Norwich Rodgers Bedrock Compilation Sheet (paper)

Map

NOTICE!

Bedrock quadrangle 1:24,000 scale compilation sheets for the Bedrock Geological Map of Connecticut, John Rodgers, 1985, Connecticut Geological and Natural History Survey, Department of Environmental Protection, Hartford, Connecticut, in Cooperation with the U.S. Geological Survey, 1:125,000 scale, 2 sheets. [minimum 116 paper quad compilations with mylar overlays constituting the master file set for geologic lines and units compiled to the State map, some quads have multiple sheets depicting iterations of mapping]. Compilations drafted by Nancy Davis, Craig Dietsch, and Nat Gibbons under the direction of John Rodgers.

Geologic unit designation table translates earlier map unit nomenclature to the units ultimately used in the State publication.

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NORWICH QUADRANGLE, CONNECTICUT

INTRODUCTION

The Norwich quadrangle is in southeastern Connecticut at the head of the Thames estuary. The forest covered, takes in about 55 square miles and comprises parts Sprague, Lisbon, Montville, and

of the quadrangle. Rock crops out commonly as anhedral masses of accessory constituents as those over nearly 20 percent of the Nor- fibers (fibrolite). Prismatic silli- found in the calc-silicate rocks. wich quadrangle, and outcrops are manite generally occurs in sheaves Bates Pond lentil.—A uniform, the quadrangle.

uniformly distributed throughout or parallel clusters of needles that unlayered gray gneiss that is uni-Several earlier small-scale geo- in certain layers of the rock. Pods porphyroblasts of black hornblende logic maps of eastern Connecticut of pinite (Sohon, 1951, p. 51, 52), a and flesh-colored soda-orthoclase as (Mather, 1834; Percival, 1842; waxy translucent microcrystalline much as several centimeters in Gregory and Robinson, 1907; Foye, aggregate of white mica that here length is here named the Bates 1949; Rodgers and others, 1956) show is pseudomorphous after sillimanite, Pond lentil for exposures near Bates the southeastern half of the Norare characteristic of the rocks of exposed in several exposed in low ledges from the south

OF THE HONEY HILL FAULT wich quadrangle as underlain by a this facies. In a fresh exposure the lenticular bodies in the southeastern side of St. Manes Cemetery to the gneiss of variable composition that pinite is dark gray to greenish corner of the Norwich quadrangle.

Swamp near the head of Hartshorn the southwestern corner of the was named the Putnam gneiss by black, whereas in weathered outMany exposures are broad low Brook. South of this it is known Gregory (Rice and Gregory, 1906, crops it is dirty white to light green; roches moutonnées. The origin of from three equally spaced patches of (Rice and Gregory, 1906, p. 134-136). p. 129-132). Other units are less normally the pods stand out in relief this rock is uncertain but its unusual fine-grained calc-silicate float. Finedirectly comparable to those de- on the surface of the rock. composition suggests that it may grained layered rocks of this belt scribed by earlier workers and the Major minerals of the sillimanite- have originated as trachyandesite or contain calcic andesine, quartz, reader is directed to the original pinite schist phase of Putnam gneiss tephrite lava flows. (1842) mapped the Canterbury gneiss, Goldsmith, 1959, p. 109-110), and the ite, epidote-clinozoisite, and tourthe Norwich quadrangle. Putnam gneiss in one unit here. they are considered separate forimately as shown here but he, Orange to brown monazite was gneiss. Small unmappable lenses followed by Rodgers and others, also recognized as a minor constituent also occur in rocks of the biotitemapped a large area of Canterbury of one-fourth of the sillimanitegneiss east of Baltic, that is here containing schists of the Putnam in 200 yards of the contact with the mapped as pegmatite and the Fly gneiss sampled and probably occurs rocks of the Fly Pond member. Pond member of the Putnam gneiss. in more but was not recognized Amphibolite is locally in sharp con-The bedrock map of the Norwich because of unfavorable optical tact with sillimanite-pinite schist,

Most of the rocks are aluminous part of the quadrangle is light- to epidote. PUTNAM GNEISS

Schist and gneiss underlie 90 percent of the Norwich quadrangle and Gregory (Rice and Gregory, 1906, p. 129-132). Diffuse compositional ally of poorly twinned oligoclase or andesine, are prominent in nearly area are separated for descriptive ing phases; three of the amphibolecontaining phases are mappable and member status. The pelitic phases are biotite-muscovite schist, sillimand graphite schist; all contain abundant biotite and collectively lentil, amphibolite, and (unmapped)

resemblance to rocks of the silli
mafic calc-silicate rock.—Many

apatite, pyrite, magnetite-ilmenite

The regional strike of schistosity is mafic calc-silicate rock. All pelitic manite-pinite schist phase except unmappable lenses of green, massive and graphite. another but their contacts with ite flakes and the nearly universal of varied compositions and dimencontaining phases are in sharp coniron sulfide minerals. Pinitized the eastern part of the quadrangle. tact with other units and probably sillimanite occurs only in the graph- Most of the lenses are east of the boundaries that originally formed hypersthene (one locality), kyanite or greenish brown biotite, labraphyroblasts of muscovite. Although member, here named for exposures net, iron oxide minerals, iron sul-

contain much more muscovite than Browning Road but are poorly HEBRON FORMATION tional, concordant or discordant In manite-pinite schist during late muscovite dominates. The mineral as by numerous cataclastic or par-fossil collection, which was never Goldsmith, Richard, 1959, Granofels, exposed; at a typical outcrop in this Purplish-gray calcareous schist many exposures potassium feldspar The biotite-muscovite schist is belt one or two layers of calc- and green calc-silicate rock, here augen are prominent in wall rock composed of four main minerals, silicate granofels adhere to the termed the Hebron formation, near the contact and in a few places quartz, calcic oligoclase, biotite, and underside of a ledge of quartz- occur in two parallel belts in the metamorphic minerals characteristic muscovite, and minor amounts of microcline pegmatite. Near Brown-northwestern quarter of the quad- of the wall rock, such as sillimanite, garnet and potassium feldspar. ing Road the layered calc-silicate rangle. Rocks of the Hebron formagraphite, or diopside, occur within Accessory minerals include magnet- granofels grades into graphite- tion differ from typical rocks of the the pegmatite. Swarms of larger of the towns of Norwich, Franklin, ite-ilmenite(?), specular hematite, biotite-diopside marble within a Fly Pond member of the Putnam pegmatites occur in the southeast pyrite, pyrrhotite(?), rutile, apatite, quarter of a mile. The marble forms gneiss chiefly in that they are finer corner of the Norwich quadrangle Preston. Norwich, an industrial sphene, zircon, monazite, allanite, very few natural exposures but is grained and contain more calcite and and in or adjacent to the Fly Pond community of 37,000 population, is epidote-clinozoisite, and calcite. indicated by a few fist-size float less diopside. The rocks in the northlocated on tidewater in the southern

Sillimanite-pinite schist.—The boulders on steep slopes. It is best western corner of the quadrangle northern quarter of the quadrangle. part of the quadrangle. The elevamost common phase of the Putnam exposed in a roadcut along Rogers were mapped as Hebron quartz schist Peg matite lenses within the Fly tion ranges from sea level along the gneiss forms more than 40 percent Road at the west edge of the by Foye (1949, pl. 1). He showed Pond member generally contain Thames River to more than 510 feet of the Norwich quadrangle and is quadrangle.

on Hearthstone Hill in the north- distinguished by the presence of, or Layered medium-grained calc- in Hebron township that were orig- of the Putnam gneiss generally conwestern corner of the quadrangle; evidence indicating the former pressilicate rocks of the Fly Pond memthe local relief is as much as 200 feet. ence of, sillimanite. Rocks of this ber typically contain andesine- Gregory (Rice and Gregory, 1906, larger pegmatite bodies form ledges The area is in the New England phase typically are gray to brown, labradorite, quartz, actinolite- p. 140-141). The rocks underlying or crop out in roches moutonnées. Upland section of the New England medium to coarse-grained and hornblende, clinozoisite, light-brown the northwestern corner of the Nor-Physiographic Province (Fenneman, strongly foliated. Where the sillibiotite, diopside, sphene, and wich quadrangle were shown on the the Canterbury gneiss and muscovite 1938, pl. 1). Drainage is southward manite-pinite schist is in contact numerous accessory minerals and a State map by Rodgers and others quartz monzonite gneiss in its through the Thames, Shetucket, with the biotite-muscovite schist, few alteration minerals. Accessory (1956), who included the Hebron coarser grain size, higher content of Quinebaug, Yantic, and Little Rivers. the two are identical in composition minerals are potassium feldspar, gneiss and Scotland schist of Gregory potassium feldspar, and more vari-The courses of these rivers are not except for the sillimanite. From the allanite, apatite, graphite, zircon, or the Hebron quartz schist and able biotite-to-muscovite ratio; probinfluenced by the trend of the under- west side to near the center of the calcite, magnetite, and pyrite. lying bedrock units nor by structural main belt, rocks of the sillimanite
Primary amphibole is generally

Called the Hebron gneiss. The and composition exist between the features, but the smaller streams pinite schist phase contain progress- light-green actinolite but ranges to clearly reflect the generally north- ively less coarse muscovite and dark-green hornblende and to colorern to northeastern trend of the progressively more sillimanite and less tremolite, sometimes within a underlying rock units. Differential garnet. Sillimanite is most abundant single grain. Tremolite grains are resistance to erosion of the mapped near the center of the belt and more elongate than the grains of units is not marked, however, except decreases as the contact with rocks actinolite-hornblende. where valleys have been cut along of the biotite gneiss phase is Typical graphitic marble consists the relatively weak calcareous and approached. Sillimanite commonly of calcite, diopside, light-brown adjacent Fitchville quadrangle. The calc-silicate rocks of the Hebron occurs as colorless to slightly brown biotite, scapolite (meionite?), graphformation in the northwestern corner elongate prismatic crystals or less ite, pyrrhotite(?), and the same

in most places are segregated withformly granular and contains large

references for an exact comparison are quartz, biotite, calcic oligoclase The Bates Pond lentil is com- aluminous epidote, and minor of contacts and lithologic descriptor sodic andesine, sillimanite, and posed mainly of andesine, biotite, amounts of light-brown biotite. The tions. Mather projected a so-called garnet, and smaller amounts of pocontorted gneiss as far north as tassium feldspar, muscovite, and iron minor amounts of quartz. Accessory these minerals. Accessory minerals Yantic from the Uncasville quad
Yantic from the Uncasville quad
Oxide minerals (specular hematite, minerals are epidote, allanite, zircon, are orthoclase, diopside, magnetite, considerable variety of granite, rangle; other authors recognized magnetite, and ilmenite). Potassium scapolite, pyrite magnetite, rutile, pyrite, sphene, allanite, clinozoisite, granite gneiss, and migmatite of a prominent lithologic break between feldspar was observed in one-fourth and tourmaline (?). The soda-ortho-apatite, and zircon. the gneisses and schists of the of the sillimanite-pinite schists clase occurs as large porphyroblasts

Rocks in the northwestern part of Because of the uncertainty in corre-Norwich quadrangle and the granites

Norwich quadrangle and the granites

Norwich quadrangle and the granites

A composition of about Or Ab Cr and gneisses to the south. This ably occurred in greater quantity composition of about Or_{70} Ab₂₅ Cn₅ break is along the Honey Hill fault originally and was consumed in the for the potassium feldspar of one in the southwestern corner of the formation of pinite. Accessory sample is indicated from a semiquadrangle (Lundgren, Goldsmith, minerals in the sillimanite-pinite quantitative spectrographic analysis and Snyder, 1958, p. 1606). Percival schist include cordierite, monazite, by John C. Hamilton. Pleochroic kyanite, spinel, apatite, sphene, halos about the zircons are narrower part of the Hebron formation, the rutile, zircon, limonite, or goethite, (0.01 mm) than those about zircons Fly Pond granofels (compare with pyrite, pyrrhotite(?), calcite, allaning any other rock (0.02-0.04 mm) in biotite-muscovite schist phase of the maline. Of these, only cordierite, Amphibolite.—Numerous lenses of kyanite, zircon, pyrite, epidote- dark-green, generally unlayered, clinozoisite, tourmaline, and mona- granular hornblende-labradorite mations. Foye separated the Canterbury gneiss and mapped it approx
1 percent, and then only locally.

biotite gneiss phase of the Putnam

of rocks evenly sampled over the Stone, 1914, p. 53; Schairer, 1931, of rocks evenly sampled over the quadrangle. The most abundant p. 55, 112; Heermance, 1935, p. 255; p. 55, 112; Heermance, 1935, p. 255; p. 57, 112; Heermance, 1935, p. 255; p. 58, 112; Heermance, 1935, p. 255; p. 25 mineral is always mentioned first in

Foye, 1949, p. 83; Palache, Berman,

The Host abundant Foye, 1949, p. 83; Palache, Berman,

The Fly Pond member of the Putnam mapped as Canterbury granite gneiss

the Putnam gneiss in the eastern layers or pods of light-colored type Canterbury gneiss but which units and the obliteration by deforis contained in the belt of graphitic mation and metamorphism of sediand calcareous metasedimentary dark-gray, medium- to coarse
Most amphibolites are composed marble of the Fly Pond member of mentary or other features that rocks that are divided into the grained, strongly foliated biotite largely of equal amounts of labra-Putnam gneiss and the Hebron forgneiss. This gneiss is gradational
dorite and dark-green or brown
between the Norwich and Fitchville
units. The simplest structural picmation. Other lithologic units are with sillimanite-pinite schist and amphibole with minor amounts of quadrangles. Foye (1949, pl. 1) later ture consistent with the present possible lava flows of quartz latite graphite schist in many exposures. graphite schist in many exposures. graphite schist in many exposures. biotite, quartz, scapolite, pyroxene, mapped the main belt of Canterbury knowledge is that of a generally and trachyandesite composition and Rocks of the biotite gneiss phase and other accessory and alteration gneiss in the Norwich quadrangle northwesterly dipping homocline intrusive (?) rocks of quartz monare distinguished from rocks of the
minerals. Dark-green to brown subessentially as it is shown on the
with Hebron formation and Canterzonite and granite composition.

phases to the west by their lack of hedral actinolite-hornblende is the present map; Foye and later Rodgers bury gneiss overlying Putnam large muscovite porphyroblasts, commonest amphibole but euhedral and others (1956) showed a large gneiss. sillimanite crystals, or pinite pods. light-green to colorless tremolite- area of Canterbury gneiss in Sprague BEDDING-SCHISTOSITY RELATIONS Plagioclase and garnet make promiactinolite is also common; both
township east of Baltic, an area
Crude compositional layering withnent augen, and quartz commonly varieties are commonly zoned to a occupied largely by the Fly Pond out recognizable primary structures are continuous with similar schist occurs in lenses and layers several blue-green amphibole on tips and member and lenses of pegmatite. inches long parallel to the mica foliation giving the rock a ribbed as poikiloblasts or radiating aggreappearance on weathered surfaces.

gates along joints or veinlike areas.

erals, a consistent medium-grain the sheared remnants of original Major minerals in rocks of the Clinopyroxene, generally diopside, is size, and no internal layering. Mussedimentary bedding. Schistosity, as layering and feldspar augen, gener-biotite gneiss phase are andesine, biotite gneiss phase are andesine, known from six amphibolites. quartz, biotite, and garnet, and
Hypersthene is known from four not visible megascopically. Quartz of micaceous minerals, is parallel to smaller amounts of potassium feldamphibolites and is pleochroic in veins as much as several yards long the compositional layering in most spar, iron oxide minerals (specular three of them. Olivine is known and a foot wide occur throughout places; only rarely is schistosity hematite, magnetite, and ilmenite), from two amphibolites. Other accessions the rocks, and uniform layers of oriented at an angle to the layering. and muscovite. Accessory minerals sory minerals are magnetite-ilmen-leucocratic garnet aplite as much as Schistosity is generally parallel to are hypersthene, diopside, hornite, chalcopyrite(?), tens of feet long and several inches major formational contacts (for blende, tremolite, spinel, zircon, pyrite, specular hematite, apatite, wide crosscut the foliation of the example, the west contact of the

monazite, apatite, sphene, rutile, epidote-clinozoisite, allanite, zircon, Canterbury gneiss at a slight angle Fly Pond member of the Putnam pyrite, pyrrhotite(?), chalcopyrite(?), titanite, garnet, calcite, rutile, and are concentrated near the gneiss), but there appears to be no calcite, allanite, epidote-clinozoisite, chlorite. eastern contact. The quartz monzo-simple relation between schistosity and tourmaline. Of these, only

A single outcrop of rock of nitic rocks crop out in extensive and the contacts between the pelitic hypersthene, diopside, hornblende, peridotitic composition, composed ledges on hillsides and broad flat phases of the Putnam gneiss. These tremolite, apatite, and tourmaline entirely of dark minerals, is exposed whalebacks on hilltops. occur in amounts greater than 1 in a small prospect pit just north of Major minerals of the Canterbury have been steep or irregular (at percent, and then only very locally. the "y" in "Rye Hill", in an area gneiss are oligoclase, quartz, microsome angle greater than the hori-Graphite schist.—Rocks of the largely of normal amphibolite. The cline, greenish black biotite, ferruzontal) in contrast with the contacts 80 percent of the quadrangle. The graphite schist phase are reddish-80 percent of the quadrangle. The amphibole-containing phases are the brown, medium to coarse grained, brown, medium to coarse grained, surrounding amphibolite are include allanite, sphene, zircon, originally have been nearly horizontal.

CANTERBURY GNEISS

phases are gradational with one for the universal presence of graph- or layered, mafic calc-silicate rock or layered, mafi other rocks are sharp; amphibolerusty weathering caused by oxidized
sions occur in the Putnam gneiss in
Uniform, white to gray, mediumdips about 30° along the eastern borsharp contact, though exposed in few places, with each other. The gradational interphase contacts are much tional interphase contacts are much rangle. Similar rocks occur in the Quinebaug River. The lenses are Pond member or the biotite-musco- ally to the northwestern part of the more complex than the contacts of any other formations and members, any other formations and members, (Sclar, 1958, p. 33, 34).

any other formations and members, (Sclar, 1958, p. 33, 34).

mostly several inches to several feet thick.

The lenses have sharp connearly horizontal. which are linear or simply curvelinear at the surface. The political interval of the surface o linear at the surface. The pelitic graphite schist phase are quartz, rically insignificant. They generally tacts with and are generally parallel

them as continuous with the rocks white feldspar, and those in the rest Scotland schist of Foye in one unit ably all gradations both in texture Hebron formation within the area granite pegmatite and muscovite here mapped is equivalent to the quartz monzonite gneiss. Hebron gneiss of Rodgers and others Major minerals of granite pegmatites are microcline perthite, oligo-

The two belts of the Hebron for- clase, quartz, biotite, and muscovite, mation join around the southern end with numerous accessory minerals of the Canterbury gneiss body in the and minor alteration minerals. The contact of rocks of the Hebron for- Plagioclase in the microcline perthmation with rocks of the Putnam ite occurs as equant blebs, elongate in two pegmatites studied in detail, Green, layered, fine-grained, plagioclase forms 5 to 7 percent of actinolite-aluminous epidote calc- microcline perthite. Accessory minsilicate rock forms the thin belt of erals are apatite, rutile, sphene, Hebron formation east of the zircon, monazite, magnetite-ilmen-Canterbury gneiss. Two small areas ite, pyrite, specular hematite, tremoof the calc-silicate rock are com- lite, garnet, calcite, epidote-clinopletely enclosed by Canterbury zoisite, allanite, graphite, diopside,

gneiss on the east side of Hearth- and sillimanite. stone Hill. The main belt is well OUARTZ MONZONITE GNEISS SOUTH The quartz monzonite gneiss in (Rice and Gregory, 1906, p. 134-136; Gregory and Robinson, 1907, map in pocket) as part of the Sterling granite gneiss and was shown to underlie an appreciable part of eastern (Loughlin, 1912, pl. 2; Foye, 1949, pl. 1). The Sterling granite gneiss quadrangle are probably fine- gneiss, the name Sterling is not used grained, granular, purplish-gray in this report. No outcrops of this calcite-biotite schist. They do not gray- to red-weathering uniform crop out, but the area is topograph- quartz monzonite gneiss are known ically low like similar areas on strike in the Norwich quadrangle, but the in adjacent parts of the Fitchville, topography and the projection of Willimantic, and Scotland quad-nearby geology makes its location rangles that are underlain by fine- clear. This rock differs from the grained schist composed chiefly of Canterbury gneiss, muscovite quartz andesine, quartz, actinolite, light- monzonite gneiss and granite pegbrown biotite, and calcite. These matite in its red color, absence of rocks differ from those east of the muscovite, low biotite content, and Canterbury gneiss in their universal low anorthite content of plagioclase.

aluminous epidote. Accessory minerals are similar in the two belts

Uncasville quadrangle is composed except that garnet and tourmaline of equal amounts of microcline, are only recognized in the rocks west sodic oligoclase, and quartz and 2 percent or less of magnetite, pyrite, green biotite, anatite, and sphene. 7½ minute quadrangle was started orientation in thin sections and its orientation in thin sections and its by G. L. Snyder in 1955 who was close resemblance to zircon. Monazite close resemblance to zircon. Monazite joined by Karl E. Seifert in 1956; is reported in the Norwich area from Middle Road), and the rocks of the Canterbury gneiss, forms a belt rock consists of equal amounts of mapping was completed in 1957. Yantic Falls (Shepard, 1837A, p. 66,

Bates Pond lentil. Rocks mapped about a mile wide in the northwestmicrocline, albite, and quartz and Petrographic descriptions are based 123; 1837 B, p. 163; 1840, p. 253; as amphibolite have about 50 percent ern part of the Norwich quadrangle. upon study of about 500 thin sections

Cochrane, 1896, p. 516; Sanford and

Cochrane, 1896, p. 516; Sanford and mineral is always mentioned first in the following descriptions, followed the following descriptions, followed the following descriptions, followed the following descriptions and Frondel, 1951, p. 695). Foye the following descriptions, followed successively by minerals of lesser abundance.

and Frondel, 1951, p. 695). Foy small lenses of mafic calc-silicate shows this locality (his fig. 21)

5½ miles too far to the northwest.

Biotite gneiss.—The main phase of the Putnam gneiss in the eastern of the Putnam gneiss in the Putnam gneiss in the Putnam gneiss in the Putnam gneiss in the Norwich quadrangle, and Frondel, 1951, p. 695). For the successively by minerals of lesser and Frondel, 1951, p. 695). For the successively by minerals of lesser and Frondel, 1951, p. 695). For the successively by minerals of lesser and Frondel, 1951, p. 695). For the successively by minerals of lesser and Frondel, 1951, p. 695). For the successively by minerals of lesser and Frondel, 1951, p. 695). For the successive properties and Frondel, 1951, p. 695). For the successive properties and Frondel, 1951, p. 695). For the successive properties and Frondel, 1951, p. 695). For the successive properties and Frondel, 1951, p. 695). For the successive properties and Frondel, 1951, p. 695). For the successive properties and Frondel, 1951, p. 695). For the successive properties and Frondel, 1951, p. 695). For the successive properties and Frondel, 1951, p. 695). For th

interphase boundaries may originally north to northeast and the regional

grained muscovite quartz monzonite der of the quadrangle. Its dip ingneiss by their abundant muscovite. the small folds occur singly rather

diverse orientation and sense are muscovite is conspicuous it is comnear Fly Pond, includes two distinct fide minerals, graphite, orthoclase,

GRANITE PEGMATITE

best developed in a wide belt along monly less abundant than biotite rock types: layered gray-green olivine, spinel, apatite, sphene, rutile, Very coarse-grained, dirty-white, the center and eastern side of the (predominance of biotite distin- medium-grained, granular calc- zircon, and allanite. strongly foliated granite pegmatite main mass of sillimanite-pinite guishes this rock from the Scotland silicate rock, and dirty-white to Diopside-scapolite-graphite marble with prominent feldspar-augen schist from a point between the schist of Gregory (1906) in the green graphitic marble. Rocks of is exposed beneath sillimanite schist occurs in practically every outcrop Middle Road fault and the Thames adjacent Fitchville quadrangle). this member occur in a well-defined in a roadcut due north of BM 111 of Putnam gneiss in the Norwich River northward as far as Occum. Fine-grained varieties are present belt extending from Rogers Road to north of the Quinebaug River. quadrangle. Pegmatite layers less In many outcrops in this belt the locally in the biotite-muscovite Colegrove Hill. The calc-silicate Graphitic limestone crops out east of than 5 ft thick are not shown on the rocks are highly contorted but withschist unit. The texture is typically rock generally is in 1- to 3-in. thick Taft Station (Schairer, 1931, p. 110) map. Single pegmatite lenses are as out a measurable symmetry. This granular, schistose, and porphyro- resistant layers rich in aluminous and dolomite lenses are known in much as one-half mile long; some of contortion is probably related to west edge of the map).

Dynamic metamorphism continued are continuous with the Hebron 74,95 p. blastic. Several outcrops near the epidote that are separated by non- the Putnam gneiss in the adjoining the larger units as mapped are nonsystematic disturbances or northwestern border of the western resistant biotitic rock. The calc- Jewett City quadrangle (Shepard, groups of pegmatites. The contact shuffling near and along the probelt of schist are similar to Scotland silicate rocks comprise the entire 1837A, p. 122; Loughlin, 1912, p. 76, of a granite pegmatite with its wall jection of the Middle Road fault or schist with biotite generally domi- mylonite gneisses along the Honey believes Perry and Emerson's reactions and metamorphic facies: cester phyllite: Washington Acad.

parallel to the small fold axes; there
potassium feldspar zone.

Late alteration took place mostly fore, it is a "b" lineation. This Pelitic rocks of the hypersthene or through low-temperature hydration indicates a northwest-southeast cordierite zone are largely silli- reactions that affected all rocks

adjacent Fitchville quadrangle, slickensides, mineral lineation, and fold shown on the present map. However, axes are nearly parallel to the dip of the sillimanite isograd does not enter the sillimanite isograd does not enter A single new lead-alpha age the sillimanite isograd does not enter the sillimanite isograd does

calcite and general absence of The rock cropping out just south of

ditions ranging from those of the crystallization. (Turner, in Fyfe, Turner, and ous small fold structures and mineral facies (Turner, in Fyfe, Turner, and Verhoogen, 1958). Following the dynamic metamorphism a late alteration affected most rocks slightly but was especially prominent in the hydration of the sillimanite-containing schists of the Putnam gneiss. During this late alteration the rocks affected were recrystallized in the quartz-albite-muscovite-chlorite subfacies of the greenschist facies

(Turner, in Fyfe, Turner, and Verhoogen, 1958). REGIONAL DYNAMOTHERMAL METAMORPHISM

grade as the Scotland schist of taken for andalusite. Gregory (1906) which contains zone are largely biotite-muscovite the finer-grained, lower-grade rangle. Billings (1956, p. 101) hoogen, John, 1958, Metamorphic White, C. D., 1912, Age of the Worschist but atypical here in that they belt of Fly Pond member north of 149, pl. 2; Sclar, 1958, p. 22, 23, 84). rock may be either sharp or grada- to regional expansion of the silli- nant over muscovite, but locally Hill and Middle Road faults, as well Lepidodendron is inorganic; White's Geol. Soc. America Mem. 73, 259 p. Sci. Jour., v. 2, no. 5, p. 114-118.

kyanite is unknown near the possible tially cataclastic rocks that are inter- adequately described, is lost. Recon- a new metamorphic rock name: Most small folds are isoclinal with kyanite isograd in the Norwich quad- calated with the normal pelitic rocks. naissance mapping by the writer Jour. Geology, v. 67, no. 1, p. 109axial planes parallel to the trend of rangle but occurs in pelitic rocks in All gradations between normal north of the Norwich and Fitchville 110. the foliation and with most axes the southwestern part of the Scot- coarse-grained schist or gneiss and quadrangles indicates that the Scot- Gregory, H. E., 1906, Connecticut plunging steeply to gently south- land quadrangle 11/4 miles north of fine-grained mylonite gneiss exist land schist of Gregory (1906) in the Geol. Nat. History Survey Bull. 6, west. The seeming lack of regional the quadrangle boundary. locally; flaser structure and mortar Fitchville quadrangle is probably p. 114, 132, 141, map. consistency to the movement sense Most pelitic rocks of the silliman- structure are common. Numerous correlative with if not continuous Gregory, H. E., and Robinson, H. H., the beds are right side up; both nous epidote granofels, usually with foliation within these isolated out- A Silurian and Devonian age is 1038, 104 p. ately large but very gentle sigmoid sillimanite-biotite schist, biotite given an excellent description of a selves been traced from fossiliferous 472.

for example, northwest of Taftville. manite in thin sections of unpinities with recrystallized biotite and Vermont, and southern New Hamp-Most of these have dextral sense tized rocks. It does not occur in muscovite prove that mylonitization shire are of Silurian and Devonian which, with the regional northwest pinitized rocks probably because it took place at elevated temperatures, age (Boucot and others, 1953, 1958, dip, indicates that the beds are right was consumed during the alteration. but not at temperatures as high as p. 855, 863; Thompson, 1956; Boucot Most of the mineral lineation, in those below this grade. Calcmaking movements continued after to be continuous with those in the including both elongate individual silicate rocks of the types found in the thermal peak, and the latest Middle Haddam quadrangle 20 miles minerals and elongate groups of the Hebron formation or Fly Pond dynamic metamorphism was confined west of the Norwich quadrangle minerals (for complete listing see member of the Putnam gneiss are to prominent fault zones. (Rosenfeld and Eaton, 1956; Boucot map explanation), plunges gently to not known in large bodies of higher

during dynamothermal metamoror sillimanite-graphite schist, with example, in the pinite-bearing rocks

Mississippian of Holmes time scale, late alteration minerals. In the east, the hypersthene or cordierite alteration of the rock.

axes are nearly parallel to the dip of the mylonitized rocks.

A vertical branch of the Honey Hill fault, here called the Middle Road fault, crosses the southern border of the quadrangle along and fault of the Middle Road fault, and the minimum age of the Putnam gneiss are nearly parallel to the dip of the Middle are new metamorphic minerals are nearly parallel to the dip of the Norwich quadrangle at the north determination on monazite from a small pegmatitic lens in sillimanite sugratures from a small pegmatitic lens in sillimanite singratures from a small pegmatitic lens in sillimanite sugratures from a small pegmatitic lens in sillimanite sources from a small pegmatitic lens in sillimanite sugratures from a small Middle Road and extends slightly west of north across the Shetucket spinel are new metamorphic minerals not previously identified from this is 340 ± 40 million years. The new metamorphic minerals is 340 ± 40 million years. The new metamorphic minerals is 340 ± 40 million years. west of north across the Shetucket
River and joins the Honey Hill fault
River and River to the south in the Uncasville quadas well as previously reported and
by T. W. Stern (written communication of the State of Connectrangle. The Middle Road fault is new occurrences of cordierite, are tion) and is based partly on lead rounding calc-silicate rock, is either icut: New Haven, Conn., Osborn marked by a well-exposed zone as shown on the geologic map. Hyper- determinations by H. J. Rose, Jr., and the same age as the Hebron formation for the same age as the same age as the Hebron formation for the same age as the much as one-tenth of a mile wide of sthene, either pleochroic or non- H. W. Worthing. The monazite tion or much older, depending upon mylonite gneiss and mylonitic breccia pleochroic, is found in rocks mapped forms as much as 5 percent of the mylonite gneiss and mylonitic breccia pleochroic, is found in rocks mapped with ultramylonite in the interstices.

as biotite gneiss, amphibolite, or rock and occurs as unaltered orange as unaltered orange of flow) or remobilized basement. The Within this north-northwest-trend- graphite schist. Cordierite is always euhedral crystals as much as 5 mm ing zone the mylonitic foliation strikes north to slightly east of north

found in sillimanite-pinite schist.

Kyanite is found in sillimanite-pinite pinitized sillimanite, partly albitized pinitized sillimanite, partly albitized suggesting that relative horizontal schist, graphite schist, or biotite and sericitized oligoclase-andesine, with the series of granites in Rhode movement along the zone was east side north. The abrupt termination side north. The abrupt termination side north. The abrupt termination side north and the big side north are side north. The abrupt termination side north are side north as a seric size of the big side north are side north. The abrupt termination side north are side north as a seric size of the side of the sid of the highest grade metamorphic rangle but it does occur as a minor exsolution intergrowth of magnetite, monzonite has been correlated with rocks on the east against the Middle constituent in biotite gneiss oneilmenite and rutile, apatite, pyrite, the Sterling granite gneiss which is Road fault suggests that relative vertical movement along the fault intersection of Brickyard Road and intersection of Br wertear invertear along the fault zone was east side up. Following mylonitization, the fault zone rocks monazite crystals are uniform yellowish-green in thin section and yellowish-green in thin section and section and section and yellowish-green in thin section and in the Norwich quadrangle the were intensively altered to chlorite

Spinel is found in sillimanite-pinite
were intensively altered to chlorite

Spinel is found in sillimanite-pinite
show no trace of internal zones or
quartz monzonite gneiss and the

Perry, J. H., and Emerson, B. K., and sericite, and some carbonate schist, biotite gneiss, or amphibolite. growth layers. They probably Putnam gneiss are separated by the 1903, The geology of Worcester, was introduced. In this respect the

The mineral assemblages occurring formed during the main dynamo
Honey Hill fault. The quartz mon
Massachusetts: Worcester Nat. rocks of the Middle Road fault zone with these new index minerals seem thermal metamorphism but may zonite gneiss south of the Honey Hill differ from the blastomylonites and to be thermodynamically stable.

to be thermodynamically stable.

have crystallized during the late fault is probably a magmatic rock

Hamilton Press, 166 p. mylonite gneisses of the main

Such evidence supports the idea of alteration, though the latter poswhich was intruded just before or Quinn, A. W., 1951, Bedrock geology Honey Hill fault zone. Perhaps the chemical equilibrium implicit in the sibility seems extremely unlikely.

Sibility seems extremely unlikely.

Sibility seems extremely unlikely. mylonites of the Middle Road fault recognition of isograds. All the mylonites of the Middle Road fault recognition of isograds. All the recognition of isograds. They certainly postdate the original ment on the Honey Hill fault Rhode Island: U.S. Geol. Survey zone were thoroughly altered because minerals are stable in the assemdeposition of the Putnam gneiss deposition of the Putnam gneiss (Richard Goldsmith, oral communitheir nearly vertical orientation blages in which they occur as far as which is pre-Middle Silurian of the which is pre-Middle Silurian of the Quinn, A. W., Jaffe, H. W., Smith, cation). The small bodies of muspermitted easy access for altering one can discern with standard petromone can discern with standard petro assemblages themselves contain a METAMORPHISM minimum number of constituents

Three recognizable periods of none of which are chemically incommetamorphism have affected the patible with each other, as predictrocks in the Norwich quadrangle. able from the mineralogical phase During the first, a regional dynamo
Tule. One exception to this, the

Lambert, and York (1959, p. 212) cite

pegmatites contain sillimanite;

Manual of the geology of Conthermal metamorphism, all primary occurrence of kyanite with sillimanstructures were obliterated and the structures were obliterated as rocks were recrystallized under conage. In any event, this lead-alpha al mandine amphibolite facies to those of the hornblende granulite subfacion of the hornblende granulite sub subfacies of the granulite facies to occur with spinel. In addition, the Pennsylvanian period. at this time. After the thermal peak, blende and pyrrhotite, less commonly 1949, p. 73), or "Precambrian(?)" and became gradually more localized never with quartz or potassium feld-correlation with the Precambrian(?) ing where the rocks were recrystalalways found with quartz, plagiowhich is a correlation based only lized in the quartz-albite-epidotebiotite subfacies of the greenschist potassium feldspar and garnet, and and not upon distinctive stratigraphlocally with graphite, diopside, or ic units or sequences. The correlahornblende. Kyanite is always found tion is across the regional strike and with quartz, plagioclase, biotite, and probably across a major thrust fault garnet, commonly with potassium (Lundgren, Goldsmith, and Snyder, feldspar, muscovite, sillimanite, and 1958). Moreover, although the best magnetite, locally with graphite, modern estimate of the age of the never with amphibole or pyroxene. Blackstone series is Precambrian(?), Cordierite is always found with all that is really known is that it is and sillimanite, commonly with Pennsylvanian and may be Devonian specular hematite, never with communication, Jan. 12, 1959).

It forms as much as 5 percent of the Putnam gneiss "possibly of Carbon-Putnam gneiss in one 50-ft ledge iferous age." This is incompatible 700 ft due west of the "I" of with the new metamorphic monazite Regional dynamothermal meta- "Brickyard road." Cordierite local- age. The designations of Precammorphism increased in intensity from ities shown on the geologic map brian age restrict the Putnam gneiss Boucot, A. J., and Thompson, J. B., northwest to southeast in the include those previously reported to an age more ancient than is Jr., 1958, Late Lower Silurian Norwich quadrangle. Four Barrovian from the railroad cut east of the necessary in the present state of fossils from sillimanite zone near and the associated metamorphic metamorphic zones (Barrow, 1893) dam on the Quinebaug River east of knowledge. are delineated on the map by three Taft Station (Shepard, 1837A, p. 139; The age of the metasedimentary Science, v. 128, no. 3320, p. 362-363. phases of the Putnam gneiss as they calcic oligoclase, sillimanite, biotite, occur in or near rocks of the biotite occur in or near rocks of the b are mapped reflect the observed garnet, and smaller amounts of varietions in mineral composition:

are mapped reflect the observed garnet, and smaller amounts of mineral composition:

on the first appearance of critical general composition:

on the first appearance of critical general composition:

on the first appearance of critical general composition:

on the first appearance of the Putnam gneiss.

Cochrane, Hattle E., 1896, Rocks and minerals of Connecticut, in Report general composition. this foliation. Rocks of the lenses minor folds are present in nearly minerals in pelitic rocks. These iso- p. 83). Deep-green spinel is nearly Pennsylvanian and Silurian and of the Board of Education of the variations in mineral composition; graphite, potassium feldspar and this foliation. Rocks of the lenses graphite, potassium feldspar and always in contact with magnetite, can be distinguished in hand specified (pyrite and pyrrhotite?)

The boundaries between these phases of the boundaries between these phases or implied previously from regional cut: New Haven, Hamlen, 188 p. the boundaries between these phases are interpreted as lithofacies are nonpleochroic a manite, sillimanite and potassium ded in garnet. It probably formed in correlations; no fossils have been (one locality), apatite, sphene, rutile, dorite-bytownite, quartz, and calcite

(one locality), apatite, sphene, rutile, dorite-bytownite, quartz, and calcite

(one locality), apatite, sphene, rutile, dorite-bytownite, quartz, and calcite

(one locality), apatite, sphene, rutile, dorite-bytownite, quartz, and calcite

(one locality), apatite, sphene, rutile, dorite-bytownite, quartz, and calcite

(one locality), apatite, sphene, rutile, dorite-bytownite, quartz, and calcite

(one locality), apatite, sphene, rutile, dorite-bytownite, quartz, and calcite

(one locality), apatite, sphene, rutile, dorite-bytownite, quartz, and calcite by sedimentary deposition.

Biotite-muscovite schist.—The most abundant rock in the coarse-grained, strongly foliated rock containing porphyroblasts of obligation and large glistening porphyroblasts of muscovite schist in the biotite-muscovite schist in the policitie.

Major minerals of rocks of the muscovite schist in the biotite-muscovite schist in the policitie.

In the dictite diction is in the biotite-muscovite schist in the policitie.

A syntic equartz, and calcite which occur in widely varied proportions. The mafic mineral content, which occur in widely varied proportions. The mafic mineral content, which occur in widely varied proportions. The mafic mineral content, which occur in widely varied proportions. The mafic mineral content, should be placed in the northwestern corner of the map (in the Canter bury gness and parallel to its content of the muscovite schist in the biotite-muscovite schist in the biotite-muscovite schist in the biotite-muscovite schist in the proportion and is greater than in groups. All muspers in the diction is in the biotite muscovite schist in the proportions in the proportion of the muscovite schist in the proportion of the case for a Pennsylvanian age of the case for a Pennsylvanian age of the fast of the muscovite schist in the proportion of the muscovite schist in the proportion of the muscovite schist in the proporti this area is overturned. Folds of of the northwesternmost zones Shepard (1837A, p. 66; 1837B, p. 163); Kemp, 1887, p. 75-76; Perry and U.S. Geol. Survey Bull. 597, 289 p. rence: Connecticut Geol. Nat. places them in the almandine amlater writers largely repeat Shepard's

Emerson, 1903, p. 18). The PennsylFaul, Henry, 1959, Doubts of the

History Survey Bull. 77, 133 p. phibolite facies; the southeasternphibolite facies; the southeasternphibolite facies; the southeasternphibolite facies; the southeasternaccount, apparently without having

Vanian age of the rocks in the
Paleozoic time scale: Geophys.

Thompson, J. B., Jr., 1956, Skitchemost zone lies in the granulite facies.

account, apparently without having seen corundum themselves. And aluse seen corundum themselves. And aluse in Emercon Research Jour., v. 64, no. 8, p. 1102.

Thompson, J. B., Jr., 1950, Skitche-way and the White (1912) in Emercon way nappe, a major recumbent The staurolite zone may be represite is reported from the town of firmed by White (1912; in Emerson, sented in the northwestern corner of Norwich (Sohon, 1951, p. 26); per- 1917, p. 63-64) and has been accepted Fenneman, N. M., 1938, Physiography fold in the area near Claremont, the quadrangle by fine-grained calhaps the optically similar kyanite or by Emerson (1917, pl. 10, p. 76-78), of eastern United States: New New Hampshire[abs.]: Geol. Soc. cite-biotite schist (of the same nonpleochroic hypersthene were Jahns (1941, p. 1910-11), and Hansen York, McGraw-Hill, 714 p.

America Bull., v. 67, no. 12, pt. 2, staurolite 1 mile west of the north- LATE DYNAMIC METAMORPHISM that includes some that certainly Geol. Nat. History Survey Bull. R. J., 1955, A"-K" dating: Geo-

Specular hematite is a local accesthose indicated for the original dyand Thompson, 1958), and the rocks sory in rocks of this grade, but not namothermal metamorphism. Schist- at these fossil localities are believed Silurian and Devonian age for the Middle Haddam rocks is consistent direction of regional transport manite-biotite schist, biotite gneiss, slightly and some greatly, as for

phism, and agrees with the later or without garnet. The zone is and those mylonites in the Middle pre-Permian of the time scales of crops are near the fault in this area kyanite localities, 6 in this zone; and to green biotite, chlorite, and serischistosity is warped into parallelism with the fault, which strikes and 56 of 74 localities of accessory specular hematite are in this zone, northwest and dips gently northeast. as well as most red biotite and tine, magnetite, and several unknown ing to the Littleton formation of the Stonington region, Connecti-The rocks are much finer grained accessory rutile (all of these localisotropic substances. The abundant Early Devonian age of Massachu-cut: Connecticut Geol. Nat. Histhan the normal Putnam gneiss and ities are within the sillimanite plus pinite is probably largely a potas
setts, and New Hampshire; similarly tory Survey Bull. 33, 70 p. their texture ranges from catatheir texture ranges from cataclastic to blastomylonitic. Most of (1950, 1958) found neither cordierite (1950, 1958) found neither cordier the blastomlyonites are very finethe blastomlyoni grained biotite gneiss without any

the Jewett City quadrangle to the greater Devonian when correlated to the Jr., 36 p. this anomaly it is apparent that

staurolite-quartz subfacies (?) of the

Hypersthene, cordierite, and

determination indicates that the

REFERENCES CITED Baadsgaard, Haefdon, Nier, A.O.C., hypersthene is usually found with The Putnam gneiss has previously Geophys. Union Trans., v. 38, Verhoogen, 1958, p. 217-235). Numer-plagioclase, never with muscovite or been called "Cambrian or older" no. 3, p. 385-386. sillimanite. Hypersthene in amphib- (Hawkins, 1918, p. 446), "Precam- Barrow, George, 1893, On an intruolite is always found with horn- brian" (Martin, 1925, p. 46; Foye, sion of muscovite-biotite-gneiss in the southeastern Highlands of dynamic metamorphism continued with diopside, biotite, and garnet, (Perhac, 1951, p. 1470; 1958, p. 26) by Scotland, and its accompanying metamorphism: Jour. Geol. Soc. and became gradually more localized along certain zones of active faultspar. Hypersthene in other rocks is spar. Hypersthene rocks is sp Billings, M. P., 1956, The geology of Bull. 84, 64 p. Devel. Comm., 203 p. MacDonald, G. J. F., and Milton, pt. 2, p. 1823. pt. 2, p. 1397-1398. quartz, plagioclase, biotite, garnet a considerable time earlier than the Boucot, A. J., MacDonald, G. J. F., Milton, Charles, and Thompson, potassium feldspar, magnetite, and (Prof. Alonzo W. Quinn, written J. B., Jr., 1958, Metamorphosed middle Paleozoic fossils from muscovite, amphibole, or pyroxene. Loughlin (1910, p. 448) called the Vermont, and western New Hampshire: Geol. Soc. America Bull.. v. 69, no. 7, p. 855-870.

(1956, pl. 1, p. 20) for a wide zone of Foye, W. G., 1949, The geology of p. 1826-1827. schists in central Massachusetts eastern Connecticut: Connecticut Wasserburg, G. J., and Hayden, The pelitic rocks of the kyanite after the thermal peak as shown by formation of the Norwich quad- Fyfe, W.S., Turner, F.J., and Ver- v.7, nos. 1-2, p. 51-60.

of the small folds suggest that there ite zone are biotite-muscovite schist isolated outcrops of mylonite are with the Worcester formation at the 1907, Preliminary geological map are no large folds. The folds are with biotite always dominant over mapped within the Putnam gneiss, Worcester coal mine. If the Wor- of Connecticut: Connecticut Geol. about evenly divided between sinis- muscovite; sillimanite in these rocks especially in the southern third of cester forms are truly fossils and if Nat. History Survey Bull. 7, 39 p. tral and dextral. When interpreted never occurs in the same thin section the quadrangle. They are not they really date the Worcester foras drag along limbs of major folds, with potassium feldspar. Calc- restricted to any one type of rock mation, then Pennsylvanian rocks mineral resources of the Hudson about half indicate that the beds are silicate rocks of the sillimanite zone within the Putnam gneiss, and they crop out in Connecticut at least as and Maynard quadrangles, Masoverturned and half indicate that are coarse-grained actinolite-alumiare not connected. The mylonitic far south as the Honey Hill fault. sachusetts: U.S. Geol. Survey Bull. types are evenly scattered over the diopside. crops is always parallel to the also possible for the Hebron forma-Pelitic rocks of the zone of sillischistosity of the surrounding tion by correlation with rocks 20 geology of Rhode Island: Am. Jour. In addition to small folds, moder- manite and potassium feldspar are schists. Sclar (1958, p. 64-66) has miles to the west which have themfolds of the schistosity with wave- gneiss, or graphite-sillimanite schist, similar isolated outcrop of mylonite localities many miles to the north. Heermance, E. L., 1935, The Conlengths of about one-fourth mile with or without garnet and without from a roadcut on Highway 12 just Recent finds and reexaminations of necticut guide: Hartford, Conn., and amplitudes of several hundred much muscovite. Potassium feldspar east of the eastern border of the fossils show that many rocks of Emergency Relief Comm., 320 p. feet are present in several areas, has been observed locally with silliNorwich quadrangle. Blastomylonnorthern Massachusetts, southern

Jahns, R. H., 1941, Stratigraphy of the Lowell-Fitchburg area, Massachusetts [abs.]: Geol. Soc. America Bull., v. 52; no. 12, pt. 2, Kemp, J. F., 1887, Notes on fossil plants from near Worcester [abs.]: New York Acad. Sci. Trans., ser. 1,

scale [abs.]: Geol Soc. America map explanation), plunges gently to the southwest or south generally grade than the sillimanite and LATE ALTERATION and Thompson, 1958; Rodgers, Gates, Bull., v. 70, no. 12, pt. 2, p. 1634. Long, L. E., Kulp, J. L., and Eckelmann, F. D., 1959, Chronology of major metamorphic events in the Jour. Sci., v. 257, no. 8, p. 585-603. direction of transport on the Honey defined by 7 cordierite and 10 hyperRoad fault zone. Most rocks contain

Faul, Long, and Kulp) obtained on Loughlin, G. F., 1910, Intrusive sthene localities, which are plotted less than 5 percent of late alteration numerous radioactive minerals from granites and associated metathe Middletown pegmatite district morphic sediments in south-The Honey Hill fault (Lundgren, phic minerals are preferentially coning schists have an average of more

(Rodgers, 1952, p. 414-15; Wasserwestern Rhode Island: Am. Jour. Goldsmith, and Snyder, 1958)

Goldsmith, and Snyder, 1958)

Goldsmith, and Snyder, 1958)

Goldsmith, and Snyder, 1958, centrated in this zone, including separating the Putnam gneiss from the quartz monzonite gneiss to the manite and potassium feldspar zone (See profiles of total alteration along cross section lines.) The most commandate the guards of the putnam gneiss from manite and potassium feldspar zone (See profiles of total alteration along cross section lines.) The most commandate the putnam gneiss from manite and potassium feldspar zone (See profiles of total alteration along cross section lines.) The most commandate the putnam gneiss from the putnam gneiss from the quartz monzonite gneiss to the manite and potassium feldspar zone (See profiles of total alteration along cross section lines.) The most commandate the putnam gneiss from the quartz monzonite gneiss to the manite and potassium feldspar zone (See profiles of total alteration along cross section lines.) The most commandate the putnam gneiss from the quartz monzonite gneiss to the manite and potassium feldspar zone (See profiles of total alteration along cross section lines.) The most commandate the putnament of the putnament o south crosses the extreme southwest but are more abundant in the hyper- mon reactions altered sillimanite section at Middle Haddam is similar associated rocks at Preston, Concorner of the quadrangle. No outsthe sthene or cordierite zone. Seven to pinite, biotite to chlorite, garnet to that of the Scotland schist of necticut: U. S. Geol. Survey Bull. but moderately northeastward- 18 spinel localities, 16 in this zone; cite, and plagioclase to albite and quadrangle, and John Rosenfeld Lundgren, Lawrence, Jr., Goldsmith, dipping mylonitized rocks crop out are plotted on the map. In addition, sericite. Other alteration minerals (written communication, Sept. 23, Richard, and Snyder, G. L., 1958, near Highway 32 where it leaves the southern margin of the quadrangle.

38 of 52 localities where both sillimanite and potassium feldspar were southern margin of the quadrangle.

38 of 52 localities where both sillimanite and potassium feldspar were ene, sphene, blue-green or colorless of the quadrangle. Here the regional attitude of the observed in the same thin section, amphibole, talc, pickeringite, kaolin-ative. Gregory's Scotland schist is

America Bull., v. 69, no. 12, pt. 2,

> west, and Pennsylvanian when cor- Mayne, K. I., Lambert, R. St. J., and related to the north. In the face of York, Donald, 1959, The geological Perhac, R. M., 1951, Origin of the porphyritic phase of the Sterling America Bull., v. 62, no. 12, pt. 2, ____1958, Petrogenesis of the

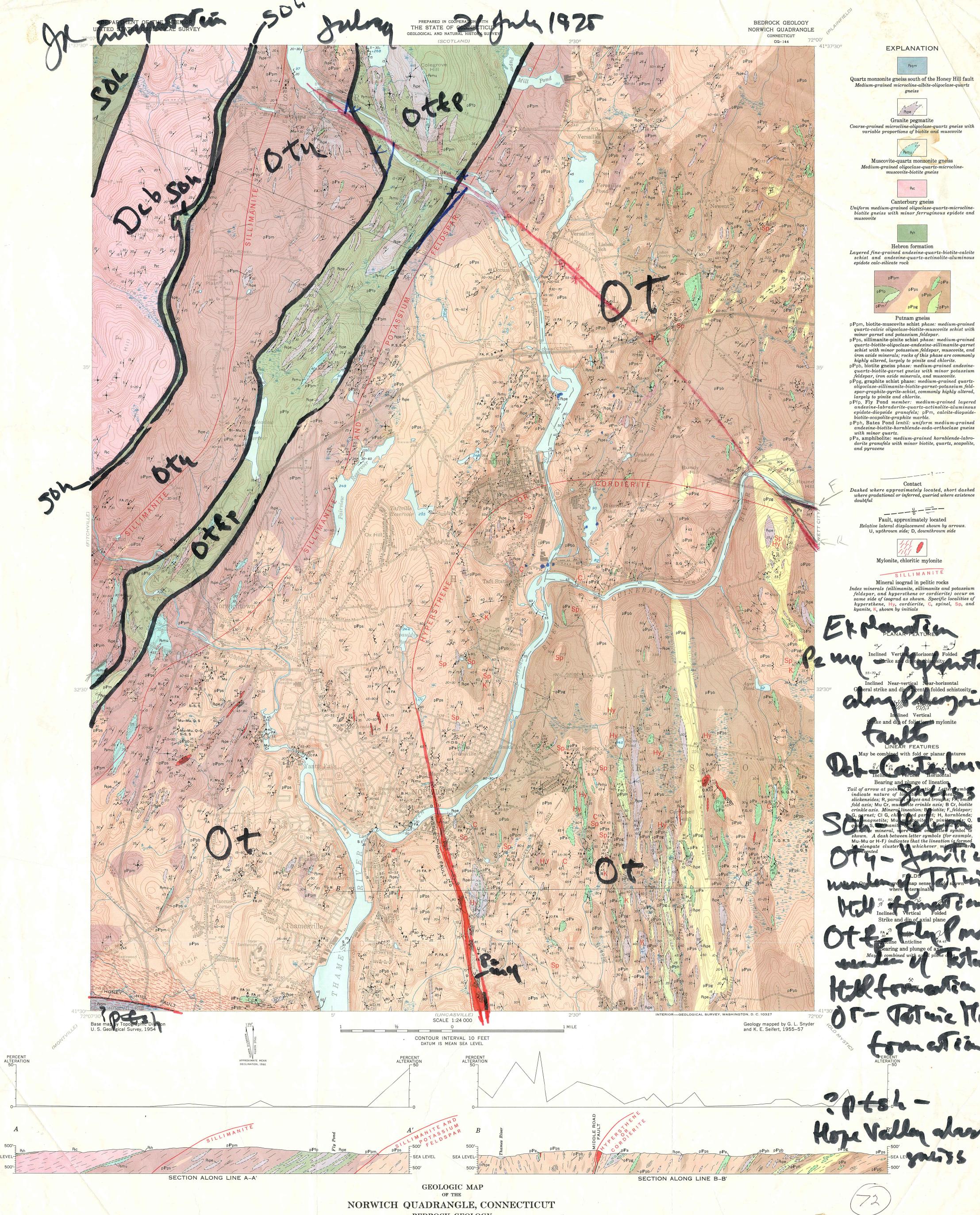
Connecticut Geol. Nat. History Survey Bull. 89, 32 p. Perry, J. H., 1885, Note on a fossil deposit in mica schist at Worvanian of several corrected time pegmatite north of the Honey Hill Lead-alpha ages of Rhode Island scales (Faul, 1959; Long, Kulp and fault were probably formed in place granitic rocks compared to their Eckelmann, 1959, p. 596; Kulp, 1959; or intruded over a considerable time geologic ages: Am. Jour. Sci., tion, Jan. 15, 1960). However, Mayne, mothermal metamorphism. Some Rice, W. N., and Gregory, H. E., 1906,

> Appalachian region: Am. Jour. Sci., v. 250, no. 6, p. 411-427. and Goldich, S. S., 1957, Investiga-Rodgers, John, Gates, R. M., tions in A⁴⁰-K⁴⁰ dating [abs.]: Am. Cameron, E. N., and Ross, R. J., map of Connecticut: Connecticut Geol. Nat. History Survey Bull. 84. Rosenfeld, J. L., 1959, Explanatory text for preliminary geological necticut Geol. Nat. History Survey New Hampshire, Pt. 2—bedrock Rosenfeld, J. L., and Eaton, G. P. geology: Concord, N. H., New 1956, Metamorphic geology of the Hampshire State Planning and Middle Haddam area, Connecticut: a progress report [abs.]: Geol Boucot, A. J., Harner, R. S. Soc. America Bull., v. 67, no. 12,

Charles, 1953, Age of the Ber-Sanford, Samuel, and Stone, R. W., nardston formation [abs.]: Geol. 1914, Useful minerals of the Soc. America Bull., v. 64, no. 12, United States: U. S. Geol. Survey Schairer, J. F., 1931, The minerals of Connecticut: Connecticut Geol. Nat. History Survey Bull. 51, 121 p. central Massachusetts, eastern Sclar, C. B., 1950, Time relation of magmatic intrusion to polymetamorphism at Preston, Connecticu [abs.]: Geol. Soc. America Bull., v. 61 no. 12, pt. 2, p. 1573. _____1958, The Preston gabbro gneisses, New London County, Connecticut: Connecticut Geol Shepard, C. U., 1837A, A report on

chimica et Cosmochimica Acta,

Kulp, J. L., 1959, Geological time Voluntown and Oneco quadrangles:



BEDROCK GEOLOGY George L. Snyder