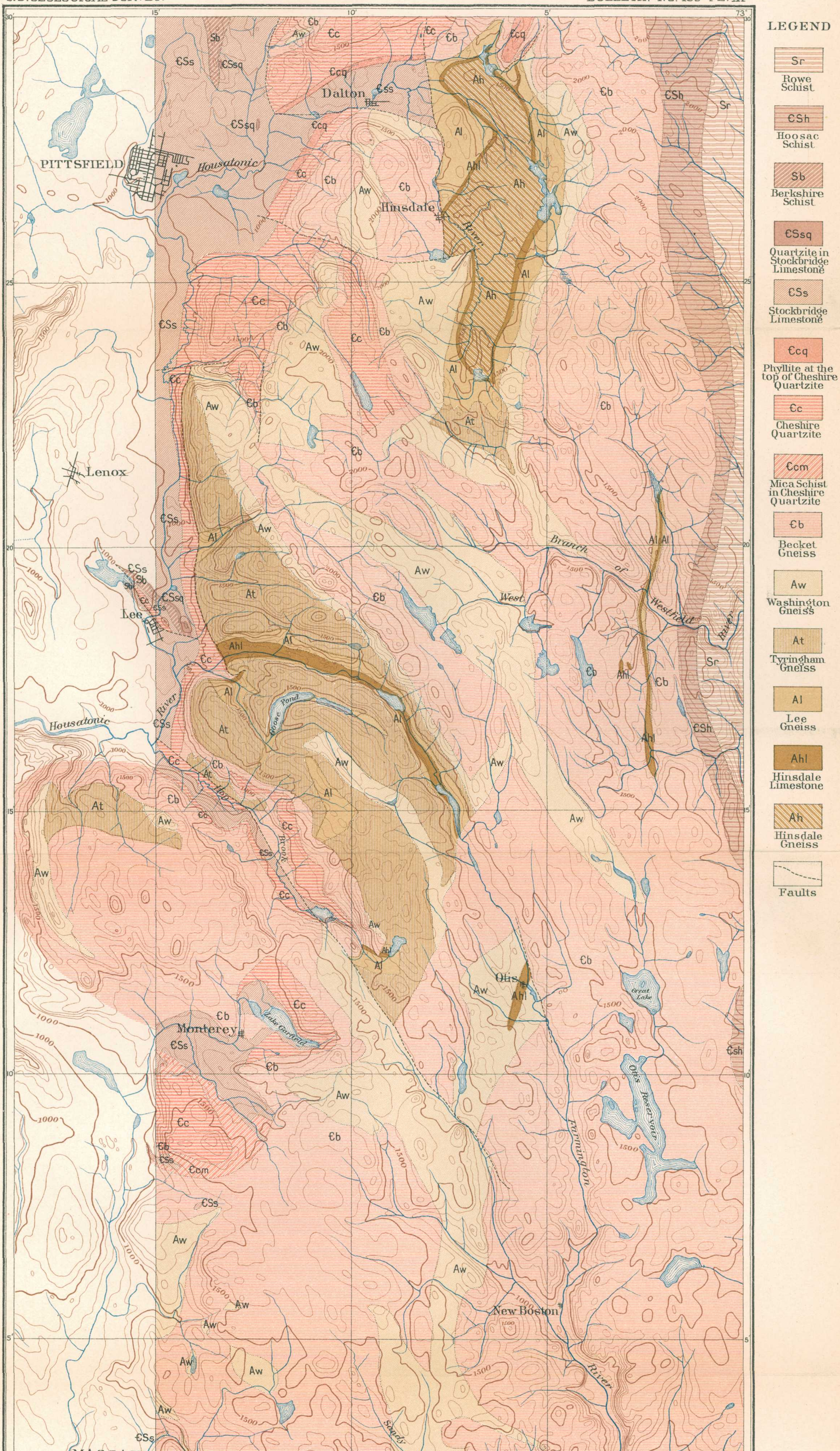
The discoveries at Primrose farm have stimulated explorations and inquiry, with results that are surprising and may be important and profitable. We announced exclusively last week Mr. Duncan's purchase of the Fleming farm, which, it is believed, contains a continuation of the Primrose "fissure," and the fact that foreign capital was ready to invest upon assay proof of a good outlook. Mr. Corey, in the town of Washington, but near the Primrose, has had assays made from superficial rock contaminated or impregnated from the Primrose, and finds a yield of $11 to the ton. The William Pease farm, also in Washington, has shown such promise that it has been leased for prospecting and mining purposes by a syndicate from Lee—W. H. Gross, E. Ely, and Mr. Davis, the latter said to be an experienced mine hunter.

That mineral wealth was suspected or believed to exist in these Washington farms is evident from the fact that thirty years ago farms were sold subject to the sellers' reserved right to prospect for and dig minerals. An instance of this is the L. A. Huban farm, owned by father and son, and comprising about 300 acres. This farm adjoins the Pease farm, we believe, leased, as stated, to Gross, Ely, and Davis, and overtures for its purchase by the individual or syndicate for whom Mr. Post is acting were made a good while since. It is only recently, comparatively, that the reservation as to minerals and mining was "bought off" by young Mr. Huban.

There is a legend lingering in the memories of men of Lenox and vicinity that, in the days of legend, an Indian, remnant of a tribe or a descendant of some family of these wandering original Americans, used to tell the white people about a coal deposit he knew of in the woods of Washington. This was before the days of railroads and coal sheds, and when wood was the only and abundant fuel. It is even related that a bottle of "fire water" was offered as a test to prove the assertions, the Indian to have the drink if he brought a pail of coal to Lenox Dale, as he said he could. He was watched, the white man then as now intending to get the best of the Indian, by discovering his secret, but he was too smart for the watchers. He slipped off in the night and returned in the night, bringing the pail of coal. Mr. Huban believes this coal mine is on his farm.

While he was plowing in one of his fields last May he turned up several lumps of coal; a piece of it is now on the Sun's desk. Mr. Huban has owned the place about thirty years, and there has been no such use of coal about the farm as should make its presence probable or even possible. He has done no prospecting, made no examinations to speak of, but is satisfied in his own mind that there is a coal deposit where the outcroppings were struck with the plow.

Of course there is not the slightest possibility of finding coal in Washington, and the prospect of discovering gold in paying quantities is scarcely better. More than fifty years ago President Hitchcock published in his final report a long list of similar legends and foolish searches for gold, in the hope that the tendency to waste money in that direction might be checked with increase of knowledge. I do not, however, find any apparent decrease in the number of "gold mines" in the region.



GEOLOGY OF THE EASTERN HALF OF THE HOUSATONIC QUADRANGLE

BY B. K. EMERSON

1897

Scale of miles

1 0 1 2 3 4 5

Contour Interval 100 feet

A MINERAL LEXICON OF EASTERN BERKSHIRE COUNTY, MASSACHUSETTS.

The region covered by this lexicon embraces the towns of Windsor, Dalton, Hinsdale, Becket, Lee, Tyringham, Otis, Sandisfield, and New Marlboro.

An attempt has been made to give a full chronological history of each mineral, its geological age and distribution, and its mineralogical varieties and crystalline form. All sections which are not followed by citations are by the author. The greater portion of the material studied is contained in the collection of Mr. Daniel Clark, of Tyringham, and where it is not otherwise stated it may be assumed that the best illustration of every mineral in the county is to be found there.

ALBITE.

1891. **Albite.** New Marlboro.

A beautiful albite in good crystals a half inch long, showing a fine moonstone effect in unusually deep blue on the face M (010). It occurs in pre-Cambrian gneiss at the Hotchkiss mine, associated with pyrrhotite and pyroxene. The crystals are limpid and free from inclosures, as seen under the microscope, and the opalescence is due to the cleavage on OP (001). It extinguishes in plates cut parallel to M at $+14° 21'$, and is thus an albite.

1895. **Albite replaced by quartz.** Tyringham (Sodom).

Pre-Cambrian. See page 52 for a description and illustration of this remarkable pseudomorph, which retains the twin striation and pearly luster with great perfection.

ALLANITE.

1852. **Gadolinite.** Becket.

C. U. Shepard: Treat. Min., p. 253. This is probably the allanite from the pre-Cambrian gneiss.

1876. **Allanite.** Becket.

C. U. Shepard: Cat. Min. within 50 miles of Amherst, p. 7.

1890. **Allanite.** Becket. Hinsdale. Dalton. Washington. Otis. Tyringham. Sandisfield.

Allanite is everywhere found in scattered crystals of small size in the Washington (pre-Cambrian) gneiss. Its small pitch-black crystals, with dark reddish decomposition borders and the slight puckering of the fracture in the inclosing gneiss which radiates from each crystal, are very characteristic of the rusty pre-Cambrian gneisses. The best localities are on the brook south of the Dalton clubhouse and opposite D. Clark's house in Tyringham.

AMPHIBOLE.

1823. **Asbestos.** Windsor (near Cummington soapstone quarry).
Asbestos adhering to actinolite.
J. Porter: Min. Loc., Am. Jour. Sci., Vol. VII, p. 252.

1824. **Black hornblende.** Washington.
Well crystallized.
J. Porter: Am. Jour. Sci., Vol. VII, p. 253.

1824. **Tremolite.** New Marlboro.
E. Hitchcock: Geol. of a part of Mass., Am. Jour. Sci., Vol. VIII, p. 35.

1824. **Tremolite.** New Marlboro. Pittsfield. Lee.
New Marlboro; Pittsfield; in dolomite, bladed, granular.
Lee; fibrous, fibers more than 2 feet long.
C. Dewey: Geol. Berkshire, Am. Jour. Sci., Vol. VIII, p. 46.

1825. **Tremolite.** Lee.
Above cited.
S. Robinson: Cat. Am. Min., p. 55.

1825. **Tremolite.** New Marlboro.
S. Robinson: Cat. Am. Min., p. 63.

1825. **Actinolite.**
(The article under 1823, above, is cited.)
The actinolite is found in the north part of the town in large, elegant crystals, which are fasciculate, radiate, or intermixed (J. Porter).
S. Robinson: Cat. Am. Min., p. 77.

1825. **Hornblende.** Dalton.
C. A. Lee: Min. Loc., Am. Jour. Sci., Vol. IX, p. 43.

1828. **Hornblende.** Dalton. Becket.
Rock var. slate. East part of Becket, granitic.
Amos Eaton: Geological Nomenclature, Am. Jour. Sci., Vol. XIV, p. 145.

1832. **Hornblende.** Litchfield County, Connecticut. Sheffield and Great Barrington, Massachusetts.
White crystals, more than an inch long and three-fourths of an inch wide, but much flattened, abound throughout the dolomite of Litchfield County, Connecticut, particularly at Canaan; they are also found under similar circumstances farther north into the borders of Massachusetts, at Sheffield and at Great Barrington.
C. U. Shepard: Treat. Min., Vol. I, pt. 2, p. 266.

1841. **Tremolite.** Tyringham. Lee.
In dolomite.
E. Hitchcock: Final Rept., 585.
No. 537, Catalogue of State collection, p. 809.

1844. **Actinolite.** (*Augitus proteus.*) Windsor.
J. D. Dana: Sys. Min., 2d ed., p. 439.

1844. **Tremolite.** (*Augitus proteus.*) Lee (east part).
Excellent specimens.
J. D. Dana: Treat. Min., 2d ed., p. 371.

1858. **Tremolite.** Becket (southeast part).
Dolomite with tremolite. E. Hitchcock: No. 187 under limestone in Sixth Ann. Rept. Bd. Agri. Mass., Appendix, p. xxxv. Large masses of loosely aggregated and coarse-bladed tremolite, probably from the south end of the Coles Brook pre-Cambrian limestone.

1868. **Actinolite.** Windsor. Lee.

Specimen from Lee is radiated.

J. D. Dana: Sys. Min., 5th ed., p. 241.

1868. **Tremolite.** Lee (1½ miles southwest of meetinghouse).

Idem, 5th ed., p. 241.

1892. **Actinolite.** Windsor. Lee.

Specimen from Lee is radiated.

J. D. Dana: Sys. Min., 6th ed., p. 1060.

1892. **Tremolite.** Lee.

Cited as in 1868.

J. D. Dana: Sys. Min., 6th ed., p. 397.

1894. **Tremolite.** Lee.

In Stockbridge limestone. In separate blades and in long radiate sheaves. The bladed type was abundant in the old Gross quarry and went down to a great depth, spoiling a large quantity of stone. Specimens are found in every collection.

1895. **Asbestos.** Lee.

In Stockbridge limestone. As felted paper-asbestos in thin white sheets several inches across and as fibrous radiated masses near the Hobbs place in South Lee. D. Clark collection.

1895. **Tremolite.** Tyringham (Sodom, below Hop Brook gorge).

In broad, radiate, columnar masses as large as one's fist, made up of pale greenish gray needles 2 to 3 inches long derived from white pyroxene. Also in finest needles shooting through limpid quartz. Pre-Cambrian. D. Clark collection.

1895. **Tremolite.** Monterey (Bear Mountain).

In pre-Cambrian. Straight, fibrous, pale-green to white asbestos fibers 3 to 4 inches long. D. Clark collection.

1895. **Actinolite.** Tyringham (Hop Brook gorge).

In pre-Cambrian limestone. Black to dark-green actinolite in matted blades grown through orthoclase, and broad parallel-bladed masses several inches in length, making very beautiful specimens. It grows around wernerite and causes the bending of the crystals. D. Clark collection.

1895. **Hornblende.** New Marlboro (on road to Southfield, at deep excavation by roadside, in the very rusty rock).

Pre-Cambrian. Cavities are filled with black hornblende crystals 1¼ inches long; bladed, well terminated, simple forms. D. Clark collection.

1895. **Hornblende.** Monterey (Bear Mountain).

Pre-Cambrian. In green, massive hornblende rock, fine, stout, black crystals ∞P (110), $\infty P \grave{\infty}$ (010), $\infty P \infty$ (100), P (111), OP (001).

1895. **Tremolite.** Tyringham (the Cobble).

Fine, radiating snow-white tremolite in the Stockbridge limestone at the foot of the mountain. D. Clark collection.

1895. **Hornblende.** Tyringham (the Cobble).

Pre-Cambrian. Fine jet-black crystals in the garnet biotite rock, with ilmenite above the limestone. D. Clark collection.

1896. **Actinolite.** Becket (one hundred rods east of R. Alderman and son's house).

In the Hinsdale (pre-Cambrian) limestone in large, pale-green, compact masses and in loosely interwoven aggregates of coarse blades of rich green color shading to brown.

1896. **Actinolite.** Otis.

The coarse pre-Cambrian limestone at Otis Center contains an emerald-green bladed actinolite with scapolite.

1896. **Hornblende.**

A black fibrous hornblende is an abundant constituent of the Lee gneiss (p. 33), and of the amphibolites which occur in the Becket gneiss.

APATITE.

1841. **Phosphate of lime.** Hinsdale.

In mica-schist. E. Hitchcock: Final Report of Geol. of Mass., p. 604.

1844. **Apatite.** (*Fluellus hexagonus.*) Hinsdale.

J. D. Dana: Sys. Min., p. 238.

1868. **Apatite.** Hinsdale.

Sparingly. Idem, 5th ed., p. 553.

1892. **Apatite.** Hinsdale.

Idem, 6th ed., p. 767. This locality can not be recovered.

1895. **Apatite.** Tyringham (Sodom, below Hop Brook gorge.)

In pale-green hexagonal prisms half an inch long in white orthoclase, from the Hinsdale (pre-Cambrian) limestone. D. Clark collection.

ARAGONITE.

1895. **Aragonite.** New Marlboro (road to Southfield, at a deep cut in rusty rock by roadside).

In pre-Cambrian rocks, but of late formation. In fine tufted masses of yellow crystalline blades and needles. D. Clark collection.

BARITE.

1890. **Barite.** Becket (east of Shaw Pond).

Bowlders from the Hinsdale (pre-Cambrian) limestone, with galena and chalacopyrite. In bladed masses.

BERYL.

It is remarkable that there is no beryl in Berkshire.

BIOTITE.

1895. **Biotite.** Tyringham (the Cobble).

Broad wrinkled sheets of black biotite 2 to 3 inches across, probably pre-Cambrian, from Sky Hill above the Cobble. D. Clark collection.

1895. **Biotite.** Tyringham (Hop Brook gorge).

In pre-Cambrian rocks. Magnificent crystals were obtained by Mr. Clark from the rotten zeolite vein in the limestone; great perfect crystals, with polished faces, hexagons 5 inches by 4½ inches and 3 inches thick. Other crystals were tapering, 3 inches at the base and 1½ inches high. Very many other great crystals were compressed at the edges, often regularly at all the edges, into perfect saucers. The faces of the vertical zone were often coated by a thick layer of the white, velvety, globular sphærostilbite, forming specimens of great beauty. Smaller prisms, often an inch in length, grow out from the larger ones. A strongly developed parting often divides the great crystals into long prismatic forms. Many crystals had fallen in the cavities, where they formed and are cemented by the sphærostilbite. Many have changed to jefferisite, q. v.

CALCITE.

1814. **Elastic marble.** Pittsfield.

"On taking up one of these stones, from a quarry near Pittsfield, which was just prepared for a gravestone, about 4 feet high and 2 feet wide, I was much surprised at the tremulous motion which I perceived." It bent with the least pressure, but recovered itself without the smallest change or crack. Only a few specimens were elastic. They were grayish white, foliated, granular, and effervescent.

W. Meade: Mineralogical notice respecting elastic marble from Massachusetts.

A. Bruce: Am. Min. Jour., Vol. I, p. 93.

1814. **Elastic marble.**

A polished slab 2 feet long and 1 inch thick, dried near the fire, lost its elasticity, which was immediately restored by wetting. Wm. Meade: letter.

Am. Min. Jour., Vol. I, p. 267.

1832. **Limestone.** New Marlboro.

Gray, CaCO3, 98 per cent; residue, chiefly mica, 2 per cent marble. Abundant; production cited from Dewey. Mill for sawing in New Marlboro.

E. Hitchcock: Geol. Mass., Am. Jour. Sci., Vol. XXII, pp. 26, 38.

1895. **Calcite.** Lee.

In Stockbridge limestone. In a rare geode cavity and perched upon fine dolomite rhombs (see under Dolomite), is a beautiful crystal half an inch long, having the faces R $(10\bar{1}1)$, rounded by $\frac{1}{4}R^3$ $(21\bar{3}4)$ and $-\frac{1}{2}R$ $(01\bar{1}2)$, R $(10\bar{1}0)$, R^5 $(32\bar{5}1)$, R^3 $(21\bar{3}1)$.

D. Clark collection.

1895. **Marble.** Tyringham.

Bowlders. White marble, gray banded marble, black faulted marble.

D. Clark collection.

1895. **Stalactite.** Tyringham (the Cobble).

In the Stockbridge limestone

D. Clark collection.

1895. **Calcite.** Tyringham (Hop Brook).

Pre-Cambrian; very coarse crystalline vein stones, fine gray, pink, plum color, and white; shot through with hornblende crystals, crusted with limpid calcite crystals ∞ R $(10\bar{1}0)$, $-\frac{1}{2}R$ $(01\bar{1}2)$, 4R $(40\bar{1}1)$.

CHABASITE.

1895. **Chabasite.** Tyringham (Hop Brook gorge).

In pre-Cambrian limestone. Massive and in rhombohedra R $(10\bar{1}1)$, $-\frac{1}{2}R$ $(01\bar{1}2)$, with polished faces 5 mm. across. Green actinolite is intergrown with it. Twins; twinning plane=R. Nearly opaque white.

D. Clark collection.

CHALCOPYRITE.

1890. **Chalcopyrite.** Becket (east of Shaw Pond).

In bowlders from pre-Cambrian limestone with galena and barite.

1893. **Chalcopyrite.** Becket (east of Center Pond on farm of M. J. Alderman).

Vein worked 1 inch wide. Associated with pyrite, pyrrhotite, and calcite in hornblendic gneiss of pre-Cambrian age.

CHONDRODITE.

1841. **Augite.** Lee.

"Within 2 miles of Lee we meet with limestone which often contains a mixture of augite, and this mineral being decomposed at the surface yet projecting beyond the limestone the whole rock exhibits a brown, very irregular aspect."

E. Hitchcock: Final Rept., p. 627.

1885. **Chondrodite.** Hinsdale. Monterey.

Noted as occurring in limestone at the Hinsdale railroad station and in bowlders between South Lee and Monterey.

J. D. Dana: Am. Jour. Sci., Vol. XXIX, p. 208.

1887. **Chondrodite.** Hinsdale. Lee.

Hinsdale; in village (on railroad) and southwest of the village, west of the railroad.

East Lee; on the high hill between the two valleys coming in from the east, in masses as large as one's fist; also on the opposite side of the valley to the northwest, and in the bottom of the valley a mile east of East Lee.

J. D. Dana: Am. Jour. Sci., Vol. XXXIII, pp. 275, 276.

1892. **Chondrodite.** Lee.

In crystalline limestone in East Lee.

J. D. Dana: Sys. Min., 6th ed., pp. 1059, 541.

1895. **Chondrodite.** Becket. Middlefield.

100 rods east of R. Alderman and son's house, in Becket Center, in a Hinsdale pre-Cambrian limestone band 5 rods wide.

It occurs in red grains, and is especially abundant in a large bowlder 100 rods northeast of the ledge. Also in Coles Brook, across Becket and Middlefield, especially at the cut at the mouth of Coles Brook, where it is changed to pale-yellow serpentine.

1895. **Chondrodite.** Hinsdale. Tyringham. Lee.

In especially large masses, of dark red color, partly changed to chlorite at O. Bill's, by the roadside, a half mile north of Muddy Pond, in Hinsdale, and on the high, bare hill east of the hotel at East Lee.

CLINOCHLORE.

1895. **Clinochlore.** Tyringham. Great Barrington.

On Bear Mountain, in matted scales half an inch across, with garnet on a fine-grained biotite-gneiss of pre-Cambrian age.

CYANITE.

1896. **Cyanite.** Becket.

Gray blades, containing small, regular garnets, centrally filled with dark grains, and changing to muscovite. See Pl. I, p. 26.

DOLOMITE.

1821. **Dolomite.** Lee.

Is fetid. Most of that called limestone in the county is dolomite.

C. Dewey: Am. Jour. Sci., Vol. III, p. 239.

1824. **Dolomite.** Lee. Pittsfield. New Marlboro.

In latter place contains augite as well as tremolite.

C. Dewey: Geol. Berkshire, Am. Jour. Sci., Vol. VIII, p. 35.

1825. **Dolomite.** New Marlboro.

With augite and tremolite.

E. Hitchcock: Geol. of part of Mass., Am. Jour. Sci., Vol. VIII, p. 35.

S. Robinson, Cat. Am. Min., pp. 55, 63.

1854. **Dolomite with tremolite.** Becket (southeast part).

E. Hitchcock: Sixth Ann. Rept. Mass. Bd. Agri., Appendix, p. xxxv, No. 187.

Contains much rather fine-bladed tremolite; is probably from a bowlder of the Stockbridge limestone.

1876. **Dolomite.** Hinsdale. Lee. Lenox. Stockbridge.

C. U. Shepard: Cat. Min. found within 50 miles of Amherst, p. 3.

1895. **Dolomite.** Lee.

In a large drusy cavity from the quarry in the village, in Stockbridge limestone. Rhombs up to an inch on a side, and in other cavities up to 3 inches. Perfectly limpid, and with polished and perfect faces, piled loosely on each other. Some of the rhombs are expanded to broad, flat plates. In others are phantom crystals, containing eccentric, smoky kernels; that is, on a smoky translucent rhomb, half an inch across, is a regular transparent increment two-sixteenths to three-sixteenths inch thick, which is applied only to the three faces adjacent to a lateral solid angle. A complex rhombohedral crystal of calcite half an inch long (see under Calcite) is perched upon one of the rhombs, making a cabinet specimen of rare beauty.

D. Clark collection.

EPIDOTE.

1825. **Epidote.** Windsor.

In prismatic crystals in quartz, also granular in hornblende rocks (H. M. Wells).

S. Robinson: Cat. Am. Min., p. 77.

1825. **Epidote.** Dalton.

C. A. Lee: Min. Loc., Am. Jour. Sci., Vol. IX, p. 43.

1841. **Epidote.** Hinsdale.

In mica-schist.

E. Hitchcock: Final Rept., p. 606.

1895. **Epidote.**

Epidote is everywhere a characteristic constituent of the Hinsdale gneiss, but it rarely occurs in sufficient quantities and depth of color to form cabinet specimens. The best place to find it in any quantity is in the river, behind the stone mill in Dalton.

FIBROLITE.

1824. **Fibrolite?** Becket (Becket).

Minute fibers, dark, hard, infusible, rare.

C. Dewey: Geol. Berkshire, Am. Jour. Sci., Vol. VIII, p. 40.

1825. **Fibrolite.**

Cited in Robinson's Catalogue. (I have found no fibrolite in Becket.)

1892. **Fibrolite.** Norfolk, Connecticut.

On Tobey Hill and in bowlders to the south, nodules of feldspar and quartz more or less changed to muscovite and fibrolite. Thin section described mica arranged in twinning planes of feldspar.

Wm. H. Hobbs: Pseudomorphs after feldspar, Am. Geologist, Vol. X, p. 46.

1895. **Fibrolite.** Otis. Sandisfield.

Commencing with Filley Mountain in Otis, fibrolite becomes gradually an important constituent of the pre-Cambrian gneiss across Sandisfield and into Connecticut.

1897. **Fibrolite.** New Marlboro. Norfolk, Connecticut.

The nodular gneiss that extends from Campbell Falls in New Marlboro to Norfolk Center contains abundant fibrolite in the muscovite nodules.

GADOLINITE.

1852. **Gadolinite.** Becket.

C. U. Shepard: Treat. Min., p. 253.

See Allanite.

GALENA.

1896. **Galena.** Becket (east of Shaw Pond).

In bowlders from pre-Cambrian limestone, with barite and chalcopyrite.

GARNET.

1858. **Pyrope.** Sandisfield.

E. Hitchcock: Cat. State Coll., Mass. Agri. Rept., p. 52, No. 161. (Is a common iron garnet in Tyringham gneiss.)

1895. **Garnet.** Tyringham (pasture of Riverside Farm).

In white mica-schist of Cambrian age, forms ∞ O (110), 202 (112), rich red-brown. Also on the Cobble in deep red crystals an inch across in biotite.

D. Clark collection.

1895. **Garnet.** Monterey (Bear Mountain).

In coarse, white, shining hydromica-schist. Red crystals nearly three-fourths inch across ∞ P (110).

GRAPHITE.

1823. **Graphite.** Hinsdale.

J. Porter: Am. Jour. Sci., Vol. VI, p. 248.

1824. **Graphite.** Hinsdale.

Foliated and granular with augite, nearly slaty, in considerable quantity.

C. Dewey: Geol. western Mass., Am. Jour. Sci., Vol. VIII, p. 54.

1824. **Graphite (black lead).** Hinsdale.

With augite, foliated and massive.

C. Dewey: Hist. Berkshire County, p. 197.

1825. **Graphite.**

S. Robinson: Cat. Am. Min., p. 54.

1825. **Graphite.** New Marlboro.

In great abundance.

C. A. Lee: Min. Loc., Am. Jour. Sci., Vol. IX, p. 43.

1825. **Graphite.** New Marlboro.

E. Hitchcock: Geol. of part of Mass., Am. Jour. Sci., Vol. VIII, p. 54.

1825. **Graphite.**

Above cited. S. Robinson: Cat. Am. Min., p. 63.

1832. **Graphite.** Hinsdale.
E. Hitchcock: Geol. Mass., Am. Jour. Sci., Vol. XXII, p. 47.

1833. **Graphite.** Hinsdale. New Marlboro.
E. Hitchcock: Rept. Geol. Mass., p. 395.

1841. **Graphite.** New Marlboro. Hinsdale. Washington (1 mile northeast of deep cut at summit level—Lyman's opening).
E. Hitchcock: Final Rept., p. 240.

1844. **Graphite** (*Plumbago scriptoria*). Washington.
J. D. Dana: Sys. Min., 2d ed., p. 539.

1868. **Graphite.**
Idem, 5th ed., p. 770.

1892. **Graphite.**
Idem, 6th ed., p. 1060.

1895. **Graphite.** Monterey (Bear Mountain).
In pre-Cambrian rock. In large masses on top of Sky Hill, with tremolite in blue-quartz gneiss.
D. Clark collection.

1897. **Graphite.** Hinsdale.
The mineral is everywhere characteristic of the pre-Cambrian gneiss, and openings for mining have been made at three places in the town near the creamery, east of the center; near A. Walkin's house, in coarse salite rock; and in an extensive opening at the mine on the Lyman place above Muddy Pond, east of Washington Station.

HEMATITE.

1890. **Hematite.** Hinsdale.
In masses of imperfect flat crystals associated with fine quartz crystals. Min. Coll. of E. B. Underhill, Hallock Mills, N. Y. Presented to Amherst College, 1888.

1895. **Micaceous iron.** Dalton.
In Cambrian quartzite. An aggregate of warped plates in white quartz.
D. Clark collection.

HEULANDITE.

1895. **Heulandite.** Tyringham (Hop Brook).
Crystals 1 mm. long, implanted on hornblende and showing the faces $\infty P\grave{\infty}$ (010), $-2\,R\infty$ (201), OP (001). D. Clark collection.

ILMENITE.

1895. **Ilmenite.** Tyringham (the Cobble).
Abundant in broad plates an inch square in a quartz vein in a biotite garnet rock; also in other quartz veins 2 inches square one-fourth inch thick, in twisted plates; also in a mass from the drift, part of a large crystal 1 inch thick and 4 inches square.
D. Clark collection.

1897. **Ilmenite.** Dalton (Day Mountain).
In a lens of coarse granular orthoclase in a muscovite-gneiss full of needles of black tourmaline. It occurs in broad curved lamellæ half an inch thick. Collected by Mr. B. F. Newell, of Dalton.

JEFFERISITE.

1895. **Jefferisite.** Tyringham (Hop Brook gorge).

The great crystals of black biotite at times change to a pale-yellow jefferisite.

D. Clark collection.

LAUMONTITE.

1895. **Laumontite.** Tyringham (Hop Brook).

White square prisms, 20 mm. long, 3 mm. across, and truncated by the usual oblique face. Abundant, but changing easily.

D. Clark collection.

LIMONITE.

1822. **Compact brown oxide of iron.** Dalton.

Incrusting rocks.

P. Cleaveland: Min., p. 607.

1824. **Fibrous brown hematite.** Hinsdale (southwest of town and 4 miles from Pittsfield).

Cement of conglomerate, often half an inch thick.

C. Dewey: Geol. western Mass., Am. Jour. Sci., Vol. VIII, p. 18.

1825. **Fibrous brown hematite.**

Above cited.

S. Robinson: Cat. Am. Min., p. 54.

1825. **Limonite.**

Article cited under 1822.

S. Robinson: Cat. Am. Min., p. 47.

1825. **Iron, compact brown oxide.** Pittsfield.

Breccia, with cement of brown oxide, hematite, and carburet of iron, interstices lined with minute quartz crystals.

C. A. Lee: Min. Loc., Am. Jour. Sci., Vol. IX, p. 43.

The origin of these limonites cementing the Cambrian breccias is given on page 80.

1828. **Hematite.** Dalton (3 miles south of village).

A. Eaton: Geol. Nomenclature, Am. Jour. Sci., Vol. XIV, p. 150.

1830. **Hematite.** Dalton (3 miles south of village).

A. Eaton: Geological Text Book, p. 34.

1832. **Limonite.** Hinsdale.

At Hinsdale the fibrous variety occurs as a cement to a fragmentary quartz rock.

C. U. Shepard: Treat Min., Vol. II, pt. 1, p. 15.

1838. **Hematite iron ore (limonite).** Tyringham.

Several hundred tons dug in south part of the town.

E. Hitchcock: Econ. Geol., p. 126.

1841. **Brown hematite.** Tyringham.

Several hundred tons said to have been dug in the south part of the town. Indications of extensive beds.

E. Hitchcock: Final Rept., p. 197.

1844. **Brown iron ore** (*Siderus hœmaticus*). Hinsdale.

Cement in quartz rock.

J. D. Dana: Sys. Min., 2d ed., p. 449.

1852. **Limonite.** Hinsdale.

At Hinsdale the fibrous variety occurs as a cement to a fragmentary quartz rock.

C. U. Shepard: Treat. Min., p. 277.

1868. **Limonite.**

Idem, 5th ed., p. 173.

1892. **Limonite.**

Idem, 6th ed., p. 1059.

Cited only in locality list.

MAGNETITE.

1825. **Magnetic oxide of iron.** Windsor.

In octahedra (J. Porter).

S. Robinson: Cat. Am. Min., p. 77.

1841. **Magnetic oxide.** Tyringham.

Vein 4 inches wide in quartz rock on Bear Mountain, near the road to Beartown.

E. Hitchcock: Final Rept., p. 194.

1895. **Magnetite.** Tyringham (the Cobble).

In white Cambrian gneiss, in imperfect crystals an inch across.

D. Clark collection.

MELANTERITE.

1824. **Sulphate of iron.** Tyringham.

In loose earth near Shaker Village.

C. Dewey: Hist. Berkshire County, p. 196.

MICROCLINE.

1895. **Microcline.** Tyringham (south side of Hop Brook Valley).

Large cleavage pieces of flesh color, with fine perthitic banding of albite.

D. Clark collection.

MUSCOVITE.

1822. **Mica.** Hinsdale.

It occurs green (J. Porter).

P. Cleaveland: Min., Vol. II., p. 777.

1822. **Prismatic mica.** Hinsdale.

On the edges of common mica.

C. Dewey: Am. Jour. Sci., Vol. V., p. 399.

1825. **Prismatic mica.**

Above cited.

S. Robinson: Cat. Am. Min., p. 53.

1895. **Muscovite.** Tyringham (the Cobble).

In good crystals.

D. Clark collection.

NATRON.

1824. **Carbonate of soda.** Pittsfield (in springs).

C. Dewey: Geol. of part of Mass., Am. Jour. Sci., Vol. XIV, p. 32.

1825. **Carbonate of soda.**

Above cited.

S. Robinson: Cat. Am. Min., p. 65.

OLIGOCLASE.

1895. **Oligoclase.** Monterey (Bear Mountain).

Starting from a point east of Fernside and going south half a mile up the side of Sky Hill. The crystals occur in a green, massive hornblende rock. They are an inch long, of cubical habit and dark flesh color, and show the faces $\infty P\infty$ (010), $\infty{}'P(1\bar{1}0)$, $\infty P'(110)$, $\infty P'\breve{3}(130)$, $\infty{}'P\breve{3}(1\bar{3}0)$, $P_{\prime}(\bar{1}\bar{1}0)$, $P(\bar{1}11)$, $2_{\prime}P\bar{\infty}(\bar{2}01)$, $\frac{4}{3}{}_{\prime}P\bar{\infty}(\bar{2}01)$, $P\bar{\infty}(\bar{1}01)$, $2P_{\prime}(\bar{2}\bar{2}1)$. They show a fine striation over all the faces in the zone of b; there is a beautiful blue play of color on $\infty P\infty^{1}$, like Friedricksvärn oligoclase.

ORTHOCLASE.

1832. **Feldspar.** Middlefield. Becket.

The crystals are often deeply embedded in calcareous spar.
C. U. Shepard: Treat. Min., Vol. I, pt. 2, p. 203.

1895. **Orthoclase.** Becket (100 rods east of R. Alderman and son's).

In pre-Cambrian limestone. In stout opaque-white crystals up to an inch long, some elongate in the direction of the prism and terminated by O (001) and $P\infty(\bar{1}01)$, and some having O (001) and $\infty P\grave{\infty}$ (010), forming a square prism terminated by $\infty P(110)$ and $P\bar{\infty}(\bar{1}01)$. Shows a fine blue opalescence. The same property appears in the feldspar of the coarse granitoid rock adjoining the limestone at the Coles Brook cutting.

1895. **Orthoclase.** Tyringham (John Winthrop pasture, south side upper Tyringham Valley).

From the pre-Cambrian. A white orthoclase, in good crystals of simple form with pyroxene.
D. Clark collection.

1895. **Orthoclase, var. loxoclase.** Tyringham (one-fourth mile southwest of D. Clark's).

In red-brown forms, resembling those from Hammond, New York. Pre-Cambrian, associated with pyroxene.
D. Clark collection.

1895. **Orthoclase.** Tyringham (Hop Brook gorge).

In pre-Cambrian rocks. Greatly etched crystals in chesterlite form.
D. Clark collection.

1895. **Orthoclase.** Tyringham (Sodom, foot of Long Mountain and Hop Brook gorge).

Drusy surfaces of small crystals, often with limpid ends and rounded faces, also in opaque, well-formed crystals ∞P (110), OP (001), $P\bar{\infty}$ ($\bar{1}01$), $2P\bar{\infty}$ ($\bar{2}01$). Shows fine blue opalescence. Is associated with black, bladed hornblende in Hop Brook, and with white pyroxene and tremolite at the other localities, and is often full of square cavities, from which wernerite crystals have been removed. Pre-Cambrian.
D. Clark collection.

1895. **Orthoclase.** New Marlboro (road to Southfield, at digging in rusty rock by roadside).

Pre-Cambrian. Many fine crystals an inch long, of simple exterior forms ∞P (110), $\infty P\grave{\infty}$ (010), $P\infty$ ($\bar{1}01$), $2P\infty$ ($\bar{2}01$), $\infty P\grave{3}$ (210), P ($\bar{1}11$); fine blue opalescence; color, opaque-white.

OPAL.

1825. **Opal, hyalite, cacholong, siliceous sinter.** Dalton.
In masses of hornstone.
C. A. Lee: Min. Loc., Am. Jour. Sci., Vol. IX, p. 43.

1890. **Opal.** Sheffield.
Common opal.
G. F. Kunz: Gems and Precious Stones of the United States.

PHLOGOPITE.

1895. **Phlogopite.** Tyringham (Hop Brook).
In many small crystals in wernerite. In pre-Cambrian limestone.
D. Clark collection.

PYRITE.

1824. **Pyrite.** Lee.
In compact masses.
C. Dewey: Geol. Berkshire, Am. Jour. Sci., Vol. VIII, p. 55.

1825. **Pyrite.**
Above cited.
S. Robinson: Cat. Am. Min., p. 55.

1895. **Pyrite.** Tyringham.
One-fourth mile southwest of Mr. D. Clark's house, at the head of the Tyringham Valley. In vein quartz of pre-Cambrian age. In fine crystals one-fourth inch across, superficially changed to limonite O (111), $\left[\frac{2\,O\,\infty}{2}\right]$ π (210).
D. Clark collection.
Also in bowlders in village 50 rods west of post-office perfect crystals changing to limonite in a quartz rock full of dolomite, 2 to 3 mm. long $\infty O \infty$ (001), $\left[\frac{2\,O\,\infty}{2}\right]$ π (210). Also at Sodom, below Hop Brook gorge, in finely polished crystals 1 to 15 mm. across changed to limonite.
D. Clark collection.

PYROLUSITE.

1825. **Manganese.** Pittsfield.
The compact brown oxide, in considerable quantities.
C. A. Lee: Min. Loc., Am. Jour. Sci., Vol. IX, p. 42.

1895. **Dendrite.** Tyringham (in gorge above Riverside farm).
Beautiful forms in Cambrian quartzite. As they are in the red and black colors, they are in large part iron oxides.
D. Clark collection.

1895. **Pyrolusite.** Monterey (near Bidwell place).
Wavy plumose forms in yellow jasper.
D. Clark collection.

1895. **Dendrite.** Dalton.
Bowlder in white Cheshire quartzite.

PYROXENE.

1824. **Ancite.** New Marlboro.
Rough white crystals in limestone (doubtless white pyroxene).
C. Dewey: Hist. Berkshire, p. 194.
(Manifest misprint for augite.)

1824. **Augite.** Hinsdale.

With graphite.

C. Dewey: Hist. Berkshire, p. 197.

1824. **Augite.** New Marlboro. Hinsdale.

New Marlboro; white four, six, and eight-sided prisms. Hinsdale; with plumbago, greenish gray, brown, yellowish, in crystalline forms.

C. Dewey: Geol. Berkshire, Am. Jour. Sci., Vol. VIII, p. 47.

1824. **Augite.** Hinsdale.

With graphite, as at Ticonderoga.

C. Dewey: Geol. western Mass., Am. Jour. Sci., Vol. VIII, p. 48.

1825. **Augite.**

Same cited.

S. Robinson: Cat. Am. Min., p. 54.

1825. **Augite.** Pittsfield. Dalton. New Marlboro.

Principally massive.

C. A. Lee: Min. Loc., Am. Jour. Sci., Vol. IX, p. 43.

1825. **Augite.** New Marlboro.

E. Hitchcock: Geol. part of Mass., Am. Jour. Sci., Vol. VIII, p. 35.

1825. **Augite.**

Above cited.

S. Robinson: Cat. Am. Min., p. 63.

1841. **Augite.** New Marlboro. Tyringham.

New Marlboro; green augite in dolomite. Tyringham; white augite in dolomite.

No. 236 Catalogue, p. 809.

E. Hitchcock: Final Rept., p. 569.

1844. **Pyroxene.** (*Augitus diatomus.*) Tyringham.

Cited only under localities.

J. D. Dana: Sys. Min., 2d ed., p. 539.

1852. **Scapolite.**

The canaanite of Hitchcock (from Canaan, Conn.), which is an exceedingly tough, compact, grayish white mineral, and contains sil. 53.36, perox. iron 4.09, alum 10.38, lime 25.80, mag. 1.62, carb. acid 4.0 (99.67)

C. U. Shepard: Treat. Min., p. 178.

1852. **Scapolite.** (Canaanite.) Canaan, Conn.

SiO_2 53.36, FeO 4.09, Al_2O_3 10.38, CaO 25.80, MgO 1.62, CO_2 4, 99.67. Analysis by S. L. Dana.

C. U. Shepard: Treat Min., p. 178.

1868. **Pyroxene.**

J. D. Dana: Sys. Min., 5th ed., p. 770.

1885. **Pyroxene.** Tyringham.

A white, compact, fibrous pyroxene from Tyringham made a curious white cat's eye.

G. F. Kunz: Precious stones, Mineral Resources U. S. 1883-84, p. 728.

1892. **Pyroxene.**

J. D. Dana: Sys. Min., 6th ed., p. 1059.

1895. **Salite.** Tyringham (on the south side of the valley, a half mile above Clark's).

Large prisms of pale salite, coated, and their interspaces filled with pale-green actinolite, on which are stout, curious quartz crystals, which include actinolite. They (the quartz crystals) have wavy and rounded faces, and terminate by two or three pyramids.

D. Clark collection.

1895. **Pyroxene.** Tyringham (D. Clark farm).

Bowlders of Stockbridge limestone. The mass contained in great numbers doubly terminated crystals of white pyroxene uniformly 1 inch long, half an inch wide, and considerably flattened by the great development of the orthopinacoid. It has the forms ∞P∞ (100), ∞P (110), +P (111), —P ($\bar{1}$11).

D. Clark collection.

1895. **Pyroxene.** Lee (Upper Goose Pond, near Elwells Rocks).

Pale-green pyroxene in stout crystals with perfect basal parting, 1 inch long, three-fourths inch across.

1895. **Pyroxene.** New Marlboro (road to Southfield, in deep digging in rusty rock by roadside).

Pre-Cambrian. Green crystals an inch square, much cracked and corroded.

D. Clark collection.

1895. **Pyroxene changing into hornblende.** Tyringham (foot of Long Mountain).

Pre-Cambrian. Coarse square prisms an inch across and 2 to 3 inches long, of pale-green pyroxene, project outwardly from the limestone, and green bladed actinolite grows from it so as to spoil the surfaces of the pyroxene.

D. Clark collection.

1895. **Pyroxene passing into tremolite.** Tyringham (a half mile southeast of D. Clark's).

Pre-Cambrian. In the same way as above described the whitish green pyroxene prisms appear here corroded and separated into distinct cubical blocks, which are much displaced, and out from the whole surface of the prism grew groups of radiate sheaf-like masses of tremolite, with needles often bent. A secondary green pyroxene, having a broad OP (001) face with—P ($\bar{1}$11) and a second prism, is also developed at this locality.

D. Clark collection.

1895. **Pyroxene.** Tyringham (Hop Brook gorge).

Pre-Cambrian. Deep emerald-green transparent prisms, with perfect basal parting and poor prismatic cleavage. Many twins, twinning parallel to ∞P∞ (100) and reaching 4 inches in length. Other crystals are blackish green and pale green. The following combinations occur:

∞P (110), —P$\bar{\infty}$ (101), OP (001).

∞P (110), —P$\bar{\infty}$ (101), OP (001), P$\bar{\infty}$ ($\bar{1}$01).

∞P (110), —P$\bar{\infty}$ (101), P$\bar{\infty}$ ($\bar{1}$01), +P (111), —P ($\bar{1}$11), 2 P ($\bar{2}$21), OP (001).

Minute, long, square prisms occur in greasy wernerite. Other crystals occur with the first combination above; stout crystals an inch broad and 2 inches long, deep green, with dull etched surface.

D. Clark collection.

1895. **Salite.** Tyringham (Sodom, below Hop Brook gorge).

The finest salite prisms of dull white color and an inch across and 2 to 4 inches long. The base occurs implanted in black, white, and pink quartz, distantly or thickly scattered. They show the perfect basal parting. Often the prisms have been dissolved and the etched fragments sometimes remain in the square cavities in the black quartz, and blades of white tremolite tapestry the walls as if they had been formed from the dissolved pyroxene. The pyroxene had often been broken and recemented by quartz, so that the cavities had cross partitions of quartz like the tabulæ of a rugose coral. These quartz masses, from which the pyroxene has disappeared, were called by the early geologists mortised rock and thought to be the work of Indians. In the gorge itself occur stout columnar masses of crystals an inch across, which are as large as one's fist. The quartz is pseudomorph after albite. See Pls. II, III, p. 52.

D. Clark collection.

1895. **Salite.** Otis Center.

Bowlder. Coarsely cleaving, with cleavage surfaces several inches across; pale-green to white color.

1895. **Pyroxene.** Becket (100 rods east of R. Alderman's).

In pre-Cambrian limestone in large masses of pale-green, massive, coarse pyroxene rock and in loose aggregates of stout eight-sided prisms with strong prismatic and basal cleavage.

1896. **Augite.** New Marlboro (Cleveland mine).

W. H. Hobbs describes and figures a light-green hornblende which is surrounded and intergrown by a colorless pyroxene ("augite"), the two being orientated. Science, Vol. XX, p. 516.

PYRRHOTITE.

1895. **Pyrrhotite in crystals.** New Marlboro (Hotchkiss and Cleveland mines).

Hotchkiss mine; often an inch long; tapering hexagonal prisms with basal planes. Massive at the Cleveland mine.

1896. **Pyrrhotite.** Becket (M. J. Alderman's place).

In large masses from pre-Cambrian limestone.

1897. **Pyrrhotite.** Dalton (limestone locality on brook south of clubhouse on Day Mountain).

Collected by B. F. Newell.

QUARTZ.

1822. **Granular quartz.** Hinsdale.

It is said to occur in large friable masses, snow white and much resembling sugar. It may prove important in the manufacture of glass and stoneware.

P. Cleaveland: Min., Vol. I, 239. Refers to great bowlders of Cheshire quartzite. Cited 1825 by S. Robinson: Cat. Am. Min., p. 53.

1824. **Quartz.** Lenox. Lee. Hindsdale. Pittsfield. Washington.

Flattened terminated prisms; in quarry at Lenox.

Granular or as sand; everywhere. Yellow and red; Pittsfield, a considerable rock composed almost entirely of small crystals. Chalcedony, yellowish hornstone, cacholong, and opal; Hinsdale. Buhrstone; Washington.

C. Dewey: Geol. Berkshire, Am. Jour. Sci., Vol. VIII, p. 38. Cited 1825 by S. Robinson: Cat. Am. Min., p. 55.

1824. **Blue quartz, fetid quartz, hornstone.** Lenox. Pittsfield.

Ferruginous quartz, massive and well crystallized, Lenox. Hornstone jasper, generally gray and blue, Pittsfield.

J. Porter: Min. Loc., Am. Jour. Sci., Vol. VII, p. 252.

1824. **Cacholong, hornstone, chalcedony.** Hinsdale.

C. Dewey: Geol. western Mass., Am. Jour. Sci., Vol. VIII, p. 39.

1825. **Cacholong.**

Before cited.

S. Robinson: Cat. Am. Min., p. 54.

1825. **Yellow ferruginous quartz.** Dalton.

Crystallized and amorphous. J. Porter.

S. Robinson: Cat. Am. Min., p. 47.

1825. **Jasper, hornstone, agate, quartz crystals, ferruginous quartz.** Pittsfield. Dalton. New Marlboro.

Massive and crystallized. Very large agates in masses of hornstone and jaspery quartz and jasper; Pittsfield. Ferruginous quartz in yellow crystals; Dalton.

Arenaceous quartz; New Marlboro.

C. A. Lee: Min. Loc., Am. Jour. Sci., Vol. IX, p. 43.

1825. **Blue quartz.** Windsor.

Of good color in amorphous masses. (J. Porter.)

S. Robinson: Cat. Am. Min., p. 77.

1841. **Chalcedony.** Tyringham.

E. Hitchcock: Final Rept., p. 186.

1841. **Mammillary chalcedony.** Tyringham.

Nos. 2328, 2329 in catalogue of State collection.

(Quartz.)

E. Hitchcock: Final Rept., p. 819.

1854. **Mammillary chalcedony.** Tyringham.

Nos. 236, 237.

E. Hitchcock: Cat. Rocks of Mass., 6th Rept. Mass. Bd. Agri., Appendix, p. 54.

1876. **Quartzite, iron flint.** Hinsdale.

C. U. Shepard: Cat. Min. within 50 miles of Amherst, p. 7.

1890. **Quartz.** Hinsdale.

Large geode cavities, with fine slightly smoky crystals, doubly terminated with very short prisms associated with specular iron.

Coll. of E. B. Underhill, Hallock Mills, N. Y. Presented to Amherst College, 1888.

1890. **Quartz.** Becket (east of Shaw Pond).

Blue chalcedony with drusy surfaces, in bowlders of pre-Cambrian gneiss.

1895. **Amethyst.** Becket (R. Alderman's).

In contact selvage of pre-Cambrian limestone with actinolite, etc.

1895. **Quartz.** Monterey (Bear Mountain).

Pre-Cambrian. In pale smoke-gray crystals, with etched and rounded faces, associated with fine fibrous actinolite and graphite.

D. Clark collection.

1895. **Quartz.** Tyringham (the Cobble).

In well-terminated crystals in a granite vein.

D. Clark collection.

1895. **Rose quartz.** Otis (roadside near east side of Tyringham).

D. Clark collection.

1895. **Yellow jasper.** Tyringham.

In drift; with surface of blue chalcedony. Also a deep liver-red jasper brecciated with white, from bowlder in John Winthrop pasture.

D. Clark collection.

1895. **Chalcedony.** Tyringham (D. Clark farm, one-fourth mile east of house).

Beautiful great masses of translucent chalcedony; flesh color to amber, with small botryoidal surface of bluish or whitish shade.

D. Clark collection.

1895. **Jasper.** Monterey (Marshall Bidwell's land, near Lake Garfield).

Jasper of various shades of yellow, often colored black by manganese and coated by fine drusy quartz; also colored black by manganese and running into fine blue shades, often raised above the general surface in matted masses of finely interlaced threads, as if the quartz had coated rootlets. This is the best locality, but the same jasper is found all up and down the Tyringham Valley in the drift—at Fernside, in Otis, in Becket, where a great mass was blasted in the roadside, and near the West Becket post-office. All these jaspers indicate faults.

D. Clark collection.

1895. **Brown jasper-agate.** Tyringham.

Beautiful botryoidal masses showing white and brown concentric rings from the truncation of the balls.

D. Clark collection.

1895. **Black quartz.** Tyringham (the Cobble and at the foot of the Hop Brook gorge).

A black quartz vein, the mineral often beautifully iridescent from fissuring.

D. Clark collection.

1895. **Cellular quartz.** Tyringham.

Bowlder. A quartz breccia with the pebbles dissolved out. A fault rock probably brought south from the South Dalton fault.

D. Clark collection.

1895. **Fetid quartz (necronite).** Tyringham.

Bowlder.

D. Clark collection.

1895. **Quartz crystals.** Tyringham (Fernside).

Fine limpid crystals half an inch long.

1895. **Greasy quartz.** Lee.

From a bowlder on the old turnpike from Lee to South Lee, one-fourth mile south of the covered bridge. A fine greasy quartz, white and deep leek-green.

D. Clark collection.

1895. **Quartz pseudomorph** after albite and containing salite crystals which are often dissolved or replaced by tremolite. Tyringham (Sodom).

In pre-Cambrian limestone; see page 52 for figures and full description.

1895. **Amethyst.** Tyringham (near Upper Goose Pond).

Of pale color.

1896. **Chalcedony.** Otis Center.

Bowlder. Very large masses of a white chalcedony, which in cavities is fine botryoidal, drusy, and of faint sky-blue color.

It includes angular fragments of a yellow jasper, showing that it is the filling in of a vein in which the yellow jasper had been a previous filling shattered by a later movement of the vein walls. Both contain fragments of the wernerite, which shows that they are fillings of fissures in the calcite bed on the Otis fault.

1896. **Jasper.** Hinsdale.

In large masses on west slope of hill 1,720 feet high, 2½ miles north of station. Also on Peru road north of Ashmere Lake, in yellow, red, and white colors. (Doubtless from Cheshire quartzite.)

Collected by B. F. Newell.

RUTILE.

1825. **Red oxide of titanium.** Pittsfield (southeast part; in green quartz). Dalton (in quartz). New Marlboro.

C. A. Lee: Min. Loc., Am. Jour. Sci., Vol. IX, p. 42.

1832. **Rutile** (Peritoneous Erythrone-ore). Windsor.

The locality affording rutile in the greatest quantity in the United States is a very extensive ledge of chlorite slate at Windsor, Mass. The crystals of rutile are here thickly disseminated through narrow veins of feldspar traversing this rock, and also occur in seams in the rock itself.

C. U. Shepard: Treat. Min., Vol. II, Pt. I, p. 169.

1844. **Rutile** (*Peritoneous Erythrone-ore*). Windsor.

Fine crystals thickly disseminated through veins of feldspar intersecting chlorite slate.

J. D. Dana: Sys. Min., 2d ed., p. 421.

1852. **Rutile.** Windsor.

C. U. Shepard: Treat. Min., p. 256.

1868. **Rutile.** Windsor.

J. D. Dana: Sys. Min., 5th ed., p. 161.

1876. **Rutilite.** Windsor.

C. U. Shepard: Cat. Min. within 50 miles of Amherst, p. 7.

1881. **Rutile.** Windsor.

In red-brown deeply striated prisms up to 1½ inches long, closely resembling the Chester County, Pennsylvania, variety. In white albite.

1892. **Rutile.** Windsor.

J. D. Dana: Sys. Min., 6th ed., p. 235.

1895. **Rutile.** Tyringham. Dalton (Cottsville quarry).

Bowlder in Stockbridge limestone. Dark red-brown striated needles.

SCOLECITE.

1895. **Scolecite.** Tyringham (Hop Brook gorge).

Radiated blades on orthoclase. In masses of radiated tufts and globules graduating upward into fine globes of 1 inch in diameter of finest fibrous character, also in thick masses so finely fibrous and altered to kaolin that it has a massive porcelaneous look and botryoidal surface, also a soft, drusy surface growth forming great masses of balls an inch across. It also occurs encrusting biotite and pyroxene, and in a later generation with other zeolites. See p. 55.

D. Clark collection.

1895. **Scolecite pseudomorph after wernerite.** Tyringham (Hop Brook).

(See under wernerite.)

D. Clark collection.

SERPENTINE.

1823. **Serpentine.** Windsor (northwest part).

C. Dewey: Geol. western Mass., Am. Jour. Sci., Vol. VIII, p. 50.

1824. **Serpentine.** Windsor.

C. Dewey: Hist. Berkshire County, p. 191.

1824. **Vert antique?** Becket.

A magnesian mineral found in a bed in gneiss on the river in Becket, colored green by serpentine. It may, as Dr. Emmons supposes, be a serpentine marble. It is a tough mineral and takes a fine polish. The quantity of serpentine is sometimes small and the color yellowish white.

C. Dewey: Geol. Berkshire, Am. Jour. Sci., Vol. VIII, p. 58.

(This is the Coles Brook limestone with altered chondodrite.)

1825. **Vert antique.**

The above localities in Windsor and Becket cited.

S. Robinson: Cat. Am. Min., p. 77.

1825. **Serpentine.** Dalton (east part of town).

Containing asbestos.

C. A. Lee: Min. Loc., Am. Jour. Sci., Vol. IX, p. 43.

1841. **Serpentine.** Windsor (northeast and northwest parts). Cheshire (south of M. House's, a little east of the four corners).

Windsor, northeast part; serpentine with chondrodite. Cheshire; hard serpentine in gneiss.

Catalogue of State collection.

E. Hitchcock: Final Rept., pp. 616, 877, 878.

SPINEL.

1892. **Spinel.** Norfolk, Connecticut.

Spinel is absent in the pre-Cambrian limestones of the Sandisfield and Becket quadrangles, and first appears south of the border of the map in Norfolk in the same limestone.

STAUROLITE.

1822. **Staurolite.** Pittsfield.

In small, light-brown crystals, either single or crossing each other at right angles.

It is associated with garnets and sulphuret of iron (Hall).

P. Cleaveland: Treat. Min., Vol. II, p. 776.

1823. **Staurotide.** Hinsdale.

"In vast quantities in mica-schist." Am. Jour. Sci., Vol. VI, p. 219.

S. Robinson: Cat. Am. Min., p. 53. This is a citation from Hitchcock's Geology of the Connecticut, and refers to Hinsdale, New Hampshire. Hitchcock is giving the list of towns up the Connecticut and crosses the State line without indicating it.

1824. **Staurolite.** Sheffield.

In small area of mica-schist.

C. Dewey: Am. Jour. Sci., Vol. VIII, p. 7.

1885. **Staurolite.**

J. D. Dana: Am. Jour. Sci., 3d ed., Vol. XXIX, p. 214.

STILBITE.

1895. **Sphærostilbite.** Tyringham (Hop Brook).

Pre-Cambrian. In balls with faceted faces, radiated within with pearly luster. Fine groups coating biotite; also in sheaves and in segments of wheels. One beautiful cylindrical mass, 7 inches high, 4½ inches in diameter, covered with the warty protuberances made of the fine spheres, was sent to the exposition at Chicago. One mass more than a foot across was found. There is also a second growth of small, single crystals of stilbite. It occurs also in separate projecting and interlaced thick blades ∞ P ∞̆ (010), ∞ P ∞̄ (100), OP (001). Color, opaque-white, often smoky exteriorly. Other crystals appear with tapering ends from the development of P (111). Other specimens are small, limpid, single crystals ∞ P ∞̄ (100), ∞ P ∞̆ (010), OP (001).

The zeolites were found in a rotten vein in the coarse pyroxene rock with big crystals of dark brownish black biotite changed to jefferisite; well-formed crystals 1½ inches to 5 inches across, some often fused together by sphærostilbite and deeply warped.

D. Clark collection.

SULPHUR.

1824. **Sulphur.** Tyringham.

In mica-slate.

C. Dewey: Geol. western Mass., Am. Jour. Sci., Vol. VIII, p. 54.

1824. **Sulphur.** Hinsdale.

In cavities of a mica-slate rock consisting chiefly of quartz. It is a brown powder, from its mixture probably with oxide of iron.

C. Dewey: Geol. Berkshire, Am. Jour. Sci., Vol. VIII, p. 33.

1825. **Sulphur.** Localities in Tyringham and Hinsdale cited above.

S. Robinson: Cat. Am. Min., pp. 54, 73.

I have not found sulphur in the cavities of the Hinsdale gneisses, which are, however, often filled with a yellow pulverulent limonite.

TALC.

1823. **Steatite (potstone).** Windsor.

Very fine; formerly wrought into inkstands, which are still made by Shakers.

C. Dewey: Geol. western Mass., Am. Jour. Sci., Vol. VIII, p. 51.

1824. **Talc.** Windsor.

C. Dewey: Hist. Berkshire County, p. 191.

1824. **Steatite.** Windsor.

C. Dewey: Geol. Berkshire, Am. Jour. Sci., Vol. VIII, p. 51.

1825. **Steatite.**

Cited above. Also talc. (H. M. Wells.)

S. Robinson: Cat. Am. Min., p. 77.

1825. **Talc.** Pittsfield.

Of different colors.

C. A. Lee: Min. Loc., Am. Jour. Sci., Vol. IX, p. 43.

1841. **Steatite.** Hinsdale.

E. Hitchcock: Final Rept., p. 156.

1841. **Steatite.** Hinsdale.

In gneiss.

E. Hitchcock: Final Rept., p. 610.

1892. **Talc.** Hinsdale.

The great beds of talc connected with the Hinsdale limestone are described on pages 28–32. The largest beds are at the quarry near Wakonah Falls, the stratum being 30 feet thick, where the brook from Ashmere reservoir crosses River Bend Farm below the mill pond.

TITANITE.

1824. **Red oxide of titanium.** Pittsfield.

In small prisms in quartz associated with dolomite; rare.

C. Dewey: Geol. Berkshire, Am. Jour. Sci., Vol. VIII, p. 58.

1841. **Sphene.** Lee (east part of town). Tyringham.

Lee; in augitic gneiss; finest in New England; No. 1091, Cat. State Coll., p. 637. In talcose limestone, No. 1981, Cat. State Coll., p. 810.

Tyringham; with hornblende, No. 2301, Cat. State Coll., p. 818.

E. Hitchcock: Final Rept. Geol. of Mass.

1844. **Sphene** (*Rutilus obliquus*). Lee (eastern part).

Very good specimens in gneiss.

J. D. Dana: Sys. Min., 2d ed., p. 422.

1854. **Sphene.** Becket.

In talcose limestone (probably Coles Brook bed).

E. Hitchcock: No. 193, Cat. Mass. Coll., Agri. Rept., p. 35.

1858. **Sphene.** Tyringham.

With hornblende; No. 210.

E. Hitchcock: Cat. Mass. Rocks in 6th Ann. Rept. Mass. Bd. Agri.

1868. **Sphene.**

J. D. Dana: Sys. Min., 5th ed., p. 386.

1872. **Sphene.**

J. D. Dana: Sys. Min., 6th ed., p. 715.

E. Hitchcock: Final Rept. Geol. of Mass.

1895. **Titanite.** Sandisfield. Becket. Coles Brook.

Sandisfield; in drift on Birch Hill, with hornblende and wernerite.

Becket; 100 rods east of R. Alderman's house.

Crystals a half inch long.

Coles Brook; in Hinsdale limestone.

1895. **Titanite.** Tyringham (Sodom, Hop Brook gorge).

In pre-Cambrian limestone. Beautiful flat transparent chestnut-brown crystals, often an inch long. Some are rich red-brown at one end and grade to clove-brown or dusty-white at the other. There are also most beautiful limpid hyacinth-red bladed crystals in calcite. In Sodom chestnut-brown crystals occur in pink calcite with radiating black hornblende. They show the faces OP (001), P (111), $\infty P\infty$ (100), ∞P (110), and multiple twinning according to the third law (Dana) approximately parallel to 221.

D. Clark collection.

1895. **Titanite.** New Marlboro (road to Southfield).

Deep cutting in rusty rock by roadside. Pre-Cambrian. Large pale-brown wedge-shaped crystals.

D. Clark collection.

1895. **Titanite.** East Lee (east of the Gousset road).

Bowlder of pre-Cambrian Hinsdale limestone.

The crystals are half an inch long and of pale Isabella yellow. Forms: OP (001), $\infty P\infty$ (100), ∞P (110), P (111).

D. Clark collection.

1895. **Titanite.** Becket (near West Becket post-office).

A large mass was blasted out in improving the road. The mineral occurs in a white, granular feldspar rock (pre-Cambrian), with green actinolite, and is probably from an altered form of the Hinsdale limestone. It is in very abundant crystals of rich chestnut color, often an inch long, and shows the forms OP (001), P (111), ∞ P (110).

D. Clark collection.

1895. **Titanite.** Otis (Hop Brook gorge).

From the upper bed of pre-Cambrian limestone. Flat-bladed chestnut-brown crystals an inch long.

D. Clark collection.

TOURMALINE.

1821. **Schorl.** Dalton. Pittsfield (southeast part of the town).

In mica-slate.

C. A. Lee: Min. Loc., Am. Jour. Sci., Vol. IX, p. 42.

1822. **Yellow tourmaline.** Dalton (near the Housatonic).

In groups of straw-yellow crystals from an inch to 2 inches long, sometimes with terminations in granular limestone (M'Euen).

P. Cleaveland: Min., p. 321.

This interesting occurrence I have not been able to verify. It may be tremolite in the Stockbridge limestone, but from the great abundance of minute tourmaline in the subjacent Cheshire quartzite the occurrence of tourmaline in the limestone is not improbable.

1824. **Black tourmaline.** Washington.

J. Porter: Min. Loc., Am. Jour. Sci., Vol. VII, p. 252.

I have not found this mineral in Washington.

1825. **Yellow tourmaline.** Dalton (near the Housatonic).

In groups of straw-colored crystals in granular limestone.

S. Robinson: Cat. Am. Min., p. 46.

1895. **Tourmaline.** Sandisfield (in field near Mr. George Blake's house).

Black crystals 1 inch across and 3 to 5 inches long, in a small pegmatite vein, much jointed, faulted, and recemented into beautiful series of echeloned disks.

1895. **Tourmaline.** Tyringham (the Cobble).

In well-terminated black crystals in a granite dike.

D. Clark collection.

1895. **Tourmaline.** Sandisfield (near town hall).

Black crystals 1½ inches across, much jointed, and recemented with quartz.

D. Clark collection.

WERNERITE.

1841. **Scapolite.** Tyringham. Lee.

Tyringham; crystallized hornblende and scapolite; No. 2300, State collection.

Lee; augite with scapolite; No. 1092, State collection.

E. Hitchcock: Final Rept. Geol. of Mass., p. 818.

1844. **Scapolite.** (*Scapolus pyramidalis.*) Tyringham.

J. D. Dana: Sys. Min., 2d ed., p. 539.

1858. **Scapolite.** Tyringham.

With hornblende.

E. Hitchcock: No. 218, Cat. Rocks of Mass., 6th Ann. Rept. Mass. Bd. Agri.

1868. **Scapolite.**

J. D. Dana: Sys. Min., 5th ed., p. 770.

1892. **Scapolite.**

Idem, 6th ed., p. 1059.

1895. **Wernerite.** Tyringham (Hop Brook gorge, Sodom).

Pre-Cambrian. Pure white prisms 2 inches long and 1 inch square. Other crystals in almost acicular square prisms; crystals generally bent or broken by later growth of hornblende.

D. Clark collection.

1895. **Wernerite.** Lee (Upper Goose Pond, near Elwells Rocks).

Peculiar forms; deep topaz to flesh-colored; glassy and highly lustrous on crystal faces; transparent, and a true gem form. Some crystals broken. The crystals are black at base and change up through brown and wine-yellow to nearly colorless. Inset crystals raised from the polished faces. The ∞ P ∞ (101) cleavage is perfect; crystals are half an inch wide and 1 inch long, with the form ∞ P ∞ (101), P (111).

Masses 2 inches square show deep flesh-color; more fibrous cleavage, like ordinary scapolite; growing paler by alteration. Blades of deep-green actinolite and pyroxene prisms are grown through the mass.

Also large masses of coarse granular texture composed of imperfect stout crystals 1 inch across, bluish gray shading to white at border, and very fresh, greasy luster, with biotite.

D. Clark collection.

1895. **Wernerite changing into scolecite.** Tyringham (Hop Brook gorge).

Large imperfect square prisms, with greasy bluish luster, and masses of a colorless wernerite granular rock, full of small phlogopites and actinolite blades, are changed to a mass of radiated fine fibrous balls of scolecite, opaque white, at the surface forming delicate botryoidal surfaces of the fine free needles. In cross sections the balls are concentrically banded, the lower half opaque-white, the upper translucent. This wernerite is found in masses of tons in size along the brook gorge, white and pale gray, with crystals growing from the surface. Other crystals are small square prisms one-half inch long, one-fourth inch wide, often bent; snow-white, with satiny luster, apparently changed to scolecite in needles parallel to OP (001). Other specimens are also coated with the radiated balls of scolecite as above. One piece bristles with white needles of wernerite one-half millimeter across, many of which are deep square hollows, leaving only shells, and many are inclosed in deep-green pyroxene and remain hollow.

D. Clark collection.

1895. **Wernerite.** Tyringham (Hop Brook).

A large impure crystal, full of calcite and phlogopite, was examined in thin section under the microscope. The crystal is full of minute, long, square prisms, whose cleavage, high relief, and oblique extinction show them to be white pyroxene. The wernerite is brown, shaded in irregular patches, which are white by reflected light. This is caused by the fibrous decomposition product common in wernerite, which is optically positive and has very weak double refraction (V =.008), agreeing exactly with scolecite. A twinning suture runs parallel with OP (001), and the optical axis makes an angle of 16° with this on either side.

1895. **Wernerite.** Sandisfield (Beech Plain).

In drift, with hornblende and titanite.

1895. **Wernerite.** Otis (Otis Center).

The coarse limestone at Otis Center contains wernerite in groups of stout, white, interlaced crystals and purple glassy masses. It occurs in the brook bed near the mill and just west of the village street.

ZOISITE.

1841. **Zoisite.** Hinsdale.

In mica-schist.

E. Hitchcock: Final Rept., 606.

(I have never seen zoisite from Hinsdale. It may be the same mineral cited herein as fibrolite.)

1844. **Zoisite.** (*Carbunculus rhomboideus.*) Hinsdale. Windsor.

J. D. Dana: Sys. Min., 2d ed., p. 300.

1868. **Zoisite.**

Idem, 5th ed., p. 292.

1892. **Zoisite.**

Idem, 6th ed., p. 514.

BIBLIOGRAPHY.

1734. WINTHROP (John). Selections from an ancient catalogue of objects of natural history found in New England more than a hundred years ago, by John Winthrop, F. R. S., from the Journal Book of the Royal Society, Vol. XV, p. 451. (Manuscript.) Am. Jour. Sci., Vol. XLVII, p. 282, 1824.

1809. MACLURE (W.). Observations on the geology of the United States, with geological map. Trans. Am. Philos. Soc., Vol. VI, pp. 411, 428.

1814. MEADE (W.). Mineralogical notice concerning elastic marble from Massachusetts. A. Bruce, Am. Min. Jour., Vol. I, pp. 93, 267.

On taking up one of these slabs it was found to be so completely elastic that the writer feared it would fall in pieces before he could replace it.

1816. CLEAVELAND (Parker). Elementary treatise on mineralogy and geology, with colored geological map of the United States; 668 pages.

The map was taken from Maclure. Berkshire County is colored as "Primitive."

1818. EATON (Amos). An index to the geology of the northern States, with a transverse section from the Catskill Mountains to the Atlantic, prepared for the geological classes at Williams College, Northampton, Belchertown, Leicester, and Worcester (Massachusetts).

The section gives, although crudely, the Hinsdale anticline, but makes its core granite instead of gneiss, and identical with the much later granite of Chesterfield. On this granite rest the "granular limestone" and quartz. This is the Hinsdale limestone, and it is clearly separated from the newer "metalliferous limestone" to the west, the latter being the Stockbridge limestone (p. 84).

Next above this is the gneiss, which "sinks laterally under the mica-schist to the west, and probably does not rise again until it reaches the continent of Asia." Above this is the mica-slate, "the calcareous and granular quartz," the "soapstone rocks," including the hydromica-schists, as well as the steatite and serpentine, and lastly the "syenite." By this is meant the Chester and Hawley amphibolites, and he notes the spotted or "porphyritic" varieties in Hawley. This bed is said to cap the series east of Dalton, and "therefore all the tract is 'Primitive.'"

1818. MACLURE (W.). Observations on the geology of the United States, with map. Trans. Am. Philos. Soc., n. s., Vol. I, p. 1.

1820. EATON (Amos). An index [etc.]; 2d edition.

"Written over anew."

1820. ——— Localities of minerals, from the minutes of the Troy Lyceum. Am. Jour. Sci., Vol. II, p. 238.

1821. Dewey (C.). Fetid dolomite found in Lee; found by analysis to be magnesia. Am. Jour. Sci., Vol. III, p. 239.

1822. Cleaveland (Parker). An elementary treatise on mineralogy and geology. Second edition, 2 vols. With copy of W. Maclure's geological map, from work cited above, 1818.

1822. Dewey (C.). Prismatic mica (Hinsdale). Am. Jour. Sci., Vol. V, p. 399.

1823. Porter (Jacob). Localities of minerals. Am. Jour. Sci., Vol. VI, p. 246.

1823-6. Boston Journal of Philosophy and the Arts. J. W. Webster, editor. 3 vols.

Catalogues of minerals from several localities.

1824. A history of the county of Berkshire, Mass. By gentlemen of the county, clergymen, and laymen. Colored geological map.

Geology by Prof. Chester Dewey. The central gneiss mass, with soapstone and serpentine, is mentioned. The quartzite and the limestone are said to extend south in two bands; the western, from Adams to Cheshire, is the Stockbridge limestone; that from Windsor to New Marlboro is pre-Cambrian.

1824. Hall (F.). Catalogue of minerals.

1824. Porter (Jacob). Localities of minerals. Lenox, Pittsfield, Washington. Am. Jour. Sci., Vol. VII, p. 252.

1824. Dewey (Chester). A sketch of the geology and mineralogy of the western part of Massachusetts, and a small part of adjoining States. Am. Jour. Sci., Vol. VIII, pp. 1–60. Geological map.

The first connected account of the geology of Berkshire County. All the upland country mapped in this study is assigned to mica-slate except a band of gneiss along the Peru line and a broad band of primitive limestone which runs down across Hinsdale and Washington and is given the same color as the valley limestone. The quartzite is the only other rock distinguished upon the map.

1824. ———. Additional remarks on foregoing. Am. Jour. Sci., Vol., III p. 240.

1825. Lee (Charles A.). Notice of minerals in Pittsfield and Dalton. Am. Jour. Sci., Vol. IX, pp. 42, 43.

1825. Robinson (Samuel). A catalogue of American minerals, with their localities. Boston.

Quotes minerals from Becket, Dalton, Hinsdale, Lee, Lenox, New Marlboro, Pittsfield, and Windsor.

1830. Eaton (Amos). Geological text-book. Albany.

Southeastern Berkshire is mapped as follows: limestone from the west up to the Housatonic; quartzite east of this to Franklin and Hampshire counties; in the southeastern corner is primitive, interrupted by a band of limestone entering from Litchfield County.

1830. A history of the county of Berkshire, Massachusetts, in two parts; the first being a general view of the whole county; the second an account of the several towns, by gentlemen of the county, clergymen, and laymen. Geographical and geological map.

Geological part by Prof. Chester Dewey.

1832. HITCHCOCK (E.). Report on the geology of Massachusetts, examined under the direction of the government of that State during the years 1830 and 1831 by Edward Hitchcock, professor of chemistry and natural history in Amherst College. Part I. The economical geology of the State, with a geological map. Am. Jour. Sci., Vol. XXII, p. 1.

1832. SHEPARD (C. U.). Treatise on mineralogy. 2 vols. New Haven.

1835. HITCHCOCK (E.). Second edition of above report on geology of Massachusetts, 1832.

1838. ——— Report on the reexamination of the economical geology of Massachusetts.

Notice of the limonite.

1841. ——— Final report on the geology of Massachusetts. 4°. 831 pp., plates and map.

1842. PERCIVAL (J. G.). Report on the geology of the State of Connecticut, with geological map. 495 pp. 8°. New Haven.

Formation L (limestone) K_2 (gneiss) are extended into Massachusetts.

1842. EMMONS (E.). Geology of New York, 2d district. 4°.

The discussion of the Taconic system extends into this region, under "Granular quartz," p. 158.

1842. MATHER (W. W.). The geology of New York, 1st district.

All the limestones of western Massachusetts are said to be altered Lower Silurian, pp. 464, 476, 542.

1844. DANA (J. D.). System of mineralogy. 2d edition.

1844. HITCHCOCK (E.). Geological map of Massachusetts on the topographical map by E. Borden. Explanation of the above map, separate pamphlet. 8°. 22 pp. Boston.

1845. LYELL (C.). Travels in North America.

"The opinion of Professor Hitchcock and H. D. Rogers that the Taconic Range is altered Silurian appears to me highly probable." P. 195.

1852. SHEPARD (C. U.). A treatise on mineralogy. 3d edition. New Haven.

1853. MARCOU (J.). Geological map of the United States, with explanatory text. Boston.

See Bull. U. S. Geol. Survey No. 127.

1853. HITCHCOCK (E.). Outlines of the geology of the globe and of the United States in particular, with map.

Area made hypozoic and metamorphic.

1854. HUNT (T. S.). On the crystalline limestones of North America. Am. Jour. Sci., 2d Ser., Vol. XVIII, p. 195.

All the limestones of western Massachusetts are Lower Silurian; the Archean limestones considered to be only more metamorphosed portions.

1855. MARCOU (J.). Ueber die Geologie der Vereinigten Staaten, mit Karte.

Makes the whole area granite and metamorphic rock.

1855. EMMONS (E.). American geology.

Gives Greylock section of "Taconic rock" and explains the iron breccia as igneous.

1858. WALLING (H. F.). Map of the county of Berkshire, based upon the trigonometric survey of the State. The details from actual surveys under the direction of Henry F. Walling.

1858. HITCHCOCK (E.). Geological map of Berkshire County.

On the above topographical map.

1859. ——— Agricultural museum catalogue of collection of rocks, minerals, and fossils in the State cabinet, obtained during the geological surveys of the State by Dr. Edward Hitchcock, with later additions. Appendix 6th Ann. Rept. of Board of Agriculture. Boston: State printer.

Collection in State capitol many years, then in Agricultural College, Amherst; thrown in confusion by a fire and not rearranged. Duplicate collection in Amherst College.

1866. HALL (J.) and GAGAN (W. E.). Geological map of Canada and the adjacent region, 1866.

The Stockbridge limestone is made Levis's 5a, in Quebec group, and the Hoosac schists are Sillery (6); all the rest Lauzon 56.

1868. DANA (J. D.). System of mineralogy. 5th edition.

1868. PERRY (J. B.). Life of E. Emmons. Proc. Boston Soc. Nat. Hist., Vol. XII, p. 214.

1871. HITCHCOCK (C. H.). Geological description of Massachusetts, with geological map. Walling's Atlas of Massachusetts, p. 17.

Eozoic are "the gneissic rocks of the Hoosac Mountain Range, which have anticlinal structure." The quartz rock is the lower Potsdam of Billings. The Stockbridge limestone is Levis group of Canada. The Berkshire schist is "Lauzon" of Canada, and all those parts of the Quebec group above the Chazy are Sillery. The "Talcose schist" (Hoosac and Rowe schists) are also Quebec. The Middlefield and Rowe serpentines (that is, in effect, the Chester series) are the equivalent of the limestones in the schists of the Taconic Range. The map, by the inexcusable blundering of the colorist, is wholly worthless, and was repudiated by its author at the Boston meeting of the American Association for the Advancement of Science.

1871. CREDNER (H.). Die Geognosie und der Mineralreichthum des Alleghany-Systems. Petermann's Mittheilungen, 1871, p. 41.

Makes the Berkshire Valley Huronian, the highlands Laurentian.

1872. DANA (J. D.). Green Mountain geology. Am. Jour. Sci., 3d series, Vol. III, pp. 179, 250.

On the quartzite.

1872. DANA (J. D.). On the quartzite, limestone, and associated rocks of the vicinity of Great Barrington, Berkshire County, Mass. Am. Jour. Sci., 2d series, Vol. IV, pp. 362, 450.

1873. ——— Same, Vol. V, pp. 47, 84; Vol. VI, p. 257.

1873. HITCHCOCK (C. H.) and BLAKE (W. P.). Geological map of the United States.

The hill country on the east is assigned to the Eozoic; the western valley to the Silurian.

1875. BRADLEY (F. H.). A geological chart of the United States.

The whole of Berkshire County is made Lower Silurian.

1876. SHEPARD (C. U.). Catalogue of minerals found within 75 miles of Amherst College. Privately printed May 20, 1876.

The greater number are found within 50 miles of this center.

1876. CROSBY (W. O.). Report on the geological map of Massachusetts, prepared for the Centennial Exposition at Philadelphia. Boston. 52 pp.

Noticed, probably by J. D. Dana, in Am. Jour. Sci., 3d series, Vol. XII, p. 459, where the statement that the Berkshire limestones and associated rocks are older than the Primordial is criticised and the Lower Silurian fossils found in Vermont are adduced.

1877. DANA (J. D.). On the relations of the geology of Vermont to that of Berkshire. Am. Jour. Sci., Vol. XIV, pp. 37, 132, 202, 257.

1877. HITCHCOCK (C. H.). Geology of New Hampshire. 3 vols. Atlas in folio.

Vol. II, p. 8, Pl. I, assigns the valley to the Silurian and Cambrian; Bear Mountain and the area south across Monterey, New Marlboro, and Norfolk to the Laurentian; and the broad area of the Cambrian gneisses to the east of these subdivisions to the "Atlantic"—a subdivision of the Archean between the Laurentian and the Huronian.

1879. ——— Macfarlane's railroad guide.

This gives Professor Hitchcock's views as to the age of the rocks in the area along the Housatonic and Boston and Albany railroads. The Hinsdale pre-Cambrian is called Green Mountain gneiss; the hydromica-schist of Middlefield, Huronian.

1880. DANA (J. D.). Note on the age of the Green Mountains. Am. Jour. Sci., Vol. XIX, p. 191.

Only general considerations on this special region.

1881. HITCHCOCK (C. H.). Geological map of the United States and Territories. Julius Bien. Scale, 20 miles to an inch.

The gneisses are assigned to: "Gneisses of the Atlantic Slope, including Montalban," and "Metamorphic Paleozoic;" the valley rocks, to Lower or Cambro-Silurian (Lorraine to Calciferous).

1882. DANA (J. D.). Geological age of the Taconic system. Jour. Geol. Soc., Vol. XXXVIII, p. 397.

Refutation of Hunt's idea of the pre-Cambrian age of the Taconic. The map gives the slates and limestones, leaves the highlands uncolored, and writes over Bear Mountain, "Here some Archæan?"

1883–1885. KUNZ (George F.). Precious stones; from Mineral Resources of the United States, U. S. Geol. Survey.

1884. NEWBERRY (J. S.). Notes on building stones used in New York. Tenth Census, Vol. X, pp. 318–324.

Lee marble, uniform, not brilliant white, coarser than Vermont, finer than New York marbles. Strong and durable, has little iron, and becomes somewhat brown on exposure. This is thought by some to be an excellence. Not weakened by the change.

1884. McGEE (W J). Map of the United States, exhibiting the present status of knowledge relating to the final distribution of geologic groups. (Preliminary compilation.) Compiled by W J McGee, 1884. Fifth Ann. Rept. U. S. Geol. Survey, Pl. II.

All the region given as Azoic-Archean.

1884. HITCHCOCK (C. H.). Geological map of the United States, in The National Atlas. Grey, Philadelphia.

1884. DANA (J. D.). On the decay of quartzite and the formation of sand, kaolin, and crystalline quartz. Am. Jour. Sci., Vol. XXVIII, p. 448.

1. Sand from quartzite. 2. Feldspathic quartzite the source of the kaolin. 3. Pseudobreccia from quartzite and in some of this pseudobreccia crystallized quartz.

1884. HAWES (G. W.), KELLEY (C.), MERRILL (G. P.), and SHALER (N. S.). Report on the building stones of the United States. Tenth Census, Vol. X.

Muscovite-biotite-gneiss of the Chester Granite Company, called Archean, p. 54.

1884. WHITNEY (J. D.) and WADSWORTH (M. E.). The Azoic system, Vermont and western Massachusetts. Bull. Mus. Comp. Zool., Vol. VI, p. 440.

So far as relates to our area, the section is almost wholly devoted to an accurate and detailed exposition of T. Sterry Hunt's views on the Taconic system and its remarkable metamorphoses. It is thus wholly given to a discussion of post-Azoic rocks and rocks it recognizes as such, and does not mention any of the rocks or areas of pre-Cambrian age in this territory.

1885. MERRILL (George P.). The collection of building and ornamental stones in the United States National Museum. A handbook and catalogue. Rept. Smith. Inst., 1885–86, Part II, pp. 277–648, Pls. I–IX.

1885. DANA (J. D.). Decay of quartzyte: Pseudo-breccia. Am. Jour. Sci., Vol. XXIX, p. 57.

Explains the breccias by the wedging action of crystallizing iron compounds.

1885. (1883–84.) HUNT (T. S.). The Taconic question in geology. The "Taconian" is a late pre-Cambrian formation. Trans. Can. Roy. Soc., Vol. I, Pt. 4, p. 227; Vol. II, p. 125.

1885. DANA (J. D.). On Taconic rocks and stratigraphy, with a geological map of the Taconic region. Am. Jour. Sci., Vol. XXIX, pp. 205, 437.

1886. Topographical map of the State of Massachusetts. Executed by the United States Geological Survey, at the joint expense of the State and the Survey.

Scale 1: 62,500; 20-foot contours in brown; water in blue; roads in black.

1887. DANA (J. D.). On Taconic rocks and stratigraphy, with a geological map of the Taconic region. Am. Jour. Sci., Vol. XXXIII, p. 270.

Also published separately, with 1885 part.

1888. Geology of Berkshire County. Child's Berkshire County Gazetteer, pp. 24–26.

Inadequate and worthless.

1888. WALCOTT (C. D.). The Taconic system of Emmons, with map covering western border of the area. Am. Jour. Sci., Vol. XXXV, pp. 229, 307, 394.

1889. MERRILL (George P.). Handbook and catalogue of building and ornamental stones in the United States National Museum. Rept. Smith. Inst., 1885–86, p. 277, Pls. I–IX.

1890. DANA (J. D.). Archæan axes of eastern North America. Am. Jour. Sci., Vol. XXXIX, p. 378.

1890. ———. Archæan limestone and other rocks in Norfolk, Connecticut. Am. Jour. Sci., Vol. XXXIX, p. 321.

R. H. Cornish writes of a limestone ledge with spinel and chondrodite on land of Mr. Ralph Cressey, near a spring southeast of his house.

1890. CROSBY (W. O.). Macfarlane's geological railway guide, 2d edition.

Gives character of rocks along Boston and Albany Railroad.

1890. EMERSON (B. K.). Porphyritic and gneissoid granites in Massachusetts. Bull. Geol. Soc. Am., Vol. I, p. 559.

Describes briefly the Archean areas and their bordering conglomerate-gneisses. The Hinsdale area is taken as type.

1891. WALCOTT (C. D.). Correlation papers: Cambrian. Bull. U. S. Geol. Survey, No. 81.

1891. MERRILL (G. P.). Stones for building and decoration. New York. John Wiley's Sons.

This adds nothing concerning building stones of Massachusetts to the handbook of the United States National Museum, 1885.

1892. HOBBS (William H.). Intergrowths of hornblende with augite in crystalline rocks. Science, Vol. XX, p. 354.

Augite surrounding hornblende, from the Cleveland mine.

1892. ———. Notes on some pseudomorphs from the Taconic region. Am. Geologist, Vol. X, p. 47.

Pseudomorphs of fibrolite and mica after feldspar.

1893. McGEE (W J). Reconnaissance map of the United States, showing the distribution of the geologic system so far as known.

Compiled from data in possession of the Geological Survey. Berkshire County, uncolored.

1894. McGee (W J). Preliminary geologic map of New York, exhibiting the structure of the State so far as known.

Prepared by W J McGee under the direction of James Hall. A rounded area wholly southwest of the true pre-Cambrian of Bear Mountain is assigned to Laurentian granite, including unclassified crystallines. The rest assigned to (Gg) Georgia formation, and (Strm) Metamorphic, Trenton, and Calciferous limestone.

1894. Pumpelly (Raphael), Wolff (J. E.), and Dale (T. Nelson). Geology of the Green Mountains in Massachusetts. Mon. U. S. Geol. Survey, Vol. XXIII.

Notice in Am. Jour. Sci., 1896, p. 146.

1895. Dana (J. D.). Manual of geology, 4th edition.

1895. Shaler (N. S.). The geology of the road-building stones of Massachusetts. Sixteenth Ann. Rept. U. S. Geol. Survey, Vol. II, p. 277.

Notice Am. Jour. Sci., 4th series, Vol. I, 1896, p. 489.

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