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TRAPROCK RIDGES OF CENTRAL CONNECTICUT: OVERVIEW OF CONSERVATION VALUES

Most of the higher traprock ridges are already protected open space, especially those with the most spectacular views, such as the Hanging Hills, Ragged Mountain, West Rock, Sleeping Giant, and Mount Higby. Figure 1 is a topographic map that shows the volcanic ridges in Central Connecticut, some well-known and others not. The Berlin Land Trust has commissioned this document, believing that a better understanding of the natural resources associated with these ridges would be helpful to land use boards and decision-makers, as pressure grows to develop the remaining privately owned portions of the volcanic ridges. Decision-makers have long been aware of the recreational and scenic value of the higher traprock ridges, but the ecological, educational, and geological value of the lower ridges and the lower slopes of ridges is less obvious.

1.0 GEOLOGY OVERVIEW

Connecticut does not have cone-shaped mountains that once rumbled and spewed ash and lava. Instead the lava oozed more slowly from deep, elongated cracks, that started to form 200,000,000 years ago, when the super-continent Pangaea, began to pull apart. Tension between the freshly separated continents opened up two elongated cracks (faults). The land settled between two deepening faults, creating a rift valley. Molten lava oozed up through the deepest cracks and spread across the valley, and then cooled and hardened into trap rock (basalt). Three separate periods of lava flows formed three beds of variable thickness. The middle bed (Holyoke Basalt) may be hundreds of feet thick. These are shown in Figure 2, from the Bedrock Geology Map of Connecticut (Rodgers 1985)

The valley gradually filled with sediment eroded from what used to be high mountains in eastern and western Connecticut. The eastern and western highlands are still many hundreds of feet higher in elevation than the lowlands of the Connecticut valley. Each successive bed of basalt (cooled lava) was buried by sediment that was compressed into a reddish-brown sedimentary rock, known as brownstone or New Haven Arkose. Total sediment deposition was two miles thick at the Eastern Border Fault in Middletown. Climate conditions at that

time were tropical, which accounts for the red, oxidized color of the sedimentary rock and its low mineral content.[1]

Because the rift valley was still deepening along the Eastern Border Fault (often called the trapdoor), the rock beds all tilted down to the east, by 15 to 25 degrees. The broad basalt beds were glued together by sedimentary brownstone. Eventually they broke apart into several "sandwich" chunks. Over time, especially during the periods of glaciation, the process of erosion exposed the higher, western, "up-tipped" edges of the these basalt beds, since trap rock is considerably harder than brownstone. The broken western edge of each broad basalt slab became a basalt ridge. This explains the characteristic profile of traprock ridge, visible on Mount Higby, from Interstate 91: a steep western slope/cliff and a gentle eastern slope. As west-facing summits continue to erode, chunks of basalt keep falling onto the western slopes, and create the *talus slopes* so characteristic of traprock ridges.

The ridges often show an interesting triplet pattern: a taller ridge corresponding to the Holyoke basalt bed is associated with two much lower parallel ridges, an anterior and a posterior one (corresponding to the thin slabs of Talcott and Hampden Basalts). The brownstone "glue" between the up-tilted layers of basalt rock has been weathered away. The far north end of Cathole Ridge shows this pattern very clearly. Sometimes the smaller ridges have been squeezed against the primary one. Wetlands are often found in the dips between ridges, including outstanding vernal pools,

Most of our traprock ridges originated as described above, from the western edges of cracked lava slabs. In central Connecticut (Berlin, Southington, Plainville, New Britain, Newington, and Rocky Hill) these include the four ridge systems extending northerly from four prominent peaks in Meriden and Middletown: The Hanging Hills, Cathole Mountain, Mount Lamentation, and Mount Higby, as shown on the attached topographic map.

However, some "intrusive" formations like Sleeping Giant and West Rock[2] in Hamden and Cheshire were formed underground. The oozing lava cooled slowly underground, rather than on the surface. Crystals are larger in this slow-cooled rock, called diabase, visible to the naked eye. The rock weathers more slowly, but mineral composition is identical to basalt. These intrusive ridges or *dykes* were buried by sediment and then gradually exposed by weathering and glacial scour, just like the basalt ridges.

Connecticut's continuous, above-ground traprock ridge system extends northerly into Massachusetts, but cracks in the rift valley oozed lava as far north as Newfoundland.

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[1] An infertile "tropical" soil forms from brownstone parent material unless it is enriched by basalt glacial till or by river sediment.

[2] The name of West Rock (West Haven and Hamden) changes, first to Prospect Ridge, and then to Peck Mountain in North Cheshire.

Intermittently exposed basalt also occurs in Newark and Hoboken, New Jersey (the Palisades) and in the Pomperaug valley in Southbury and Woodbury, Connecticut.

2.0 SOCIETAL CONSIDERATIONS

2.1 Hiking

The long contiguous traprock ridge systems already have excellent ridge-top hiking trails, with many excellent views across central Connecticut from exposed summits and outcrops. West Peak of the Hanging Hills is 1024 feet above sea level. In contrast to the very steep grades on many side slopes, ridge crest terrain undulates gently up and down, alternating between exposed sunny, rocky outcrops and shaded dips, for moderately strenuous aerobic exercise. Grassy glades are a dominant and important vegetation community, with special, almost magical appeal. Trees are dwarfed, though they may be very old. One finds unusual plants like bottlebrush grass and ebony spleenwort, and colorful wildflowers in spring and fall. Blueberries are a mid-summer attraction, sunflowers in late summer and early fall. Deeply shaded hemlock groves are also common.

2.2 Aesthetics, Heritage, and Microclimate

The undeveloped ridges form contiguous greenbelts that contrast with the developing valley, a green respite for the eye. Basalt cliffs are visually striking - whether eight or eighty feet tall - changing in color with light conditions. The distinctive ridge profiles are part of our local heritage. Lichen-covered rock outcrops, boulders, and talus are also visually interesting, exciting photo-subjects. An unaltered rock geologic formation often tells rich, geologic story, valuable to a high school earth science student and of scientific interest to a PHD researcher. Long distance views from traprock summits also teach local geography.

The traprock ridges also contribute to our quality of life in other ways. Transpiration from trees on the ridges cools ambient temperatures in the intervening developed valleys. Even low ridges serve as a windbreak against bitter winter winds from the west and northwest. They are important refuges for songbirds and wildlife, allowing many species to persist in the Hartford metro area, even after the valleys are largely developed, for us to observe and enjoy.

2.3 Erosion Prevention

Many ridge side slopes are extremely steep, especially to the west, but are naturally protected by a layer of rock chunks (talus), with compost in the crevices, often several feet thick. Rainfall that falls on these slopes infiltrates; it is filtered and enriched with plant nutrients by the compost, resulting in slope base plant communities of exceptional quality. The underlying soil is fine-textured and highly erosive, either Ludlow silt loam or Wilbraham loam. Even a road

cut parallel to the steep contours results in erosion when the protective talus is removed and the soil is exposed. This can be observed along a gas line service road on the east slope of Prospect Mountain in Cheshire. The fine-textured soils on traprock ridges are highly erosion-prone during construction, especially where the terrain is steep or soils are seasonally saturated by hillside seepage. These fine soil particles, and also the stone dust generated during blasting, settle out very slowly in detention basins, streams, and rivers, causing adverse impacts of long duration.

2.4 Water supply

The majority of the traprock ridges have at least one reservoir at the base of a slope, for example the reservoirs around the Ragged Mountain. Large, linear wetlands are usually found at the base of traprock ridges, parallel to the lower slopes, the headwaters of streams. Mirror Lake at the base of the Hanging Hills is the centerpiece of Hubbard Park in the City of Meriden. Rainfall onto the forested ridges often flows underground to replenish the reservoirs and wetlands with clean water. Flowing streams high on the hillsides are apt to disappear into the ground, as the water switches to below-ground channels. Grading and blasting on traprock ridge slopes has a high likelihood of degrading groundwater and downgradient wetlands and surface waters, and altering flow patterns.

3.0 CRITICAL HABITATS

The ecological communities found on trap rock ridges are distinctive; very different from the plant communities found on ridges in the Eastern and Western Highlands of Connecticut, but remarkably similar to each other. There are two reasons for this. First, the sub-acidic, volcanic soil on traprock ridges is less acid, richer in minerals, like calcium and magnesium, and finer textured than most Connecticut soil (soil derived from brownstone, granite, gneiss or schist.) Second, the thin soil, rocky outcrops, cliffs, steep talus slopes, and boulder fields create a variety of unique ecological conditions. In each of the habitats listed above, plant species may need (or prefer) the mineral-rich, sub-acidic soil derived from basalt; these species often also thrive in circum-neutral soils derived from limestone, found only in the far western part of Connecticut.

CT DEEP Ecologist Kenneth Metzler and other wildlife biologists have identified six Critical Habitats (CT ECO[3]) which overlap with Five of the Twelve Key Wildlife Habitats[4] on the trap rock ridge system. These include exposed summits, grassy glades, high-elevation shrublands,

[3] Connecticut Environmental Conditions online (eee.cteco.uconn.edu); the four trap rock critical habitats are described in Legend Descriptions Section, for Connecticut's Critical Habitats. Botanist Ken Metzler updated this list in 2009 before he retired

[4] The Twelve Key Habitats are described in detail in Chapter 4 of the Connecticut's Comprehensive Wildlife Conservation Strategy.

talus slopes (both sunny and shaded), and dry sub-acidic forest on summits and upper slopes.[5] [6]These are shown and described in the accompanying slideshows.

Each ridge encompasses multiple critical habitats. Their limited extent in the state adds to the value of these habitats. The total land area of the traprock ridge system is low, occupying less than five percent of the central valley in Connecticut and Massachusetts. This is clearly evident on the Bedrock Geology Map of Connecticut, showing multiple, narrow red and pink basalt or diabase ribbons, within a broad expanse of tan-colored sedimentary rock (see Figure 2.) Sedimentary rock still underlies most soils in the central valley. Most of the basalt is still deeply buried; just the high western edges of the basalt beds are exposed.

The stated purpose of Critical Habitats information is "to highlight ecologically significant areas and to target areas of species diversity for land conservation and protection. Biologists may use this data to target further research on associated plant and animal species." (quote from ECO website) However, it does not it itself provide protection under the Endangered Species statute, unlike presence of a listed species (though they are much more likely to occur in Critical Habitats than elsewhere). The larger critical habitat categories have been mapped on the ECO website; the habitat descriptions enable identification of the many smaller unmapped units. Many are degraded, but extensive critical habitat areas on the ridges of central Connecticut still support the expected characteristic ecological communities of native species.

3.1. *Lower slopes*

The rich, sub-acidic soils on the lower ridge slopes support sugar maple forest including white ash, basswood, tulip poplar, and hop hornbeam, all forest species characteristic of fertile mid-western soils. Canada moonseed is a distinctive, uncommon vine, the larval food plant of the rare pipevine swallowtail. Ferns, spring wildflowers, and sedges, are diverse, especially among talus chunks at the base of the western slopes. Christmas fern and Marginal Wood fern are dominant, Grape fern and brittle fern are quite rare. Wildflowers include Dutchman's breeches, Bloodroot, Anemonella, Snakeroot, and Wild Ginger. Golden Ragwort, Pale Jewelweed, and Toothwort grow in nearby slope-base wetlands, which are also rich in minerals. On the lower slopes, sugar maple forests include stands of Tulip Poplar.

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[5] The CT- ECO Critical Habitats are 1) Dry Subacidic Forest (DSF), 2) Subacidic Cold Talus Forest/Woodland (SubCTFW), and 3) Subacidic Rocky Summit/outcrop (SubRSO) with 3 subtypes: a) Scrub Oak Woodlands (found on trap summits), b) Glades and Balds (found on dry trap rock exposed summits and outcrops), and c) sparsely vegetated Cliffs and Unconsolidated rock). Connecticut's List of Twelve Key Wildlife Habitats[5] also includes Dry Oak Forests and pH Neutral Forests (moist).

[6] Many habitat units are small and were not included on the on-line CT-ECO map (only some towns were fully mapped), but the botanical and physical descriptions in the CT-ECO Key and in Chapter 4 of the Comprehensive Wildlife Management Plan, are clear, such that these critical (key) habitats can easily be identified in the field.

3.2 *Talus slopes*

This unique habitat is classified as a Critical Habitat by CTDEEP. Layers of rock chunks protect steep, erosible soil, infiltrate rainfall, and trap leaves to form fertile compost. Water that seeps though talus slopes enriches the forest and wetlands below. The miniature pink-flowering geranium, Herb Robert, is found on only on exposed traprock talus slopes, growing along side Marginal Wood fern, Red Elderberry, and Virginia Creeper. Some talus slopes are sunny and exposed; others are shaded by scattered trees, especially Basswood, Hop Hornbeam, and Sugar Maple trees. Foliose and crustose lichens grow on talus surfaces. Several snakes species, Spotted and Jefferson Salamanders, and Eastern Box Turtles find shelter under the rocks. Specialized insects, like tiger beetles, use talus habitat as well.

Cool air sinks through the talus, creating a cool microclimate. Especially at the base of north-facing basalt slopes, habitat is suitable for plants of more northern ecoregions, like Purple-flowering Raspberry and Mountain Maple. This is another Connecticut Critical Habitat with potential for rare species. Snow is found year round in some of these areas, per late botanist Les Mehrhoff.

3.3 *Summits and Upper Slopes*

The *glade, dry forest, and open summit* communities are three additional traprock communities classified as Critical Habitat by CTDEEP. The thin soils interspersed with rocks on the upper slopes and summits of the ridges support a distinctive forest community with hickories, White Ash, Hop Hornbeam, Red Cedar, Chestnut Oak, and. Hemlock groves may also be present, though they may be stressed by sucking insects. These trees are low in stature for their age, and typically grow in a "grassy" *glade* (actually Pennsylvania Sedge) or *bald*. Diverse ferns, wild flowers, and native grasses often grow in pockets of soil among boulders and rocks, sometimes in glades, and sometimes on exposed outcrops. Polypody Fern, Ebony Spleenwort, Harebell, Comandra, Wild Licorice, Smooth Rock Cress, Three-lobed Violet, Wild Oat Grass, and Bottlebrush Grass are characteristic, among many others. Fall-blooming wildflowers include uncommon species of aster and goldenrod, also adapted to the mineral-rich soil derived from volcanic rock – like Wavy-leaved Aster, Stiff Aster, and Smooth Aster. Each of these plant species is associated with host-specific butterflies and other fauna. For example, the orange falcate butterfly, found only on traprock ridges, feeds on Smooth Rock Cress. Shadblow is visited by flocks of Cedar Waxwings in June when the fruit is ripe.

Table 1, attached, is a list of plant species observed on traprock ridges of Central Connecticut in the spring and summer of 2011 -13. Traprock habitats also support many plants on the

Connecticut List of Endangered, Threatened and Special Concern Species (See Table 2, attached).

3.4 *Shrub thickets*

Stable shrub thicket is yet another critical habitat category, per the CTDEEP classification. Thickets may be the dominant groundcover on exposed, treeless summits: Scrub Oak, Downy Arrowwood, and Black Chokeberry, and low mats of blueberry and huckleberry. Edward's Hairstreak and many other insect species feed on oak on traprock summits, and blueberries are important food for wildlife as well as a treat for hikers. This cover type is uncommon in the eastern US, as trees usually grow up to shade out shrub thickets, unless soils are very thin. Bladdernut is a rare, thicket-forming shrub of traprock soils, found only on a few ridges.

4.0 WILDLIFE

As noted above, uncommon plants in each of the critical habitats are associated with uncommon insects or pother animals. The ridges are also a refuge for many formerly common insects, that have grown scarce in suburbia, like the metallic blue Six-spotted Tiger Beetle. The traprock ridges also support larger state-listed listed wildlife, like Eastern Box Turtle and Jefferson Salamander. Caves under large boulders provide dens for the uncommon, though not state-listed Bobcat.

Many migratory forest songbird species fail to breed successfully in the fragmented forests in suburbia, but can do so in the large contiguous forested ridge systems, such as the Cathole Mountain, Hanging Hills, Prospect Ridge, and West Rock, with minimal loss of eggs and nestlings from predation and parasitism. Such birds include Scarlet Tanager, Ovenbird, Black and White Warbler, and Worm-eating Warbler. Forested acreage on this scale (over 250 acres) is not available elsewhere in central Connecticut, except around Broad Brook reservoir.

The extensive contiguous forests also provide terrestrial habitat for some very large populations of Wood Frogs and salamanders; trap rock vernal pools are often tucked between primary and smaller ridges; many have egg mass counts in the order of 300 to 500.

5.0 OTHER CONSERVATION CONSIDERATIONS

5.1 *Genetic Reservoirs*

The ridges provide continuous habitat bands connecting some sizable populations of these and other plants – and associated fauna. (The exact number depends on lifespan and extent of interbreeding, etc, but it is usually thousands of individuals.) From a conservation standpoint,

plant or animal populations are not healthy unless the breeding population is large enough to encompass a healthy level of genetic diversity. This is very important for conservation of statewide uncommon species (not just rare ones). Many of the species that may be somewhat common in plant trap rock summit communities, like Bottlebrush Grass, Ebony Spleenwort, Red Columbine, and Three-lobedViolet, Hop Hornbeam, and Basswood, do occur elsewhere in the state, but are scarce and widely scattered. The same holds for fauna, such as ratsnake.

5.2 *Lower Slopes as Habitat & Community Features*

Lower ridge slopes are important habitat in themselves, for terrestrial stages of vernal pool species and for migratory song birds, as mentioned above. Many rocky lower slopes and slope bases have diverse, interesting minerotrophic plant communities, including Bloodroot, Wild Ginger, Sweet Cicely, Blue Cohosh, and Pipevine (which supports the rare Pipevine Swallowtail butterfly). The displays of spring wildflowers and ferns and the magnificent trees on these lower, rich traprock slopes have aesthetic and natural heritage value, even if not listed by CTDEEP as critical habitats. They also have potential for profitable forestry, and also sugaring, due to dominance of sugar maple. On other, gentle, forested lower slopes, past farming has reduced plant diversity, but they may still have been colonized by rare or uncommon species, such as grape fern and unusual sedges. Note that with large lot sizes, a substantial fraction of the native flora on a traprock lower slope, can be preserved and the need for grading and blasting is minimal, aside from the driveway. Botanical screening before development can identify notable resources beforehand, to allow protective planning.

5.3 *Lower Slopes and Buffering Ridges: Protection from Invasive Plant Infestation*

Statewide, the spread of invasive plant species is steadily reducing plant diversity (and diversity of associated fauna). However, the lower slopes of trap rock ridges often serve as a buffer protecting the unique ridge crest trap rock communities from invasive plant infestation and human disturbance. If the ridges are high enough, or if the central ridge is protected by an anterior or posterior ridge, invasive propagules may have simply not yet reached the critical habitats. Or a few scattered individual colonizers may fail to produce fertile seeds without pollen from a genetically different plant.

In the interior of the Metacomet system, in Berlin, there is still extensive trap rock ridge critical habitat that is not yet infested with invasive plants. This includes forests, glades, summits, and talus slopes. For example the ridge crest of Cathole Ridge, near Silver Lake, is very high and well buffered, and still free of invasive infestation. Even the low ridge on the north end of Cathole Ridge has unspoiled native traprock vegetation, likely because few invasives grow in the adjacent neighborhoods.

By contrast, on the western periphery of the Metacomet Ridge system, in Plainville, west of I-84, Autumn Olive has severely infested residual basalt ledge habitats, following extensive quarrying. In Farmington Spotted Knapweed sprouts from every ledge and crevice along roadcuts through traprock. On far north end of Peck Mountain in Cheshire burning bush was heavily used in landscaping on the developed lower slopes, and has spread throughout the remaining forest ridge crest; traprock wildflower and fern species have been extirpated, though seeds in the soil might still sprout, if the burning bush thicket were cleared.

On the northeast side of the Metacomet Ridge system most of the lower slopes have been developed, and the ridges are over-run by non-native plants. At the Beckley Farms construction site in East Berlin a several-acre plateau with embedded vernal pools and rare sedges has become a monotonous expanse of thorny Japanese barberry (rejected by livestock in this former pasture). In Rocky Hill, along the low east-west trending traprock ridge that includes Dinosaur State Park, west of I-91, corporate parks and hotels are the dominant land use. One remaining bedrock knoll, with a red columbine population, is overrun by two biennial invasives: Garlic Mustard and Hairy Cress. Farmland and roadside invasives (Morrows honeysuckle and Asiatic bittersweet) are also common wherever the ridge is not yet developed.

5.4 Invasive Control

Some invasive plants are suited to control by volunteer work parties; others are not. In May, of 2013 volunteers from the Berlin Land Trust and the Connecticut Botanical Society pulled out annual garlic mustard and hairy cress on the lower south slope of Ragged Mountain, but more will sprout from the seed bank – garlic mustard seeds are reported to stay viable for seven years. Stalwart volunteers can also dig out small to moderate-sized barberry plants, which do not resprout from remaining root fragments.

In critical traprock habitats, the root systems of larger perennial invasives plants may be too entangled with sensitive plants for simple pulling, especially if soil is dry. However, pesticide applicators need sound knowledge of traprock flora for careful spot treatment of invasives.

Garlic mustard and cress have small seeds, likely carried on hikers' shoes. Garlic mustard has colonized parts of Cedar Mountain in Newington, well used by hikers. Cleaning boot treads is advised before traprock hikes and workparties.

5.3 Sewering and Wetland Resources

One reason that ridge ecosystems in central Connecticut often remain intact from crest to base, is that traditional, non-sewered residential development has been excluded by shallow

bedrock, high groundwater tables, and steep slopes. If sewers are brought into these areas and more homes and condos are built on trap rock hillsides and ridge crests, not only will invasive plants and human disturbance threaten the traprock critical habitats, but the linear wetlands at the base of almost every trap rock ridge will be threatened by erosion and loss of high-quality seepage through talus slopes. (Sewerlines typically divert groundwater along the stone trenches.) These vulnerable slope-base wetlands are mineral-rich and sub-acidic (almost neutral), just like the terrestrial plant communities on soil derived form basalt. They are also more diverse than comparable wetlands in a landscape with acidic bedrock.

6.0 CONCLUSION

The traprock ridges of Central Connecticut are unique, valuable, and vulnerable. They warrant more publicity, more effort to keep out nuisance plants, more emphasis in school curricula, and efforts to close the remaining conservation gaps between existing open space preserves. With the growing interest nationwide, in fitness and in the environment, public support should be readily forthcoming. This report may guide changes in Berlin's Zoning Regulations and Plan of Conservation & Development.

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ATTACHMENTS:
Figure 1 - Bedrock Geology Map; Figure 2 - Annotated Topographic map of Central Connecticut (Meriden to Hartford). Available upon request: Table 1 – List of Traprock Plant Species observed by Sigrun Gadwa and other CT Botanical Society members, 2010-2013; Table 2 – List of Rare Plant Species that occur in Traprock Habitats; Ontario Breeding Bird Survey of Southern Cathole Mountain.

Photos: Below are two links to slideshows showing trap rock geologic features, plant community types, and other natural resources. Photographs were taken in the spring (mostly lower slopes and slope base wetlands) and summer of 2011, in Berlin, Rocky Hill, Meriden, Southington, and Cheshire. The first album focuses on critical habitats along summits and on upper slopes; the second on lower slope habitats and slope-base wetland resources.

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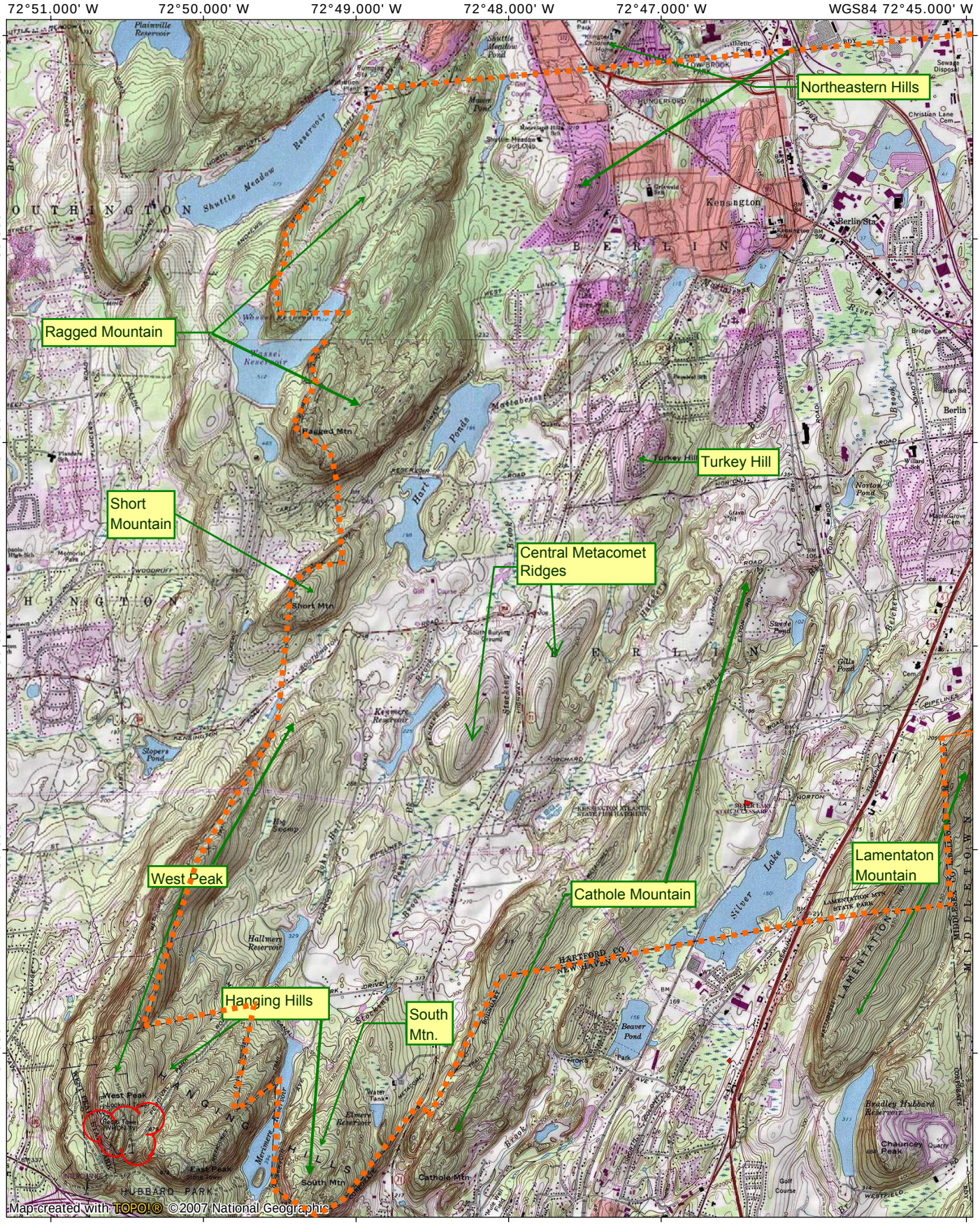
Instructions: Highlight and copy the entire URL and paste it into your browser. Click at upper left, and use arrows to proceed through slideshow, reading captions. You will not have access to any other part of FACEBOOK.

Figure 1: Metacomet Traprock Ridges in Berlin, Central Connecticut, beginning with the Hanging Hills



NATIONAL GEOGRAPHIC

0.0 0.5 1.0 1.5 miles
0.0 0.5 1.0 1.5 2.0 2.5 km

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14°
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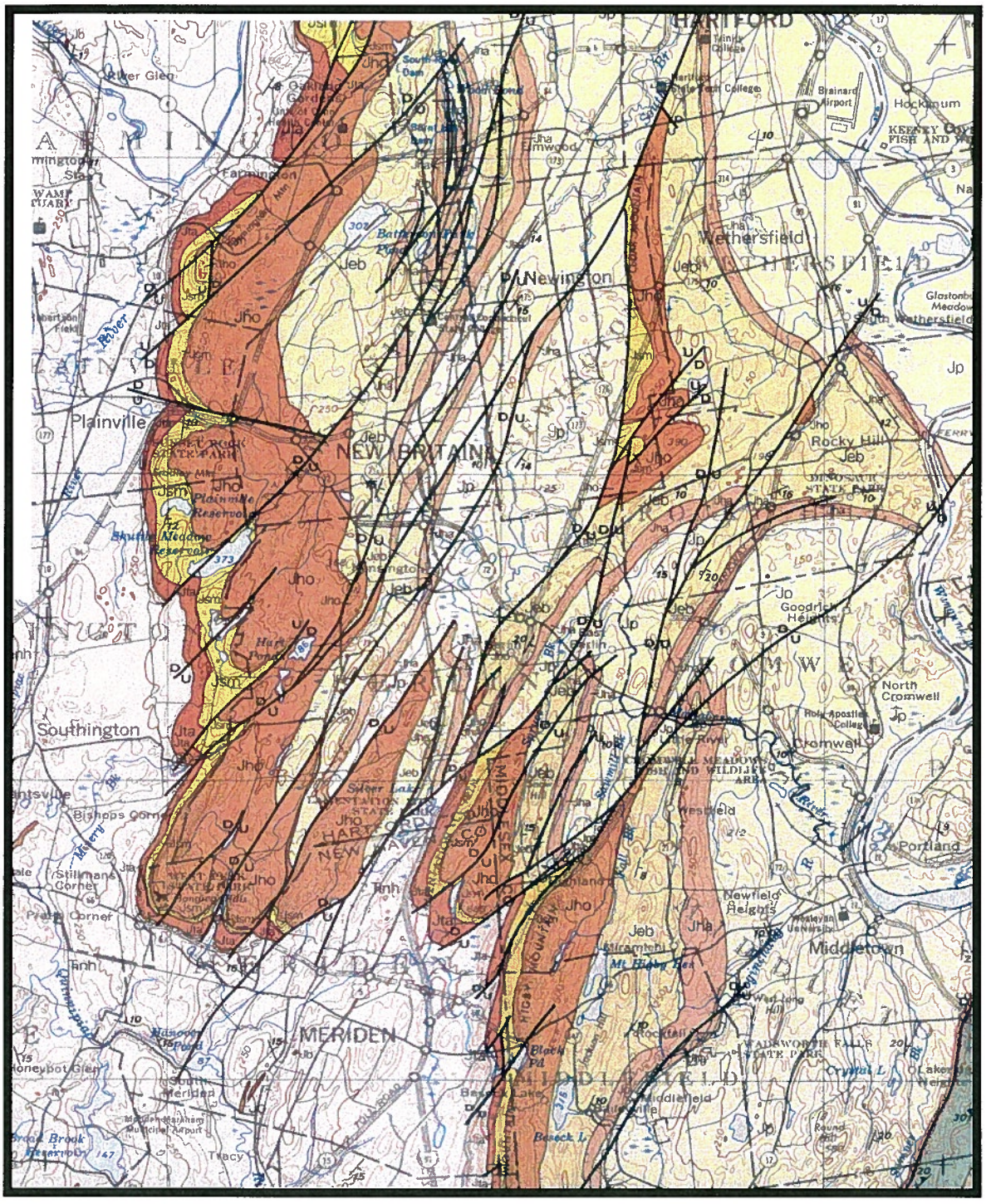
Figure 2: Bedrock Geology in vicinity of the Metacomet Ridge in Central Connecticut



KEY

Jho	Holyoke Basalt (central primary ridges)
Jta	Talcott Basalt (anterior ridges)
Jha	Hamden Basalt (posterior ridges)
Jp	Portland Arkose (reddish-brown sedimentary rock- brownstone)
Jeb	East Berlin Formatin (sedimentary, reddish brown silty shale)
Trnh	New Haven Arkose (poorly sorted, reddish sedimentary rock)

NOTE: Soils in close contact with basalt are subacidic and rich in minerals. However, glacial till may be thick enough on some gentle slopes, that soil is little influenced by traprock minerology.

Map prepared on 8-12-11.
by CARYA, after Rodgers 1985.