

INDEX TO 7.5' QUADRANGLES

[Study area shown in red]

100 meters = 328 feet

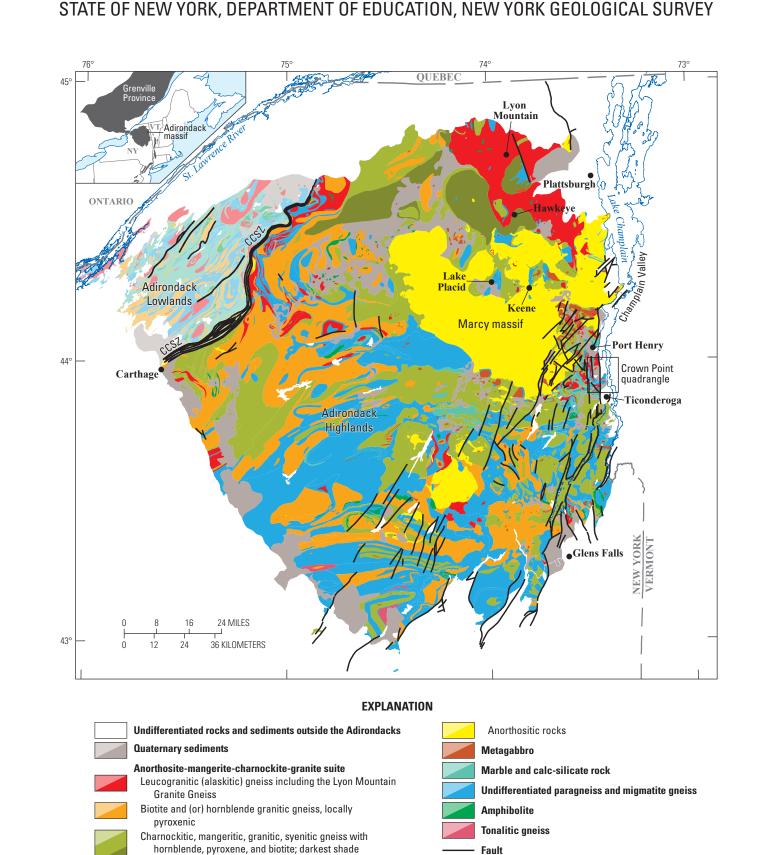
Surficial deposits are not shown

NO VERTICAL EXAGGERATION

INDEX TO GEOLOGIC MAPPING

[Colors do not correspond to map unit colors]

Prepared in cooperation with the STATE OF VERMONT, VERMONT AGENCY OF NATURAL RESOURCES, VERMONT GEOLOGICAL SURVEY



Granite Gneiss from unit "phgs" of Isachsen and Fisher (1970) Figure 1. Simplified geologic map of the Adirondacks, upstate New York, showing the location of the Crown Point quadrangle. Rocks in the Adirondack Lowlands are shown with lighter shades of the same colors as in the Highlands. Simplified from Rickard and others (1970) and Isachsen and Fisher (1970) with digital data from Dicken and others (2005). Inset map of the Grenville Province shows Mesoproterozoic inliers in northeastern North America; modified from Hibbard and others (2006). Abbreviation: CCSZ, Carthage-Colton shear zone.

dicates inequigranular texture including the Hawkeye

on the western shore of Lake Champlain west and southwest of the island, and at railroad cuts in the same area off Rock Way (the road name is not on the maps). Thickness is estimated at 250 ft (76 m) Ticonderoga Formation (Upper Cambrian)—Brownish-gray, yellowish-gray, buff, to light-gray weathering, dark- to medium-gray, medium- to thick-bedded, cherty and sandy, fine- to medium-grained dolostone with quartzose dolostone and pebbly dolomitic sandstone interbedded with quartz sandstone. Chert occurs as black nodules. Sandy dolostone beds weather yellowish gray. Quartz grains are subrounded to rounded and frosted. The base of the unit is

gradational and marked by decreasing sandstone of the Postsdam

Sandstone to dolomite and sandy dolomite of the Ticonderoga

Formation and placed at the first significant dolostone beds. Locally,

the unit contains worm burrow trace-fossils. The unit is well exposed

dolostone grades upward to dark-gray crystalline dolostone of the

Whitehall Formation. The unit is well exposed at Sheepshead Island,

CORRELATION OF MAP UNITS

PALEOZOIC SEDIMENTARY ROCKS

Great Unconformity

NEOPROTEROZOIC IGNEOUS ROCKS

Mafic dikes \ Zd \ Ediacaran

MESOPROTEROZOIC IGNEOUS ROCKS

Stratigraphic order is unknown

Syn- to Post-Tectonic Igneous Rocks

Lower Ordovician

Upper Cambrian

DESCRIPTION OF MAP UNITS

[Minerals described in order of increasing abundance where hyphenated. Represent-

HOLOCENE AND QUATERNARY DEPOSITS

af Artificial fill (Holocene)—Includes large areas of fill associated with

mapped with lidar and ground observations

he airport, landfill, paper mill, and the railroad at Gilligans Bay. The

unit was mapped with light detection and ranging (lidar) and ground

observations. Small areas of fill associated with roads and bridges are

of filled land or mine dumps related to historic mines. The unit was

The unit was mapped with lidar and ground observations. Deeply

incised stream channels of Putnam Creek and its tributaries are not

mapped, though this area contains thick glacial deposits with steeply

eroded banks, which may contain landslides that were not examined

Undifferentiated glacial deposits (Quaternary)—Large areas of the

Champlain Valley are covered in thick glacial deposits, which may

include undifferentiated till, lake sediments, beach deposits, terraces,

and deltas; these areas are not subdivided on the maps. On the lidar

map, Qal is shown as transparent yellow so the lidar percent-slope

can be seen beneath it. See De Simone and others (2008) and

Rayburn (2004) for a discussion of the surficial geology which has

yet to be mapped in this quadrangle. The large Street Road delta is

exposed in Ticonderoga between Routes 7 and 9N/22, with bottomset

sand beds to the east and topset beds in sand and gravel to the west;

the topset-foreset contact is exposed at an elevation of 525 feet (ft)

(De Simone and others, 2008). Limited publicly available water well

data shows that the overburden thickness locally exceeds 200 feet.

Unpublished well logs for eight water wells drilled for the new

Ticonderoga well field along Street Road (approximate location

shown on the map) indicate depth to bedrock as >250, 245, >235,

>215, >211, >200, >195, and 129 ft (>76, 75, >72, >65, >64, >61,

>59, and 39 meters [m]) (F. Bickford, HydroSource Associates,

discontinuous beds of crossbedded and graded dolomitic siltstone.

light-gray- to locally tan-weathering, calcareous shale interbedded

with dark-gray to black, thin-bedded shaly limestone. The basal

contact is placed at the transition from fossiliferous thin-bedded

limestone of the Glens Falls Limestone to thin-bedded shaly

limestone interbedded with calcareous shale. The unit is well exposed

from Girards Bay to Jones Dock on the eastern shore of Lake

Champlain. Thickness of the unit is undetermined due to an

incomplete section in the map area. Welby (1961) estimated the

thickness of the unit at about 1,000 ft (305 m) in Vermont where the

Stony Point Formation is overlain by the Iberville Formation (Oib);

the Iberville Formation is shown only in cross sections A-A' and B-B'

uish-gray weathering, thin- to medium-bedded, fossiliferous.

grainstone limestone with argillaceous partings interbedded with

dark-gray shaly limestone. The basal contact is placed at the

transition from medium-bedded limestone of the Orwell Limestone to

the interbedded, thin-bedded limestone and shaly limestone of the

Glens Falls Limestone. The unit grades locally upward into

sooty-weathering shaly limestones containing beds rich in fragments

of the trilobite *Cryptolithus*. The unit is well exposed on the eastern

shore of Lake Champlain from just north of West Bridport, Vt., to

black to dark-gray, medium-bedded, fine-grained limestone

containing black chert nodules. Samples from the lower part of the

formation contain conodonts of the *Belodina compressa* Biozone (fig.

19, table 2). The lower contact is not exposed in the quadrangle. The

unit is best exposed north of the Crown Point quadrangle in the Port

Henry quadrangle at Crown Point State Historic Site, N.Y., where the

lower contact is above the highest dolostone of the Valcour

Limestone. A quartz arenite occurs several feet above the contact

thick-bedded, medium-grained limestone, dolomitic limestone, and

dolostone. Dolostone weathers light brown. The lower contact is not

exposed in the quadrangle. The unit is best exposed north of the

Crown Point quadrangle in the Port Henry quadrangle at Crown Point

State Historic Site, N.Y., where the lower contact is placed at the base

dark-gray, thin- to medium-bedded, coarse-grained fossiliferous

limestone with very dark gray argillaceous partings. Basal beds are

very light gray weathering, medium- to dove-gray, thick-bedded

mudstone limestone. Contains the diagnostic gastropod Maclurites.

Upper beds contain quartz and feldspar sand grains. The contact with

the underlying Providence Island Dolomite is placed at the base of

high-calcium mudstone overlying fetid dolostone. The upper part of

the unit is best exposed north of the Crown Point quadrangle in the

Port Henry quadrangle at Crown Point State Historic site, N.Y.,

Tan and light-gray weathering, gray to light-gray, laminated

dolostone with interbedded gray limestone, noncalcareous shale, and

argillaceous partings. Has "beeswax-scored" and "butcherblock"

surfaces on weathered surfaces. Samples for conodonts were barren.

The lower contact is not exposed in the quadrangle. The unit is well

exposed in an abandoned quarry just east of NY State Route 9N and

north of Shore Airport Road. Thickness is estimated at 200 ft (61 m)

orangish-gray, and tan weathering, gray, medium- to thick-bedded

dolostone and minor dolomitic limestone. Weathered surfaces have

"butcherblock" patterns. The conodont *Oepikodus communis* Biozone

(fig. 19, table 2) occurs within the Fort Cassin Formation. The lower

contact is not exposed in the quadrangle. The unit is best exposed

along the western shore of Lake Champlain between Hickock Point

weathering, medium-gray to dark-olive-gray, thick-bedded,

crystalline dolostone, sandy dolostone, and dolomitic sandstone. Well

crossbedded in places. Weathered surfaces have butcher-block

patterns. The lower contact is placed at the transition from massive,

crystalline dolostone of the Whitehall Formation to quartz sand

dolostone of the Cutting Dolomite. The basal sandstone that Rodgers

(1937) described resting unconformably on the Whitehall Formation

was not observed in the Crown Point quadrangle. However, the lower

part of the formation is crossbedded quartz sand with dolomitic

cement; sand grains weathering in relief. The conodont Rossodus

manitouensis Biozone occurs within the Cutting Dolomite (fig. 19,

table 2). The unit is exposed in an abandoned quarry on the east side

of NY State Route 9N south of the intersection with NY State Route

S185 in the northern part of the quadrangle. The unit is best exposed

in the northern part of the Ticonderoga quadrangle along Shore

Airport Road just north of NY State Route 22/74. Thickness is

hitehall Formation (Lower Ordovician and Upper Cambrian)-

Light- to brownish-gray and pinkish, thick-bedded to massive,

medium to coarsely crystalline (sugary) dolostone with local sand and

limestone interbeds and black chert nodules. The unit is siliceous in

places with a fetid odor from fresh surfaces. The lower contact with

the Ticonderoga Formation is gradational and placed where sandy

estimated at 225 ft (69 m)

and Porters Marsh. Thickness is estimated at 400 ft (122 m)

Ocu Cutting Dolomite (Lower Ordovician)—Light-gray to light-tan

Ofc Fort Cassin Formation (Lower Ordovician)—Yellowish-gray,

of the lowest dolostone. Thickness is estimated at 80 ft (24 m)

Ocp Crown Point Limestone (Upper and Middle Ordovician)—Medium

Thickness is estimated at 175 ft (53 m)

Opi Providence Island Dolomite (Middle and Lower(?) Ordovician)-

with the Valcour Limestone. Thickness is estimated at 70 ft (21 m)

Ov Valcour Limestone (Upper Ordovician)—Dark- to light-gray,

Ogf Glens Falls Limestone (Upper Ordovician)—Dark-gray to black,

Leonard Bay. Thickness is estimated at 450 ft (137 m)

Oo Orwell Limestone (Upper Ordovician)—Dove-gray weathering,

PALEOZOIC SEDIMENTARY ROCKS

[The stratigraphic column is shown in figure 19]

Present only in cross sections A-A' and B-B'

Oib Iberville Formation (Upper Ordovician)— Dark-gray shale with thin

Osp Stony Point Formation (Upper Ordovician)—Dark-gray to black,

Undifferentiated waste rock piles and tailings (Holoocene)— Areas

Landslides (Holocene and Quaternary)—Areas of noted landslides.

ative photographs of map units are included in appendix 1]

in detail in this study

written communication, 2018)

where it is projected in the air

Upper and Middle(?) Cambrian

TIMING OF

DEFORMATION

EVENTS

Brittle Faulting

Shear Bands D4

Paleozoic Cleavage

on the western shore of Lake Champlain 0.5 kilometers (km) south of Sheepshead Island. Thickness is estimated at 175 ft (53 m) Potsdam Sandstone (Upper and Middle(?) Cambrian)—Gray to greenish-gray, locally maroon, tan, or rusty weathering, poorly sorted, subangular to subrounded, coarse- to medium-grained, well-bedded sandstone, with coarse sandstone and pebble conglomerate near the base of the unit. Bedding thickness varies from meter- to decimeter-scale and is locally massive and crossbedded. Contains abundant ripple marks. The unit grades upwards from arkosic sandstone to quartz arenite interbedded with dolostone and dolomitic sandstone. The basal contact is an unconformity overlying Mesoproterozoic rocks. The unit is well exposed on the western shore of Lake Champlain 0.4 miles (mi) (0.6 km) south of Sheepshead Island, and along Putnam Creek from Crown Point Center to an elevation of about 490 ft (149 m). The basal unconformity is well exposed at a waterfall on Putnam Creek in

PROTEROZOIC IGNEOUS AND METAMORPHIC ROCKS NEOPROTEROZOIC IGNEOUS ROCKS

surface) and is as much as 200 ft (61 m)

Crown Point Center at an elevation of about 300 feet (91 m).

Thickness is extremely variable (based on the paleotopographic

Mafic dikes (Ediacaran)—Dark-gray to olive-green or black, black to dark-reddish-green or rusty maroon weathering, aphanitic to phaneritic, equigranular diabase dikes. Dikes may show chilled margins, and thicker dikes are medium to coarse grained in the center and consist mostly of clinopyroxene and plagioclase exhibiting an ophitic texture, with minor amounts of olivine altered to serpentine, chlorite, biotite, opaques, and uralite alteration. Measured dikes range in thickness from 0.03 to 4 m. The steeply dipping dikes trend northeast with a mean trend of 60°±6° (fig. 11) and crosscut every Proterozoic rock unit, but are not found in the Paleozoic rocks, and thus predate the basal unconformity. Nineteen measured dikes are shown with strike-and-dip symbols. The dikes are also shown as mapped lines extrapolated for as much as 4 km where the linear trend is clearly visible in several places in the lidar percent-slope map, especially on Bulwagga Mountain and the north slope of Buck Mountain. A typical dike is well exposed at several places in the steep stream canyon on the west slope of Bulwagga Mountain, 0.7 km west of the junction of Route 9N/22 and 185 (the latter is labeled Route S on the base map). A more readily accessible dike measuring 0.4-m thick is located at a roadcut on Route 9N/22, 0.55 km north of Spar

Mill Bay (point CP–5060 in the database) MESOPROTEROZOIC IGNEOUS ROCKS Undifferentiated rocks (Mesoproterozoic)—Rocks concealed beneath glacial deposits on the map or shown in cross-sections A-A' and B-B'

Late- to Post-Tectonic Igneous Rocks

Yp Pegmatite (Mesoproterozoic)—Pink and white to white, coarse to

very coarse grained, hornblende-biotite granite pegmatite and unit contains garnet and graphite. May contain epidote, allanite-Ce, polycrase-Y, titanite, zircon, and fluorite; the feldspars are microcline and albite (Lupulescu and others, 2011). The pegmatites are reportedly low in lithium but elevated in rare earth elements (Tan,

1966; Lupulescu and others, 2012). In addition to quartz and feldspar, Newland (1921) reported biotite, chlorite, hornblende, titanite, magnetite, zircon, tourmaline, pyrite, chalcopyrite, and allanite from the Crown Point Spar Company quarry on Breed Hill, where large crystals of biotite, hornblende, and garnet occur in the wall rock (Tan, 1966). Tan (1966) classified the bodies at the Crown Point Spar Company quarry and the Rose Rock quarry as hornblende-biotite pegmatites. Clusters of allanite locally occur at the Crown Point Spar Company quarry (Tan, 1966), and coincide at one place in this study with elevated gamma radiation readings above background using a portable detector. Other pegmatites locally showed similar elevated gamma radiation readings (see section on Gamma Radiation Measurements). Well-exposed mapped pegmatite occurs at the Crown Point Spar Company and Rose Rock quarries (along Route 9N/22 near Spar Mill Bay) and on the west-facing cliffs on the southwest side of Miller Mountain where it is undifferentiated yet

Syn- to Post-Tectonic Igneous Rocks

Lyon Mountain Granite Gneiss (Postel, 1952) Leucogranite gneiss (plus Ylgg) (Mesoproterozoic)—Pink to white, light-gray to white and locally rusty tan weathering, medium-grained, equigranular, variably well layered and gneissic to poorly foliated, undifferentiated quartz-plagioclase-alkali feldspar rocks consisting of microperthite granite, microcline granite, quartz syenite, alkali feldspar granite (alaskite), syenogranite, monzogranite, and quartz-albite rock with ubiquitous, as much a 5 percent magnetite, and <2-5 percent biotite, hornblende, or clinopyroxene. K-feldspar may exhibit rims of plagioclase. The amounts of biotite, hornblende, and clinopyroxene vary and most samples are dominated by only one of the minerals. In many places, magnetite is the only mafic mineral visible in hand sample. The granite locally contains accessory garnet, chlorite, titanite, titanomagnetite, apatite, and trace amounts of zircon, monazite, and allanite. Garnet is locally abundant, especially near contacts with paragneiss, and in one place on the south slopes of Buck Mountain it was mapped separately as leucogranite gneiss with garnet (Ylgg). Layer-parallel and less abundant crosscutting veins of magnetite and quartz locally occur. Secondary epidote is locally present as veins and microscopic grains and saussurite alteration of calcic plagioclase; this alteration locally imparts a pale-greenish-gray color to the rock. The unit is well exposed and commonly forms resistant, glacially rounded blocky outcrops. The leucogranite is well layered at the centimeter (cm)- to m-scale and varies in modal grain size and primary mafic mineralogy between individual, submeter thick layers, but it is generally homogenous at the map scale; no systematic variation could be mapped. The unit contains both layer-parallel and crosscutting magnetite-bearing clinopyroxene or biotite granitic pegmatite. The unit locally contains partially assimilated xenoliths and screens of amphibolite (Ya) associated with mafic restite; xenoliths and screens of migmatitic paragneiss, quartzite, and metagabbro are less common. Contacts between unit Ylg and adjacent paragneiss units, especially Ybg, are gradational and marked by a transitional zone of migmatization (unit Ylgt). Unit Ylg contains rare magnetite-quartz-sillimanite nodules at one place on the southeast slope of Buck Mountain in Ticonderoga (labeled "Sil" on the map), which are interpreted as metasomatic in origin (McLelland and others, 2002). Adjacent to regions of magnetite ore there is evidence for metasomatic alteration by potassic and sodic fluids (Valley and others, 2009, 2011), and the granite near ore deposits is commonly bleached white and consists of a

Igt Transitional migmatitic paragneiss and Ylg (Mesoproterozoic)— Very complex, banded pink, white, dark-gray, black, brown, and green, well-layered stromatic migmatite consisting of paragneiss (Ybg) with increasing amounts of pink and white leuocosome in the host paragneiss towards masses of Ylg. The transitional unit contains discrete pods, sills, lit-par-lit bands and irregular bodies of leucogranite and abundant segregations and megacrysts of clinopyroxene, hornblende, and microcline, and local concentrations of magnetite-hornblende-clinopyroxene in grains, boudins, and pods. This transitional border was noted but not mapped by Walton (1966a, b). It locally contains retrograde mineral assemblages of saussuritized plagioclase, biotite, hornblende, and clinopyroxene broken down to chlorite and (or) actinolite, and paleosome containing greenish alteration assemblages of chlorite, epidote, albite, scapolite, and

magnetite-quartz-albite assemblage

quartz. This migmatite zone has not previously been mapped in the Adirondack Highlands but may correlate with what has informally been called the "Lyon Mountain Granite intrusion breccia" by McLelland and others (Stop 3, 2011) near Putnam Station, New York. On the map, we locally show the transitional migmatitic unit where it can be mapped in zones up to a few hundred meters wide along the contacts between Ylg and Ybg. We also show it mapped in places where the exposure is insufficient or end members (Ylg or Ybg) are so complexly interlayered at a fine scale to prohibit separately mapping either end member. Similar migmatitic rock occurs along the contacts with Ylg in most places, but it was difficult to separate all occurrences at the scale of the map. Areas within Ybg may contain transitional migmatitic rocks matching this description, but they are not mapped at all places due to the complexity and the challenge of mapping this unit at the scale of the map; such areas are noted in the GIS database. A typical exposure of the transitional unit occurs in Crown Point along Route 9N/22 at the Sacred Heart Church (the church symbol is shown on the map, across the street from the

cemetery labelled "Sacred Heart Cem") Metagabbro (Mesoproterozoic)—Dark-green to black, dark-gray to tan weathering, massive to weakly foliated, medium- to coarse-grained, equigranular, olivine-plagioclase-orthopyroxene metagabbro to metanorite with accessory clinopyroxene and ilmenite. The unit typically contains dark clots of concentrically zoned mafic phases and contains a metamorphic assemblage of plagioclase, clinopyroxene, biotite, hornblende, garnet, and minor orthopyroxene developed as coronas around primary phases. Locally, the margins of the metagabbro bodies contain an undifferentiated zone of foliated migmatitic amphibolite; the marginal amphibolite is interpreted as deformed and migmatitic equivalents of the metagabbro cores Syn- to Pre-Tectonic Igneous Rocks

Clinopyroxene-hornblende granitic gneiss (Mesoproterozoic)— Light- to dark-gray, white weathering, medium- to coarse-grained, equigranular, moderately foliated clinopyroxene-hornblende granitic gneiss ranging in composition from granite to syenite. Contains primary plagioclase, K-feldspar, and quartz. K-feldpsar consists of microperthite and microcline that locally exhibits flame perthite, braid perthite, and patch perthite textures. K-feldspar may exhibit rims of plagioclase. Clinopyroxene is blue-green and contains thin lamellae, hornblende is olive green to light brown; the two minerals occur in variable quantities with hornblende the more abundant and both comprise about 10–15 percent of the rock. The rock contains about 1–2 percent magnetite and trace amounts of titanite, apatite, hematite, and zircon. The unit occurs in two places on the map on the north and west side of Bulwagga Mountain. All outcrops occur in wooded areas, and at the time of mapping, the locations south of Cold Spring Park on the north side of Bulwagga Mountain occurred in an active logging area and thus offered the best exposure

Migmatite gneiss with pegmatite (Mesoproterozoic)—Heterogeneous, white to gray, dull gray weathering, well-foliated migmatite gneiss with garnet-rich leucosome and abundant pegmatite; the latter occurs as both well-foliated varieties and coarse grained; unfoliated varieties resembling unit Yp. Locally, the unit contains biotite, sillimanite, and flake graphite. The unit is a complex mixture of leucosome and pegmatite of different ages, and it occurs in contact with units Ysi and Ym on the southwest side of an unnamed hill in the southwest corner of the map. The unit is also exposed in the adjacent Ticonderoga quadrangle, and has been described at a roadcut on Route 74 by Regan and others (2015) and Williams and others (2018); the latter report uranium-lead (U-Pb) zircon ages of 1,177±10 Ma and 1,067±6 Ma from the migmatite, a 1,015±10 Ma age from a crosscutting pegmatite, and monazite ages from about 1,150–930 Ma with a dominant population at about 1,050 Ma

Granitic augen gneiss (Mesoproterozoic)—Light-gray, locally light-pink, very light-gray to dark-gray-green weathering, wellfoliated, inequigranular, megacrystic granite gneiss with K-feldspar (perthite-microperthite) augen (1–5 cm) in a matrix of quartz, plagioclase, K-feldspar, biotite, and locally abundant garnet. The unit contains accessory epidote, zircon, and allanite, and contains lesser with quartz, mesoperthite, and accessory epidote. The granite typically contains abundant xenoliths of nearby amphibolite (Ya) associated with mafic restite. The unit is well exposed and commonly forms resistant, glacially rounded blocky outcrops. Because of its characteristic texture and resistant weathering, the unit is relatively easy to recognize and map in the field. It occurs as highly deformed, foliation-parallel, thin sill-like bodies on Keeney Mountain, on the North side of Buck Mountain, on Miller Mountain, and in an area west of Route 9N/22 just east of the Crown Point Street Road delta sand and gravel pits. Regan and others (2019) report a sensitive high resolution ion microprobe (SHRIMP) U-Pb zircon age of 1,185±11 Ma from a sample collected in the adjacent Eagle Lake 7.5-minute

Mesoproterozoic Metasedimentary and Metavolcanic Paragneiss

Grenville Complex

[Lithodemic units are not described in stratigraphic order; order is unknown] Migmatitic biotite gneiss member (plus Ybgg and Yrbg) (Mesoproterozoic)—Gray to dark-gray, dark-gray to black and white banded, light-gray weathering, well-foliated, migmatitic, mediumgrained, biotite-K-feldspar-quartz-plagioclase paragneiss with locally undifferentiated amphibolite and calc-silicate rock. The unit is well layered and varies from an equigranular quartz-feldspar gneiss to a well-layered biotite-rich migmatite. Accessory phases include hornblende, garnet, sillimanite, diopside, epidote, apatite, zircon, and allanite. Where garnet and sillimanite are locally abundant, the rock is mapped as biotite gneiss with garnet (Ybgg); this rock is distinctly non-rusty weathering and non-graphitic and is thus distinguishable from unit Ysi. A rusty sulfide-rich biotite-bearing paragneiss without garnet or sillimanite (unit Yrbg) is mapped in two places on Mine Hill; the lack of obvious garnet or sillimanite distinguishes this minor unit from unit Ysi. Sedimentary layering is largely destroyed due to metamorphism and tectonism, but local compositional banding, especially of interlayered light-green calc-silicate rocks, is likely a remnant of original bedding. The unit is locally interlayered on the meter-scale with fine-grained amphibolite, locally mapped as unit Ya where thick enough. Leucosome occurs as pegmatitic segregations, dikes, and sills. Non-migmatitic varieties contain little biotite, and consist mostly of K-feldspar, quartz, and plagioclase. Map unit Ybg is the most widespread metasedimentary unit in the area and is well exposed on Miller Mountain and Buck Mountain. Good exposures occur along the west side of Route 9N/22 north of Spar Mill Bay, under the power lines northwest of Spar Mill Bay, and along Putnam Creek between an elevation of 510 and 580 feet, west of Crown Point Center. The unit may correlate with unit Y^{1,2}bg in Vermont (Ratcliffe

Rusty garnet-sillimanite gneiss member (Mesoproterozoic)—Gray to dark-gray and tan, white to tan-gray and rusty weathering, well-foliated, migmatitic, garnet-sillimanite-K-feldspar-plagioclasequartz paragneiss with variable amounts of graphite and biotite. Locally, the unit is sulfidic and very rusty weathering. Accessory phases include pyrite, monazite, zircon, apatite, xenotime, allanite, epidote, and ilmenite. Paragneiss contains undifferentiated interlayered quartzite, calc-silicate gneiss, marble, and amphibolite, and abundant layer-parallel, locally garnet- and (or) graphite-rich pegmatite as variably dismembered pegmatite boudins and sill-like intrusions. Leucosome occurs as pegmatitic segregations, dikes, and sills. Layering varies in thickness but is predominately on the order of meters to decimeters except where interleaved with calc-silicate gneiss and quartzite, where it is layered on the cm- to decimeter-scale. Referred to as khondalite (McLelland and others, 1988) or kinzigite (Walton, 1966b). The unit is interpreted as metamorphosed interbedded psammitic to pelitic rocks that underwent partial melting. Locally, coarse garnet (up to 2 cm) comprise up to 50 percent of the rock. Garnet typically contains abundant quartz inclusions and is locally book-shelved and partially replaced by biotite or sillimanite. Although tectonic and metamorphic in origin, large exposures of this unit exhibit modal variations in biotite, garnet, and quartz at the cm scale, which is interpreted as a pseudostratigraphy. The unit is well exposed on Breeds Hill north of the Crown Point Spar Company quarry and roadcuts along Route

9N/22 near Spar Mill Bay. The unit may correlate with units Y²rs and Marble and calc-silicate gneiss member (Mesoproterozoic)—White to green, white and dark-green to black spotted, tan to earthy yellowish-brown or rusty weathering, poorly exposed, deeply weathered, coarse-grained dolomite marble, calcite marble, calc-silicate gneiss, quartzite, and quartz-rich pods. The unit contains

composition and modal mineralogy vary within individual exposures, and the unit is well layered to massive. Marble is coarse grained, well annealed, and contains coarse (up 1 cm) quartz in recrystallized masses that compose <15 percent of the rock, but weather in high relief. Medium- to coarse-grained clinopyroxene (diopsidehedenbergite), calcite, and dolomite crystals are commonly present. The amount of flake graphite (up to 2 cm) varies between <2 to 30 percent and is variable on the cm to m scale. Varying accessory phases include graphite, scapolite, phlogopite-biotite, plagioclase, microcline, hornblende, wollastonite, olivine, diopside, garnet, hornblende, molybdenite, tremolite, pyrite, tourmaline, and titanite. Faults and fractures locally contain, at least in one place, white to light-gray asbestiform fibrous minerals (fig. 14). Alteration products of silicates include chlorite, talc, tremolite, actinolite, serpentine as asbestiform chrysotile-antigorite, sericite, and zoisite. Pale-green to gray, rusty weathering, calc-silicate gneiss is layered on the cm- to decimeter-scale, and consists of varying proportions of diopside, talc, tremolite, quartz, and dolomite with accessory tourmaline, titanite, and pyrite. Thick recrystallized marble horizons may contain foliated and locally folded tectonic rafts of adjacent units, especially quartzite, amphibolite, and paragneiss. This unit exhibits distinctive alternating resistant and highly recessive layers due to varying amounts of quartz and or calc-silicate minerals. The marble and calc-silicate rocks are interpreted as end-members of the same metasedimentary unit. The unit is well exposed at Mine Hill, at the Buck Mountain Pond Property Mine in Ticonderoga. The unit may correlate with units Y²dm, Y²cs, and Y²m in Vermont (Ratcliffe and

appreciable amounts of pegmatite too small to map separately. The

Yma Amphibolite, marble, and calc-silicate gneiss member Mesoproterozoic)—Interlayered amphibolite, marble, and calc-silicate gneiss. The unit is mapped where the exposure is insufficient, or end-members are so complexly interlayered at a fine scale, to prohibit separate mapping of members Ya and Ym Calc-silicate gneiss member (Mesoproterozoic)—Light-green, white nd gray to tan and earthy yellowish-brown or rusty weathering, medium-grained, epidote-tremolite-quartz-diopside calc-silicate gneiss to granofels. The unit contains accessory plagioclase, tremolite-actinolite, magnetite, chlorite, and apatite, and is dominated by a retrograde mineral assemblage, where plagioclase is saussuritized and diopside is replaced by tremolite-actinolite and epidote. The unit is layered within Ybg; its size is exaggerated on the map to show the location. The unit is mapped in only one place where it is well exposed and extends from under the power lines to along the west side of Route 9N/22, southwest of Sheepshead Island. Similar greenish calc-silicate rocks occur elsewhere in unit Ybg but are not mapped separately. The unit may correlate with unit Y^{1,2}be in

Vermont (Ratcliffe and others, 2011) Amphibolite gneiss member (Mesoproterozoic)—Massive to well-foliated, dark-green to black, gray weathering, medium-grained, amphibolite consisting of hornblende-plagioclase gneiss or pyroxene-hornblende-plagioclase gneiss. Where pyroxene is present, clinopyroxene is always part of the assemblage with or without orthopyroxene. Garnet is common and abundant in many places. Locally, the unit contains biotite; microcline and quartz are present locally where the rock is migmatitic. Unit Ya is interlayered within units Ybg, Ysi, and Ym, and the layering is probably primary. The unit locally occurs as xenoliths or screens in units Ylg, Yhg, and metagabbro bodies but it is not mapped separately in these places at the scale of the map. The amphibolite is locally interlayered with marble and calc-silicate gneiss at a scale too small to map. The unit is well exposed on Keeney Mountain and Mine Hill in the core of the Keeney Mountain synform. The unit may correlate with units Y^2a

EXPLANATION OF MAP SYMBOLS

and Y¹a in Vermont (Ratcliffe and others, 2011)

Contact—Approximately located; dotted where concealed. In cross section, dotted where projected above the ground surface; projections are based on structural measurements of surface exposures Outcrops—Areas of exposed bedrock or closely spaced contiguous bedrock exposures examined in this study; some areas are enlarged to

[Approximately located; dotted where concealed. In cross section, dotted where projected above the ground surface. Listed from youngest to oldest] Brittle fault (Mesozoic or Paleozoic)—Steeply dipping, dotted where concealed. Locally characterized by cataclasite, breccia, and veins; bar and ball on downthrown side, arrows show lateral offset where

Ductile shear zone (Mesoproterozoic)—Characterized by penetrative mylonitic textures with quartz ribbons and deformed feldspar; dotted where concealed; arrows indicate relative motion. Shear zones are characterized by upper amphibolite facies metamorphic assemblages that are syn- to post-pegmatite emplacement. Only one shear zone was mapped in the area, on the southern flank of Bulwagga Mountain. Similar structures occur at outcrop scales, and they are shown with strike and dip symbols. M, Mesoproterozoic

[Symbols show trace of axial surface and direction of dip of limbs; location is known] Axial trace of dome-stage F3 fold (Mesoproterozoic)—Associated with the Kenny Mountain synform and related structures

Overturned synform

MINOR FOLDS [Folds in the Mesoproterozoic rocks; listed from youngest to oldest] Strike and dip of D4 shear bands—Includes axial surface of related minor folds; locally filled with pegmatite (Yp) Inclined, sinistral

Strike and dip of F4 axial surface—Includes minor open fold or plane of boudinage; locally filled with pegmatite (Yp)

Strike and dip of F3 axial surface—Includes minor open to tight fold; locally filled with pegmatite (Yp) and rarely expressed as a nonpentrative cleavage; arrow, if present, shows bearing and plunge of hinge line of fold

Strike and dip of inclined F2 axial surface—Includes minor tight to isoclinal fold; locally filled with pegmatite (Yp); arrow, if present, shows bearing and plunge of hinge line of fold

PLANAR FEATURES [Symbols may be combined; point of intersection shows location of measurement; listed from youngest to oldest]

Strike and dip of inclined bedding in Paleozoic rocks Strike and dip of mafic dike (Zd) (Ediacaran)

Strike and dip of quartz vein (Mesoproterozoic)—Locally common

Paleozoic rocks but were not mapped Strike and dip of inclined pegmatite dike or sill (Yp)

Strike and dip of inclined leucogranite sill (Ylg)

from youngest to oldest] Strike and dip of inclined cleavage in Paleozoic rocks (Ordovician)—Shown only in the Stony Point Formation

[Symbols may be combined; point of intersection shows location of measurement; listed

Strike and dip of S2 gneissosity (Mesoproterozoic)—The most conspicuous foliation in the Mesoproterozoic rocks; includes the layer-parallel foliation in the Lyon Mountain Granite Gneiss, which may, in part, be related to flow banding and emplacement

in the leucogranite gneiss (Ylg); may contain feldspar, epidote,

magnetite, hematite, and calcite. Quartz-carbonate veins occur in the

Strike and dip of inclined S1 gneissosity (Mesoproterozoic)— Foliation is parallel to compositional branding in paragneiss. The S1 foliation predates the Lyon Mountain Granite Gneiss

[Symbols may be combined; point of intersection shows location of measurement; listed from youngest to oldest] Bearing and plunge of paleocurrent—From ripple marks in the Potsdam Sandstone --->17 Bearing and plunge of F3 minor fold axis—Associated with

LINEAR FEATURES

→→ 32 Bearing and plunge of L2 intersection lineation—Intersection between the S1 and S2 foliations → 26 Bearing and plunge of F2 minor fold axis—Fold axis of tight, isoclinal, or rootless fold associated with S2 ■→12 Bearing and plunge of L2 mineral lineation—Aggregate lineation or

dome-stage folds, locally parallel to aligned nodules of sillimanite

grain lineation associated with the S2 foliation; consists of quartz,

biotite, hornblende, or sillimanite OTHER FEATURES ----- Abandoned narrow gauge railroad Abandoned quarry or mine—Abandoned quarries occur in Mesoproterozoic pegmatite bodies and in the Paleozoic carbonate

rocks. Abandoned iron mines occur in Mesoproterozoic migmatitic

biotite gneiss (Ybg) and the Lyon Mountain Granite Gneiss (Ylg).

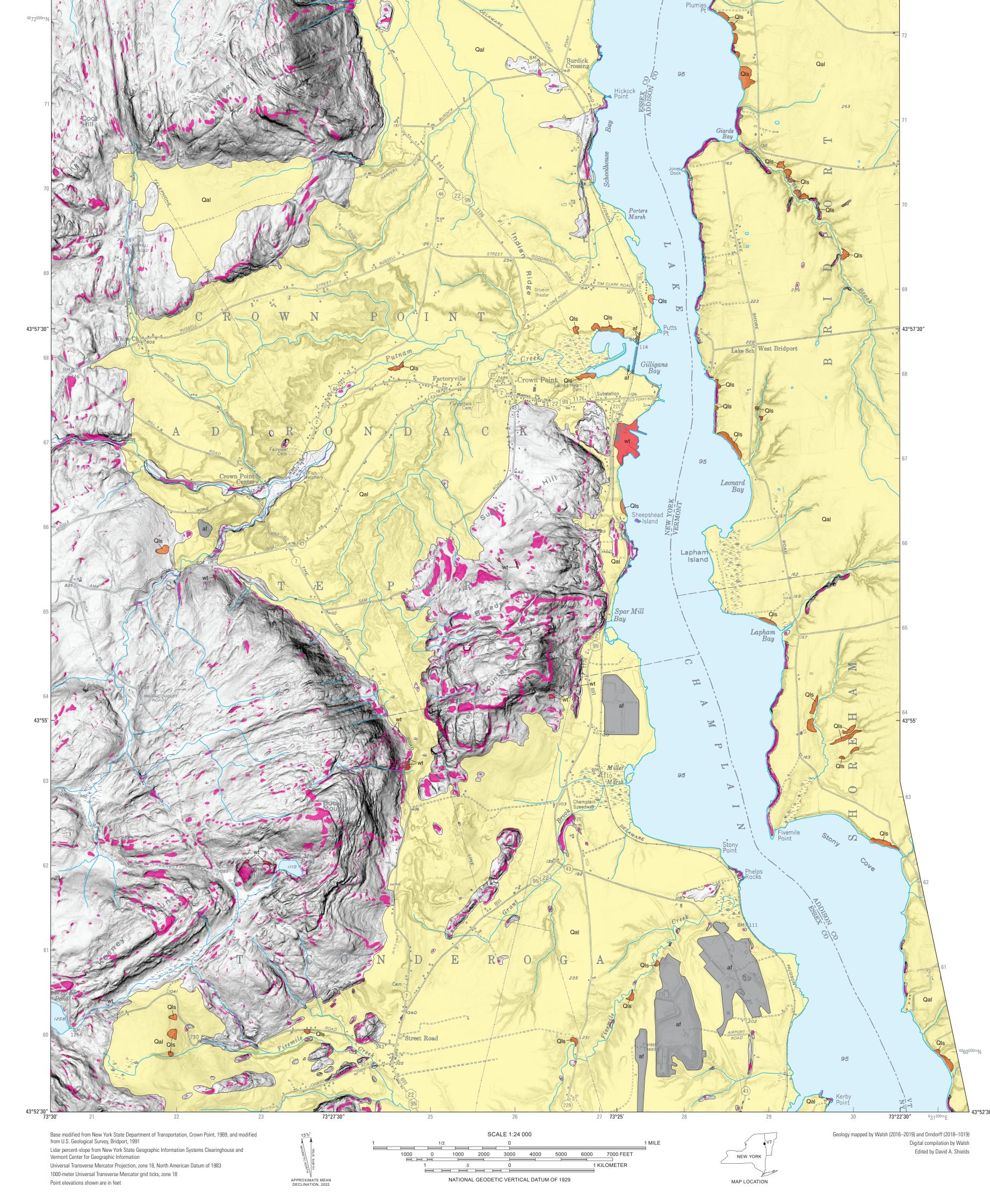
The locations of the quarries and mines are shown on the geologic

detector measured more than two times the background radiation

CP-3000 Conodont sample location—Shows sample number from table 2 • Gamma radiation point—Shows location where a portable radiation

map and in figure 16

Geochronology sample location—Shows uranium-lead (U-Pb) zircon age of pegmatite (Yp) in Ma (mega annum, million years before present). U-Pb ages from the Sugar Hill pegmatite (1,048±14 Ma) and the Crown Point Spar Company pegmatite (1,025±1 Ma) are from Lupulescu and others (2011). Geochronology samples collected Survey, unpublished data, 2020) are not shown individually on the geologic map for cartographic reasons; location coordinates of samples are provided in table 1 and the database. All sample ages are also provided in table 1 * Kettle on Street Road delta



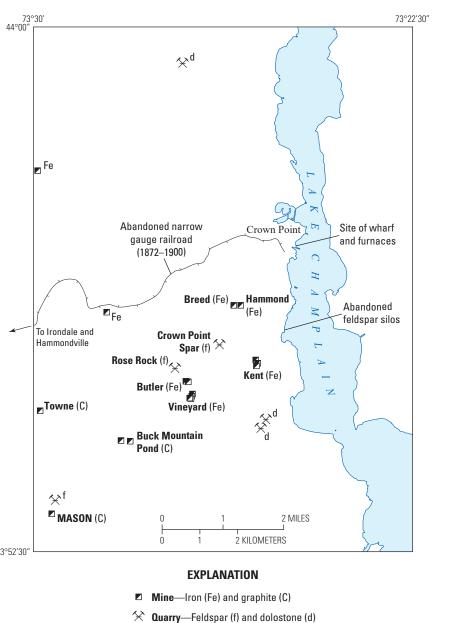


Figure 16. Map of the Crown Point quadrangle, Essex County, New

York, and Addison County, Vermont, showing abandoned mines and

quarries with the principal commodity and related features; locations

Figure 17. Photograph (looking east) of the Crown Point iron furnaces in about 1901.

are also shown on the geologic map.

Photograph from Barker (1942).

Table 1. Summary of U-Pb zircon ages from the Crown Point quadrangle, Essex County, New York, and Addison County, Vermont. [Abbreviations: na, not applicable; Ma, mega-annum (million years before present); i, igneous cores; rims, refer to metamorphic rims; SHRIMP-II, sensitive high resolution ion microprobe II (analyses at Geological Survey of Canada, Ottawa, Ontario); LA-MC-ICP-MS, laser ablation-multicollector-inductively coupled plasma-mass spectrometry (analyses at Arizona LaserChron Center, University of Arizona, Tucson, Arizona); U-Pb, uranium-lead. Latitude and longitude are in World Geodetic System 1984 (WGS 84) datum. Coordinates for the Sugar Hill pegmatite were corrected from Lupulescu and others (2011) by M. Lupulescu, New York State Geological Survey, unpublished data, 2019] Sample number Rock type and map unit Age, in Ma Source CP-4049B Syenite within paragneiss (Ybg) 1,152±7 Ma (i); 1,032±5 Ma (rims) SHRIMP-II J.N. Aleinikoff, U.S. Geological 43.911702° 73.448343° Survey, unpublished data, 202 CP-4055 Leucogranite (YIg) at Butler mine 1,146±6 Ma (i); 1,053±7 (rims) SHRIMP-II and 1,007 Ma (rims) Survey, unpublished data, 2020 CP-4049C Pegmatite (Yp) at Vineyard mine 1,034±5 Ma (i); 1,024±5 Ma (rims) SHRIMP-II J.N. Aleinikoff, U.S. Geological 43.911628° 73.448673° CP-4049A Magnetite ore at Vineyard mine 1,038±3, 1,004±4, 969±7 Ma SHRIMP-II J.N. Aleinikoff, U.S. Geological 43.911702° 73.448343°

LIST OF MAP UNITS

Undifferentiated waste rock piles and tailings (Holocene)

Qal Undifferentiated glacial deposits (Quaternary)

af Artificial fill (Holocene)

Landslides (Quaternary)

Sugar Hill pegmatite (Yp) 1,048±14 Ma

Crown Point Spar Company 1,025±1 Ma

Table 4. Mines and quarries in the Crown Point quadrangle, Essex County, New York, and Addison County, [Unnamed mines or quarries are not in the Mineral Resources Data System database. Deposits that were not located in this study are not shown on the geologic map. Abbreviations: na, not applicable; NW, northwest] Name of mine or quarry and leucogranite gneiss (Ylo Newland and Kemp (1908) Iron Leucogranite gneiss (YIg) na Newland and Kemp (1908) Iron Migmatitic biotite paragneiss (Yb Newland and Kemp (1908) Iron Leucogranite gneiss (YIg) Unnamed off Amy Hill Road na na Iron Leucogranite gneiss (YIg) Unnamed NW of White Church na Iron Migmatitic biotite paragneiss (Ybg) and leucogranite gneiss (Ylg) W033561 Alling (1918) Graphite Marble (Ym) Buck Mountain Pond W033559 Alling (1918) Graphite Marble (Ym)

Rose Rock W033541 Tan (1966) Feldspar Pegmatite (Yp)

Blye (not located) na Newland and Kemp (1908) Iron Unknown

Crown Point Spar Company W033549 Tan (1966)

Dibble Hollow (not located) dep_id 10127185 na

Unnamed na na

Kirby (not located) dep_id 10200235 Whitlock (1903)

Iberville Formation (not shown on geologic map) Stony Point Formation Ogf 450 ft (137 m) Glens Falls Limestone Orwell Limestone Valcour Limestone Ocp 175 ft (53 m) Fort Cassin Formation communis Cutting Dolomite Rossodus

EXPLANATION OF MAP SYMBOLS

Shallow outcrop area—Large areas of exposed rock, or areas that are shallow to

Outcrops—Areas of exposed bedrock or closely spaced contiguous bedrock

exposures examined in this study; some areas are enlarged to show location

Lidar percent slope—Steeper slopes are darker

rock with thin glacial overburden

----- Contact—Approximately located

Simplified surficial geologic map and lidar percent slope of the Crown Point guadrangle

Survey, unpublished data, 2020

LA-MC-ICP-MS Lupulescu and others (2011) 43.936162° 73.419391°

LA-MC-ICP-MS Lupulescu and others (2011) 43.924028° 73.439075°

Feldspar Pegmatite (Yp

Feldspar Pegmatite (Yp)

Graphite Unknown

Iron Unknown

Aggregate Dolostone (Ocu)

Aggregate Dolostone (Opi)

Pamphlet accompanies map

Geologic Map of the Crown Point Quadrangle, Essex County, New York, and Addison County, Vermont

Figure 19. Stratigraphic column for Paleozoic rocks showing the approximate thickness of map units and

conodont biozones. Queries (?) in the conodont biozone column represent missing biozones or biozones not

recognized. Dashed horizontal lines are approximate biozone boundaries. Wavy lines represent

unconformities. Abbreviations: ft, feet; m, meters; na, not applicable.

Potsdam Sandstone

€pt 200 ft (61 m)