Hampden 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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Middle ORDOVICIAN

CORRELATION OF MAP UNITS

DESCRIPTION OF MAP UNITS

1:30 in exposures west of Stoney Hill Road School

brown-weathering, thin-bedded, medium- to coarse-grained arko-

sic sandstone; minor siltstone and shale. Subordinate lenses of

conglomerate 0.5-1.0 m thick in exposures southeast of Wilbraham

near eastern border of unit. Most conglomerate clasts are pebbles

or cobbles of pegmatite (Pzp below) or Glastonbury Gneiss (DOg

below). Ratio of conglomerate to sandstone + siltstone + shale

typically greater than 1:3 in exposures east of Wilbraham, less than

weakly foliated to unfoliated sills, dikes, and irregularly shaped

bodies consisting of quartz and feldspars with accessory musco-

vite, black tourmaline, sulfides, garnet, apatite, and rare beryl.

Pegmatite bodies within Glastonbury Gneiss chiefly unfoliated.

Locally they contain pink feldspar and smoky quartz crystals as

large as 16-25 cm in longest dimension. Larger semidiscordant

bodies of pegmatite in the Erving Formation and the Ammo-

noosuc Volcanics have marginal zones 1-30 m wide that contain

schistose septa of country rock. Many small pegmatite bodies,

chiefly sills 5 cm-8 m wide, are present in crystalline rocks of the

LASTONBURY GNEISS (MIDDLE DEVONIAN TO MIDDLE OR-

DOVICIAN)—Medium- to coarse-grained, weakly to strongly

foliated, homogenous plagioclase-quartz-biotite-(epidote) gneiss

with accessory muscovite potassium feldspar hornblende and

garnet. Gneiss is typically well lineated with paper-thin patches

of biotite and epidote strung out on foliation surfaces in bands

0.5-1 cm wide. Color index typically 15 or less. Many outcrops

contain one or more schlieren of fine-grained quartz-plagioclase

gneiss rich in biotite or hornblende, or semiconcordant inclusions

of fine-grained hornblende-plagioclase amphibolite. Contains

abundant inclusions of aplite and layered fine-grained leucocratic

AREA)1—Generally rusty, dark-yellowish-orange-weathering,

fine- to coarse-grained quartz-plagioclase-muscovite-biotite schist

with accessory garnet, potassium feldspar, kyanite, chlorite, graph-

ite, and sulfide. Rusty schist is interlayered with subordinate me-

dium-grained, dark-yellowish-orange- and dark-greenish-gray-

weathering rocks that are: (1) calc-silicate-bearing marbles and (2)

d opside-(hornblende)-quartz-plagioclase-biotite-(garnet) granofels

be, in beds 10-50 cm thick, make up about 5 percent of the unit in

percent) gray-weathering schist and granofels indistinguishable

from schist and granofels of the Erving Formation described below

Generally gray-weathering biotite granofels interlayered locally with

more abundant gray- and brownish-gray-weathering muscovite-

biotite schist—Very minor amounts of very light gray quartz pla-

gioclase-hornblende-garnet-sphene granofels and hornblende-pla-

gioclase amphibolite. Biotite granofels is thinly to thickly parted

and medium grained with mineral percentages as follows: quartz

(30-50), plagioclase (20-45), biotite (20-30), garnet (1-3), and mus-

covite (1). Schist is medium- to coarse-grained, well-foliated, and

consists of quartz (30-45), plagioclase (2-40), muscovite (15-35),

biotite (5-20), garnet (1-3), and kyanite (3) with accessory potas-

Thinly to thickly parted, medium- to coarse-grained hornblende-

plagioclase amphibolite—Amphibolite contains minor amounts of

epidote, sphene, and chlorite. Unit locally encloses minor thin

layers of pink garnet-quartz rock (coticule) and plagioclase-quartz-

Generally hornblende-plagioclase amphibolite—Interlayered locally

with more abundant rusty-weathering quartz-plagioclase-biotite

gneiss and plagioclase-quartz gneisses containing variable amounts

thinly layered quartzite and quartz-muscovite gneiss. A band of

of amphibolite of the Erving Formation on the hill west and north-

west of Worthington Pond, near the southern border of the Hamp-

den quadrangle. Unit is exposed discontinuously for a distance

of 100 m, in a band about 10 m wide, on the southwest slope of

Mt. Marcy in the adjacent Ludlow 7½-minute quadrangle (Leo

Rusty-weathering quartz-plagioclase-muscovite-biotite-(kyanite)-

(garnet) schist interlayered with subordinate but appreciable

quartz-feldspar-biotite-(hornblende)-(garnet) gneiss (30 percent)

hornblende-plagioclase amphibolite (20 percent), and local quartz-

garnet granofels. Schist weathers light brown and rusty moderate

reddish brown, is medium to coarse grained, and well foliated, and

contains accessory apatite, graphite, sulfide, and retrograde chlorite.

Gneiss is medium grained, light to medium gray, and rusty weather-

Generally thinly layered, fine- to medium-grained hornblende-pla-

gioclase amphibolite interlayered with subordinate medium- to

dark-gray-weathering, locally rusty-red-orange-weathering quartz-

plagioclase-hornblende-biotite-garnet gneiss and hornblende-pla-

gioclase-epidote amphibolite — Most gneiss is strongly foliated

and thinly to thickly layered. Unit includes minor coarse-grained,

thickly parted hornblende-plagioclase amphibolite with coarse

(Lem long) hornblende laths in clots 3-4 cm in diameter. Rocks

forming inclusions in Glastonbury Gneiss across west slope of The

Finnacle are well foliated, thinly to thickly layered, dark-gray

plagioclase-quartz-hornblende-(biotite)-(garnet) gneiss and amphi-

bolite. This inclusion also contains appreciable plagioclase-quartz-

Thinly layered, medium-grained, slabby hornblende-plagioclase-epi-

Light- to medium-gray plagioclase-quartz-hornblende-garnet-(biotite

gneiss—Gneiss is strongly foliated, weakly banded, and parted

n, where gneiss having color index of over 25 grades by inter-

ornblende) gneiss interlayered with subordinate hornblende-

plagioclase amphibolite — Gneiss typically consists of layers 1-5

dm thick, richer and poorer in biotite and (or) hornblende. Unit

not exposed in Hampden quadrangle but is exposed in a wide band

Dark-gray, coarse-grained hornblende-plagioclase-epidote-quartz

amphibolite—Chiefly a weakly-foliated to massive rock in which

snall (3×6 mm) white ellipses of altered, fine-grained, anhedral

plagioclase and epidote are set in a groundmass of coarse dark-

green hornblende. Locally encloses patches of actinolite-tremolite

rock and shows sharp contacts with layered amphibolite. Unit

appears only as inclusions in Glastonbury Gneiss in Hampden

quadrangle, but similar massive amphibolite occurs with Ammoposuc rocks on Soapstone Hill in the adjacent Ellington quadrangle

and east of Kemp Road in the adjacent Monson quadrangle, where

ops indicated by ruled pattern. Solid area shows outcrop visited

n field. Many small outcrops shown only by structure symbol

Bedrock outcrops—Areas of thin surficial cover and abundant out-

the massive rock forms probable sills or flows

¹Considered Upper Silurian also elsewhere

SEA LEVEL

Light-colored, medium- to coarse-grained quartz-plagioclase-biotite-

hiotite-(garnet) gneiss north of The Pinnacle

Layers of pink garnet-quartz rock (coticule)

ledding into amphibolite of unit Oaa

in the adjacent Ludlow quadrangle

irg, and forms thinly to thickly parted, slabby layers

AMMONOOSUC VOLCANICS (MIDDLE ORDOVICIAN)

PARTRIDGE FORMATION (UPPER MIDDLE ORDOVICIAN)—

quartzite Sc is discontinuously exposed and is mapped at the base

exposures in the Hampden quadrangle. Unit contains minor (15

with accessory sphene, epidote, and graphite. Granofels and mar-

WAITS RIVER FORMATION (LOWER DEVONIAN IN THIS

quadrangle but are not mapped for reasons of scale

gneiss in sill across west slope of Pine Mountain

ERVING FORMATION (LOWER DEVONIAN)

biotite-hornblende-epidote gneiss

of hornblende, biotite, and garnet

and others, 1977)

PEGMATITE (POST-LOWER DEVONIAN)—White to light-gray,

Middle Devonian to Middle Irdovician

cover, underlain by sparsely exposed sedimentary rocks of Jurassic age. The eastern half of the quadrangle is part of an upland, an area of greater local relief (200 m), underlain by metamorphosed lower and middle Paleozoic sedimentary and volcanic rocks and lower(?) to middle Paleozoic igneous rocks. The layered crystalline rocks are well exposed in a 3 km-wide belt of numerous north-trending hogbacks that include Minnechoag Mountain and the Wilbraham Mountains. Surficial cover is thin to absent in this belt. General features of the bedrock geology were shown on small scale maps by Emerson (1917). Modern detailed mapping and geologic studies (Robinson, 1967, Peper, 1966, Herz, 1955, Aitken, 1955, Snyder, 1970, and Collins, 1954) have enhanced geologic understanding of the quadrangle and

BEDROCK UNITS The crystalline rocks in the Hampden quadrangle lie along the western edge of the Bronson Hill anticlinorium (Billings, 1956; Rodgers, 1971), a series of en-echelon gneiss domes mantled by lower to middle Paleozoic strata, that extends from northern New Hampshire to Long Island Sound. A recent composite stratigraphic column for rocks along the Bronson Hill anticlinorium in central Massachusetts and southern New Hampshire is discussed in a summary paper by Thompson and others (1968, p. 205-207). The eastern border of the quadrangle lies approximately along the axis of the Glastonbury dome, an elongate anticline with a core of granitic gneiss (Glastonbury Gneiss, Herz, 1955) that extends from southern Massachusetts southward to the vicinity of Middle Haddam, Connecticut. Five formations of metamorphosed layered rocks are recognized as forming a west-dipping homoclinal sequence on the west limb of the dome. These include: the Ammonoosuc Volcanics, the Partridge Formation, the Clough Quartzite, the Erving Formation, and the Waits River Formation. All have type localities outside the quadrangle in central western New Hampshire, southeastern Vermont, or north central Massachusetts. Paleontologic and radiometric age determination data are lacking in the quadrangle. With the exception of the amphibolite unit of the Ammonoosuc Volcanics (unit Oaa), which is possibly continuous around the north end of the Glastonbury dome (D. J. Hall, Univ. of Mass., oral comm., 1972) and onto the west limb of the Great Hill syncline in the Palmer and Monson quadrangles (Peper, 1966), none of the layered rock units can be traced north of the southern part of the Ludlow quadrangle. Rocks are assigned to a particular formation on the basis of lithologic

similarity and relative position in the stratigraphic succession. The unmetamorphosed sedimentary rocks in the Hampden quadrangle are here assigned to the Portland Formation (Krynine, 1950). They lie east of (structurally and stratigraphically above) the Hampden Basalt, a lava flow and key time-stratigraphic marker unit in the Newark Group of Connecticut and southern Massachusetts. These rocks, earlier considered to be Triassic, are now considered to be Jurassic in age (Cornet and others 1973). Earlier named units shown on Emerson's (1917) smaller-scale map (Mount Toby Conglomerate, Longmeadow Sandstone, and Chicopee Shale) are now abandoned (this report; Hartshorn and Koteff, 1967); they are not time-stratigraphic units (Larsen, 1972) and cannot be adequately distinguished on the basis of the widely scattered exposures in the quadrangle. Available subsurface information is limited to water-well logs, some of which record the color of the bedrock, but contain no other physical In the Hampden quadrangle, the upper part of the Ammonoosuc Volcanics consists of thick units of amphibolite and subordinate gneiss of chiefly mafic to intermediate composition (unit Oaa, unit Oap): the lower part is thick lenses of gneiss chiefly of felsic and intermediate compositions (units Oag2, Oag1). The thinly layered rocks in these units probably are metamorphosed water-laid and waterworked tuffs and volcaniclastic debris; some of the weakly layered rocks may represent lava flows or hypabyssal sills. On the northeast side of Perkins Mountain, a three-meter-wide lens containing amphibolite blocks as much as 0.5 m across in a more felsic matrix of plagioclase-quartz-hornblende-biotite rock apparently represents original breccia or agglomerate, as does a similarly irregular-textured amphibolite on the south-facing slope east of Rattle-

Rocks in the lower felsic lenses (Oag2, Oag1) west of Glendale Church are the oldest rocks in the quadrangle and physically resemble parts of the Monson Gneiss which underlies the Ammonoosuc to the east along the Bronson Hill anticlinorium. These rocks assigned here to the Ammonoosuc, however, because they intertongue with the thick upper unit, Oaa, in the south-central part of the Ludlow quadrangle (Leo and others, 1977). South of Hampden, semiconcordant bodies of Glastonbury Gneiss have been emplaced in Ammonoosuc strata that are, southward, progressively higher in stratigraphic position. Lower parts of the thick upper unit (Oaa) are breached by a sill across Rattlesnake Hill and the western slope of Pine Mountain, and, west of Gillette Brook, this unit is locally breached entirely. To the east, Ammonoosuc rocks appear in partial stratigraphic disarray as mapped roof pendants and inclusions and many small unmapped (20 m and less) schistose screens, all enclosed by Glastonbury Gneiss. The inclusions typically underlie the highest elevations such as the ridges west of Culver and Goodwill Ponds, and the unnamed hill east of The Pinnacle. Most of the inclusions consist of amphibolite and thinly layered gneisses of intermediate composition. These are assignable on the basis of lithology to the lower part of the thick upper unit (Oaa) or the pod-bearing unit (Oap). The wedge-shaped inclusion mapped across the western slope of The Pinnacle (unit Oaa) contains appreci-

able felsic gneiss with hornblende and garnet, but it also contains amphibolite. The position of this wedge-shaped inclusion, relative to inclusions immediately to the east of it (unit Oaa, Oap), suggests that it is a lateral equivalent of the upper part of the more extensive band of Oaa on Perkins Mountain and has been simply shouldered aside. Massive amphibolite, along with minor layered amphibolite and gneiss, forms small inclusions in the Glastonbury east of Temple and Rockadundee Brooks and east-southeast of Culver Pond, near the eastern edge of the quadrangle. The massive amphibolite has a distinctive relict porphyritic texture suggestive of a flow or a sill. Euhedral crystals of plagioclase (6-8 mm), partly altered to epidote and overgrown by hornblende, are set in a matrix chiefly of hornblende, epidote, and quartz. The layered rocks in the inclusion most closely resemble Ammonoosuc rocks, and the inclusions are here

The Partridge Formation (Op) is represented by two thin discontinuous lenses lying above the Ammonoosuc and consisting of a northern lens, across the west slope of Mt. Vision, and a southern lens, west of Gillettes Brook. The northern lens contains chiefly amphibolite and quartz-plagioclase gneisses with subordinate rustyweathering pelitic schist. The southern lens contains chiefly rustyweathering sulfidic schist with minor thin (5 cm) beds of quartz-garnet rock (possible metamorphosed cherts).

mapped as an Ammonoosuc unit (Oama).

The Clough Quartzite (Sc) is mapped only on the hill west of Worthington Pond, in the southern part of the quadrangle, where it is sufficiently thick to delineate (see Description of map units). Relict bedding in the unit is structurally conformable with relict bedding in the underlying and overlying rocks. The patchy distribution of Clough rocks may be due either to concentration in lows along the pre-Clough erosion surface or, possibly, to erosion in post-Clough pre-Erving time. The latter alternative is suggested by an abrupt discordant termination of the upper part of a thin (4 m) lens of Clough Quartzite northeastward along strike by amphibolite of the overlying Erving Formation on the hill northwest of Worthington

The Erving Formation (Deg, Dea, Desa) is represented by a thick sequence of chiefly gray-weathering mica schist and biotite granofels (Deg), whose protoliths were metamorphosed sandy shales and feldspathic siltstones and sandstones. These rocks, lying above the Clough Quartzite and resting unconformably on the Ammonoosuc and Partridge, are assigned to the Erving Formation, because they more closely resemble the type Erving (Thompson and others, 1968) than they resemble the gray staurolite-garnet schist characteristic of the Littleton Formation as used by Thompson and others (1968), along the southern parts of the Bronson Hill anticlinorium. The Erving overlies the Littleton in the Orange area of northern Massachusetts (Robinson, 1967) and is post-Littleton (Early Devonian) and pre-Acadian in age. Two subunits consisting of layered amphibolite and other layered rocks are mapped within the sequence. The lower of these two, Desa,

appears in four discontinuous lenses at or near the base of the unit. The lenses consist of layered amphibolites and a variety of layered (quartz)-plagioclase-biotite-(hornblende)-(garnet)-gneisses. The gneisses are, in part, rusty weathering, and have a highly variable quartz content. The irregular distribution of the lenses near and at the unconformity at the base of the unit, as well as their mixed compositions, suggest they might represent volcaniclastic and sedimentary material reworked locally from highs on the pre-Erving terrane. The lenses Dea south of Stafford Road consist of layered amphibolite

and minor layered quartz-garnet rock (coticule). Thin (6 m) lenses of amphibolite (unmapped) occur in the schist north and south of the large pegmatite body northwest of Hampden. These are unlayered to weakly layered and coarse grained. They may represent sills or possible flows. The Waits River Formation (Dw) is a thick unit in which rustyweathering muscovite schist and subordinate, but thick (10-50 cm),

Ticks right of vertical line in meters.

Surficial deposits not shown

Dashed lines in metamor-

phosed layered rocks show

surface of relict bedding and

beds of marble and calc-silicate granofels are characteristic. Thes rocks are similar to rocks of the Waits River on the west side of the Connecticut Valley in the Whately area of Massachusetts (Peter Robinson, G. W. Leo, oral comm., 1972). Gray-weathering schist and granofels, similar or identical to Erving schist and granofels form subordinate lenses throughout the Waits River Formation o both quadrangles, and Waits River rocks intertongue southward with Erving rocks. The age of the Waits River Formation in these quadrangles is thus probably the age of the Erving Formation. The Glastonbury Gneiss (DOg) is a regionally foliated intrusive gneiss. The gneiss is texturally homogeneous in outcrop but varies in composition from outcrop to outcrop in the Hampden quadrangly from granite to granodiorite to quartz-rich quartz-diorite. The gneish forms generally smooth rounded outcrops with widely spaced joints and weak partings parallel to the strike of inclusions. Inclusions of probable Ammonoosuc rock, chiefly screens of schistose amphibolity with sharp boundaries, and schlieren of plagioclase-biotite-quart schist with indistinct boundaries, are found in about half of the Glaston bury outcrops. The inclusions and schlieren are abundant in the southern third of the quadrangle and north and west of Goodwill Pond Much of the local variation in the biotite content of the Glastonbur Gneiss in these areas might be ascribed to assimilation of Ammo-A Devonian (355 m.y.) whole-rock, rubidium-strontium age was obtained by Brookins and Hurley (1965) on gneiss from the souther end of the Glastonbury dome in the Glastonbury and Middle Haddan quadrangles, Connecticut. Based on a recent study of rocks in the northern and central parts of the dome, however. Leo (1974) has indicated that the origin of the gneiss in the dome is complex and ma involve more than one intrusion. The Glastonbury Gneiss in the Hampden quadrangle intrudes, and therefore must be younger than the Ammonoosuc Volcanics of probable Middle Ordovician age, but the Glastonbury is not known to intrude rocks of Silurian and Devonian age. The gneiss is regionally foliated, and if the last regional metamorphism is Acadian, it must be Acadian or older. Therefore the Glastonbury Gneiss in the Hampden quadrangle is considered to be Middle Ordovician to Middle Devonian. It should be noted that the radiometric date mentioned above requires late Acadian homegenization of strontium in, but not necessarily melting of, the Glastonbury (G. W. Leo, written comm. 1974). A post-Ammonoosu pre-Clough, primary magmatic age for the Glastonbury would be most consistent with its observed distribution and contact relationships. Pegmatites (Pzp) in large mapped bodies and small unmapped sills cut all crystalline units. Many of the larger bodies, such as that

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north of Goat Rock, warp or cut relict bedding and regional foliation

in adjacent wall rock and were emplaced later than the time of regional

Folds—Minor folds of two classes are distinguished on the basis of relationship to schistosity. These classes include (1) folds that fold bedding and have axial-plane schistosity that is the dominant regional schistosity, and (2) folds that fold schistosity. Folds of the first type are developed chiefly as tightly compressed asymmetric folds with steeply dipping axial surfaces. They tend to plunge at moderate angles, near the strike of regional schistosity, and show both dextral- and sinistral-movement sense. They formed probably during the Acadian orogeny.

Folds of the second type show a wider variet

retrograde alteration.

include tightly compressed asymmetric folds, open folds, and kink folds. Groups of northwest plunging folds of the second type are abundant in the southern part of the quadrangle, particularly in the Erving Formation in the Goat Rock area and on the west slope of Minnechoag Mountain. Open folds fold the axial plane schistosity of the first type on the north side of Scantic Road near Goat Rock. Asymmetri folds fold schistosity in the Glastonbury Gneiss and an enclosed screen of hornblende schist along both sides of Root Road, approximately 700 m/S 45° W. of Worthington Pond. The open dextral warping of schistosit and relict bedding that is displayed by mapped contacts (for example, Partridge-Erving contact in Mt. Vision area) was probably formed at the time of formation of the second type of folds. Northwest-plunging kink folds are most prominent on the west slope of Perkins Mountain, where they modify the west limb of a north-plunging syncline. The folds are similar in strike and magnitude of plunge to other folds of the second type, but they show a more brittle behavior of the rocks than do the other second-type folds. Kink folds have a spaced cleavage like the two small faults that cut the Erving Formation 1650 m N. 55° E of

North Somers. Like these small faults, and unlike the faults at the

crystalline rock border, the kink folds are not associated with extensive

Faults-Northwest-trending faults are mapped northeast an southwest of Mt. Vision, and a series of northeast- and northwest-trending faults are mapped near Perkins Mountain. The fault northeast of Mt. Vision is evidenced by a strong topographic lineament and local offsets of the trend of regional foliation where the fault crosses the ridge crest. Abundant closely spaced joints suggest that a smaller near-north-trending fault crosses the ridge north of the northwest-trending fault. The fault southwest of Mt. Vision follows the narrow gully occupied by West Brook. A pegmatite dike locally follows the fault trend. Movements along this fault probably continued after emplacement of the pegmatite, because gash veins filled with vuggy quartz cut the pegmatite. Schist is locally chloritized in fractures parallel to the fault zone in an outcrop 305 m S. 12° W. of the summit of Mt. Vision. The northwest-trending faults across Perkins Mountain follow topographic lineaments. The southernmost fault forms the southwest slope of the ridge southwest of Hurds Lake and occupies a narrow gully on the ridge west of Perkins Mountain. Ridge outcrops east of the fault are broken by northwest-trending, west-dipping joints, suggesting that the fault also dips west and transects the steeply eastward-dipping axial plane

cleavage of the abundant kink folds. A zone of intersecting faults extends from south to north through the center of the quadrangle and cuts both the crystalline and sedimentary rocks. Associated cataclased, retrograded, and mineralized rocks locally separate sedimentary rocks on the west from crystalline rocks on the east. Sedimentary rocks crop out near the zone of faulting only in the Wilbraham area; thus the location of many of the faults must be inferred on the basis of exposed silicified zones in crystalline rocks, rock color descriptions from water-well logs, likely extentions of faults cutting crystalline rocks, and local topographic expression. Southeast of Wilbraham, conglomerate and sandstone dip eastward

into the fault zone. Dark-gray mylonite is exposed continuously for an east-west distance of 120 m in the unnamed brooks south of Woodland Dell Cemetery. The mylonite probably does not extend far north of the cemetery, because fractured sandstone appears to the north in an out rop along Mountain Road. A narrow (20 m) ridge of silicified protomylonite, cut by veing of jasperoid quartz, trends N. 8° E. and locally marks the trace of the crystalline border 2.1 km N. 76° E. of the intersection of Springfield and Stony Hill Roads. Well logs suggest that the zone of crushing here might extend as far west as Wilbraham Road. Outcrops of Erving schist on the

hillside west of the narrow ridge contain abundant quartz veins and are

cut by steep west-dipping joints. A series of intersecting northeast-, north-, and northwest-trending faults complicate the crystalline border in the area 3.5 km north and south of the Massachusetts-Connecticut State line. Silicified protomylonite is exposed over an extensive area; on the ridge east of North Somers and in cuts in till knobs on the east edge of the sand pit south of Stafford Road. The protomylonite probably does not extend far north of Stafford Road, however, because angular boulders of conglomerate are scattered on the till slope 200–300 m north of BM 352. Cataclastic foliation in the protomylonite strikes parallel to the adjacent fault borders occurring between the protomylonite and the Erving schist and granulite, which are exposed along a stream draining southward into Schapade Brook. Schist east of the crushed rock is generally unaltered, except for a narrow, 3–5 cm wide, zone of intense chloritization and seritization 370,000 FE

ECONOMIC GEOLOGY

adjacent to the protomylonite.

Minor copper sulfide mineralization along the border of the crystalline rocks was noted by R. B. Colton (oral comm. 1968) on boulders in the sand pit 0.4 km southeast of the intersection of Hampden and Stafford Roads in Somers, and in the Woodland Dell Cemetery in Wilbraham. Chalcopyrite, the primary copper-bearing mineral, occurs as disseminated grains in late quartz veins that cut mylonite and silicified protomylonite exposed beneath cuts in till on the east flank of the sand pit. Thin coatings of malachite occur in local patches on a few sandstone boulders in the pit. Minor copper sulfide mineralization is present locally in the crushed rocks at the crystalline border, but economic deposits were not detected. Both Glastonbury Gneiss and sandstone of the Portland Formation

have been quarried in the quadrangle, but most of the quarries were inactive at the time of the investigation. Joints and foliation planes are found parallel to steep slopes in several areas of locally high relief, particularly on the west slopes of Minnechoag Mountain and the Wilbraham Mountains between Goat Rock and Mt. Vision. Locally, in areas such as the northwest slope of Goat Rock, minor sliding on joint or foliation surfaces has taken place in recent times, as evidenced by talus blocks along the slope and relatively unweathered pavementlike outcrop surfaces. Although onsite investigations are needed to determine the type and extent of possible instability in a particular area, the joint and foliation data on the map should serve as a guide to potential problem

THE STATE OF CONNECTICUT GEOLOGICAL AND NATURAL HISTORY SURVEY

SPRINGFIELD JP PORTLAND FORMATION (JURASSIC)—Chiefly moderate-reddish-When the sium feldspar, chlorite, and apatite. Rectangular knots of very rale green muscovite and kyanite (0.6 mm in width), and knots and stringers of translucent quartz are characteristic of the Sc CLOUGH QUARTZITE (LOWER SILURIAN)—White to light-tan, 72°22'30' Geology mapped in 1964-65, 1971; as-Base from U.S. Geological Survey, 1958 sisted by R. L. Shaw, C. E. Brown and Photorevision as of 1970 10,000-foot grids based on Massachusetts coordinate system, mainland zone, and Connecticut coordinate system 1000-meter Universal Transverse Mercator grid ticks, zone 18. CONTOUR INTERVAL 10 FEET DATUM IS MEAN SEA LEVEL QUADRANGLE LOCATION

HAMPDEN QUADRANGLE, MASS.—CONN. BEDROCK GEOLOGY GQ-1368

> printed list is available on request from the U.S. Geological Survey. ———— Contact—Approximately located; queried where probable Fault—Approximately located, queried where probable; dotted in water. U, probable upthrown block; D, probable downthrown

Note: Commonly used geologic symbols are printed on the map jacket; a separately

GEOLOGIC QUADRANGLE MAP

block. Crosshatched were silicified Syncline—Showing axial trace and plunge

>--- Open anticline, showing plunge

Open syncline, showing plunge Fold with axial-plane schistosity, showing bearing, map sense, and plunge of axis Fold that folds schistosity, showing bearing, map sense, and plunge

Kink fold, showing bearing, map sense, and plunge Kink fold, showing bearing, map sense, and plunge of fold, and strike and dip of axial-plane cleavage

PLANAR AND LINEAR FEATURES

Where two symbols joined, observation is at point of intersection

Bedding in sedimentary rocks Inclined—Showing strike and dip

 Horizontal Schistosity in metamorphosed rocks

Inclined—Showing strike and dip → Vertical

Cataclastic schistosity Schistosity parallel to relict bedding in metamorphosed rocks

Top of beds not observed Top of beds observed Overturned beds Mineral lineation—Symbol shows direction and plunge; observation at

base of arrow. Letter symbol shows elongate mineral: B, biotite; H, hornblende; Q, quartz

Inclined—Showing strike and dip -- Vertical

Horizontal Water well—Circle locates well; letter shows bedrock type logged: R. red rock; G, gray rock; W, white rock; B, black rock; C, soft caving rock. Read hyphen as "to." Superposition of letters shows superposition of rock types in well. Data from unpublished water-well logs, U.S. Geological Survey, Boston, Mass.

Protomylonite—Chiefly pink-weathering, minor olive-gray-weathering, crushed rock composed of quartz, feldspar, and feldspar-quartz fragments (2-3 mm in diameter) in a schistose matrix of chlorite, epidote and minor carbonate. Rock is irregularly but strongly foliated, and texturally and compositionally homogeneous over the area of several wide) and larger veins (1-6 cm) of milky quartz

Mylonite—Brown- to dark-gray-weathering, dark-gray rock consisting of altered rock fragments, quartz, and feldspars in an aphanitic groundmass cut by thin veinlets of quartz, calcite, and ultramylonite. Rock has subconchoidal hackly fracture. Outcrops are irregularly and intensely jointed

Angular blocks of conglomerate—Cross shows location Abandoned rock quarry

horn, J. H., and Koteff, Carl, 1967, Geologic map of the Springfield South quadrangle, Hampden County, Massachusetts, and Hartford and Tolland Counties, Connecticut: U.S. Geol. Survey Geol. Quad. Map GQ-678.

Peper, J. D., 1966, Stratigraphy and structure of the Monson area, Massachusetts and Connecticut: Rochester, N. Y., Univ. Roches-Ph.D. thesis, 126 p.

Robbsen, Peter, 1967, Gneiss domes and recumbent folds of the Drange area, west-central Massachusetts, Trip B in New England legiate Cological Conference, 59th Annual Meeting, 7, Guidebook for field trips in the Connecticut 1970, The tectonics of the Appalachians: New York,

usty-red- to light-tan-weathering quartz-feldspar-muscovite-chlorte-garnet schist—Schist is well foliated. Locally includes thin dote amphibolite-Contains concordant thin (0.5 cm-wide) veins and stringers and thicker (12-25 cm) nodular masses of epidote-quartz on a scale of 1 cm-1 m. Color index 15-20, except in upper 15-25

> Amherst muscovite Erving Formation Partridge Formation __0_100_m_____ (hs) hornblende schist Oama 400 m (TB) (mg) metagabbro 0-190 m 0-570 m (B)

EXPLANATION exposed thickness ### Unit bounded by intrusive (T) Top not exposed (B) Bottom not exposed ? Correlation probable FIGURE 1.—Composite column of layered rock units in Hampden quadrangle showing exposed thicknesses and names used for similar

rocks in the adjacent Ellington quadrangle, Connecticut.

BEDROCK GEOLOGIC MAP OF THE HAMPDEN QUADRANGLE, MASSACHUSETTS AND CONNECTICUT

Surficial deposits not shown.

Dashed lines in metamor-

phosed layered rocks show

surface of relict bedding and