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Geology of Ford Glen & Beinecke Tract

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ES102

This project started with the goal of mapping the surficial deposits of the Hopkins Memorial Forest and assessing their influence on the above ground environment. Field work revealed that there is little variation of parent material, mostly till, and consequently changes in vegetation would probably be related more strongly to other factors. However, on my walks in the Beinecke Tract and along Ford Glen Brook I encountered many interesting geologic features which interested me. Consequently, my aim became to survey the geology and ongoing geologic processes along the lower part of Ford Glen (below about 260m) and within the Beinecke Tract and look at any relationships to the environment.

To achieve this goal I spent a lot of time walking through the forest with a shovel and digging pits to find parent material. My field work produced data of locations, elevations and observations of outcrops, changes in slope, interesting river features and geologic contacts. With these I have produced a surficial map for part of the Ford Glen Watershed and the Beinecke Tract(attached). I have also plotted surface water flow on a draft copy of an orienteering map being surveyed of the forest at this time. This map is at a scale of 1:5000 and has a contour interval of 5 meters. For elevations I plan to use metric units but other descriptions may include english measurements for convenience.

To understand the Geology that we see today in this part of the Hopkins Memorial Forest we must look at what we know about the geological history of the area. Between 500 and 550mya what is

today the eastern seaboard of the North American continent was rotated about ninety degrees southward to a tropical climate. A passive margin existed at the edge of the continent, similar to present conditions, which means that a sea-floor spreading event was forming a proto-Atlantic ocean. In this tropical, stable environment coral reefs grew and over millions of years their carbonate skeletons formed layers on the ocean floor near of the continental shelf.

Concurrently, erosion removed material from the land surface and water transport brought sand, silt and clay into ocean waters. During times of high discharge, in the spring or after storms for example, this sediment may have formed a pocket of sand or silt in between carbonate deposition. Farther offshore deep-sea muds formed thick layers that began to lithify into mud and silt stone. The carbonate also became rock, limestone, due to the pressure from new layers on top of old.

Soon after 500mya the North American plate began to rotate towards its present orientation and the proto-Atlantic began to close as the African continent drifted towards North America. During the time between 480 and 440mya the plate convergence, named the Taconian ^{or} ~~E~~rogeny, continued and involved a collision of North America with a volcanic island arc and later Africa. Intense heat and pressure metamorphosed limestone to marble and dolomitic marble, siltstone to slate, phyllite, schist or gneiss, and sandstone to quartzite. The convergence also thrust the offshore stone, ~~ph~~yllite over the marble layer so that at the contact between the two masses older rock overlays younger rock beneath it. Less than ~~a~~ 100 million

years later the Acadian orogeny again subjected this area to heat and pressure which further folded and deformed bedding and contacts.

These orogenies formed a mountain range that at one point reached close to 30,000 feet in height. Over millions of years wind, rain and ice eroded these peaks through climatic fluctuations. Most of the major surface features visible today are directly related to the many glacial epochs in recent geologic history. The last glaciation, the Wisconsin^{an}, peaked about 22,000ya when an ice sheet extended from Canada to the present location of Long Island, Martha's Vineyard and Nantucket. Ice carved characteristic U-shaped valleys and it scraped vegetation, soil and bedrock as it moved south. During the ice retreat, it left behind the material it carried in a number of forms, including till, erratics, eskers, kame deposits and glacial outwash sand and gravel. Roughly 15,000ya, the ice cleared this area and the processes of soil development, revegetation and erosion due to surface water flow began anew.

These processes continued largely uninterrupted until the arrival of Europeans in the 1700's. Since that time, farming and development have altered vegetation patterns and stripped soil from the landscape. However, basic geology remains the same and we can see evidence of past events as well as examples of current processes along Ford Glen and in the Beinecke Tract by looking at bedrock, surficial geology and water movement above and below the surface.

Bedrock in the study area gives evidence of past tectonic activity I have discussed. The surficial map has outcrops marked with dots or lines and labeled according to rock type. Immediately below Northwest Hill Road on Ford Glen a large phyllite exposure is

visible.(fig.1) Phyllite is visible almost continuously along Ford Glen from the bridge at 240 meters elevation to about 212 meters above a pond visible on the map. The rock is very crumbly and flaky, probably due to a high mica content. As a result, water has downcut a significant amount to create banks with phyllite exposures of up to fifty feet.

Between 260 and 280m in the Beinecke Tract I located four phyllite outcrops which all face downhill to the east. Debris from the rock litters the ground just downslope which illustrates its soft, flaky composition. These outcrops occur at rises in topography which tend to have thinner surficial deposits and are prone to erosion because of their prominence. In this upper region I found no outcrops of quartzite or dolomitic marble.

At an elevation of approximately 213 meters along Ford Glen I located the contact between phyllite and dolomitic marble on the south bank of the stream. (fig.2) The dolomitic marble exhibits dramatic coloration and banding which may have been formed by thrusting of phyllite over it during tectonic activity.(fig.3) On the north bank only dolomitic marble is present and it is uninterrupted on that side of the river until sediments bury the outcrop near a man-made pond. However, for about 150ft. of distance, phyllite remains on the south bank as seen on the surficial map. This means that Ford Glen exploited the weaker stone at the contact between the rock units to cut its path in this area.(fig.4)

Further downstream, below the pond, phyllite returns as bedrock. It either represents a layer of sediment from the ancient depositional environment or more likely, a chunk of phyllite

impressive
gorge

Don't
use m
or
meters
--- ft
or feet

it was
gradually
interlayered
with the shale

very
good

stranded there due to faulting and deformation during metamorphic events. This outcrop begins at about 200 meters and although I do not have an exact location for its terminus I know dolomitic marble returns along the Hoosic River which is 30 meters lower.

Within the Beinecke Tract the contact between phyllite and dolomitic marble is obvious as well. At 245 meters there is a line of dolomitic marble cliffs indicated on the surficial map.(fig.5) These exposures are about five meters high and run intermittently along a north-south trending line. Like phyllite outcrops higher up, these face to the east and the ground beneath them is littered with debris, in this case cobbles and boulders from the cliffs. Above the escarpment, topography becomes very steep and phyllite shards are visible on the ground at the site marked with a number six. These observations coupled with the end of cliffs vertically at that point suggest that the contact exists at 250 meters, +/- 10m in this part of the Beinecke Tract. This represents a difference of elevation with the contact at Ford Glen of 40m. Clearly the boundary is not a straight line, but rather very folded and the finger of phyllite on Ford Glen is probably an indication of many impurities on both sides of the contact due to thrust faulting millions of years ago.

Below the cliffs, there are several more outcrops indicated on the map. Most are dolomitic marble with quartz veins, but I did find two quartzite outcrops. These could be used as evidence for fluctuations in the ancient depositional environment which I described earlier. Dolomitic marble outcrops often contain quartz veins which are the result of metamorphic forces that forced heated mineral fluid into

THIS
WAS
A
FAULT!

ALL
this
is
a
separation
that
only
detailed study could lead to... nice!

fissures. As the liquid cooled, quartz precipitated out and filled the cracks which expanded as the cooling stone contracted.

Bedrock determines the general topography of mountains and valleys, but smaller features are determined by surficial deposits left by ice and which have since been reworked by weather and erosion. Generally, uplands are covered by a layer of till of varying thickness which is dotted with deposits such as the fan delta deposit in the Moon Lot. Valleys tend to have thick sand and gravel deposits in various ice contact forms. Other surficial units include lake sediments from glacial lakes and alluvial material. The Beinecke Tract is in a transition zone between highlands and lowlands so it is reasonable to expect some variation among surficial material.

As expected, the dominant material is till of which I found two general types with some variation in one. The surficial map shows in gray an area in which I found and infer to be a phyllite-rich till. At locations marked with numbers four, five, six and ten I found material dominated by phyllite fragments starting right below a thin or nonexistent A-layer. It is also present on the banks of Ford Glen either as till or as debris from bedrock exposed by downcutting. I hypothesize that the origin for this phyllite is Northwest Hill which the advancing ice would have moved directly over and to the south. This theory is supported by the fact that there is a clear break between this phyllite-rich till and a more generic till at the contact with the dolomitic marble.

*Small lake till
thin
phyllite
fragments*

A brown, clast-rich till lies to both the west and east of the phyllite-rich till. At site number three near the Rosenberg Center I found a very compact, consolidated till at a depth of about two feet.

This same light brown deposit is visible at site 1a where two small intermittent streams enter Ford Glen and expose till below. (fig.6&7)

At lower elevations in the Beinecke Tract are several exposures of till at sites marked with numbers seven and eight. This material is also brown and contain clasts from gravel to cobble size. However, it is not as consolidated as the similar deposit at higher elevation; in fact, ground water seeps through and appears at a site in the southeast corner of the tract while the other till is impermeable to ground water flow.

Just outside the southeast corner of the Beinecke Tract is a fluvial terrace composed of gravel, sand and silt which has almost no visible structure. The terrace is at an elevation within a couple meters of 190m (about 635ft.). This corresponds with an established Lake Bascom level which existed late in the history of the glacial lake. Therefore it seems that Ford Glen used to empty into the lake in the same general location as it does today. Underneath the fluvial material is a layer of till which the ice dumped while the lake formed. There is evidence of this layer at one area along the front of the deposit where a seep of ground water appears and carries out brown silt and sand. This represents another contact between surficial deposits.

A small feature worthy of mention is the fill deposited by humans to dam a pond along Ford Glen. This dam has altered the stream flow to cause deposition at the inlet to the body of water (fig.8), but eventually the obstacle to natural flow will be breached by the erosive forces of water unless more fill is added.

composition of the fill?

Upstream from Northwest Hill road we find a different Ford Glen then that which has cut the phyllite gorge below. Here the waterway has a lower gradient and it follows a meandering path through a small floodplain. Water has cut a channel, but the banks are covered with soil and ^{are} not sheer like the bedrock walls downstream. Meandering and floods have covered the floodplain with alluvium, silt, sand, gravel and cobbles which exhibit layering from deposition by the moving water. This material is marked in dark red on the surficial map.

In soil pit number one I found sand and gravel at a depth of less than two feet. This site is located on top of the present bank so either there is a delta deposit or the brook used to flood the land at that level thousands of years ago. At first, I thought this may be evidence for a Lake Bascom terrace graded to about 240m(800ft). However at site number three on the other side of Ford Glen I found only till which indicates that the sand and gravel may be more local. At site four there is some gravel saturated with water at a depth of two and a half feet below a confining layer of brown silt. From these observations I believe that there is a^m alluvial deposit which indicates the old floodplain of^f Ford Glen marked in light red on the map. A delta deposit is still possible because it would explain the broad terrace at 240m outside the Hopkins Memorial Forest to the south of Ford Glen. However, I do not have data to support such a hypothesis and there is only preliminary work on a theory that a Lake Bascom stabilized at a level of just over this elevation. --- GOOD --- NEEDS MORE STUDY

Water movement above and below the surface is an integral part of studying the geology of this area and I have mentioned such

flow often in the sections on bedrock and surficial deposits. Ford Glen ^s is the most prominent surface channel and the only one which flows all year. Its watershed starts at an elevation of approximately 320m and drains the area between Birch Brook watershed and Northwest Hill. Above Northwest Hill Road Ford Glen is first a typical mountain stream with small cascades and low flow before its discharge increases and its path flows through the floodplain previously mentioned. The floodplain shows evidence of meanders and levels reached by ten or hundred year floods. (fig.9) Stream grade becomes steeper below the road and water flows through the phyllite and dolomitic marble gorge described earlier. Ford Glen drains only a small part of the Beinecke Tract, other surface flow forms several intermittent streams indicated with dashed blue lines on the topographical map.

Water for these intermittent streams also comes from below the surface. At site number seven a stream channel seven feet deep and fifteen feet wide appears in the middle flat ground. (fig.10) This feature is an example of a phenomenon called piping. Ground water flow appears at the surface either because the water table intersects the surface here or there is an impermeable material which forces the water to flow out. My investigations revealed no confining layer and it appears this channel has migrated uphill over time so I believe this feature is due to intersection of concentrated groundwater flow and the surface.

2015
example
of it!

Below the marble cliffs at 240m an intermittent stream is fed by groundwater which may be flowing through the marble bedrock, though this is only speculation. On top of the cliffs is a depression

which may be a sinkhole, if so there may be cavities in the bedrock formed by water flow.

Groundwater flows to the surface along contacts at many locations in the study area. The 190m terrace is slumping along its leading edge due to a seep which is flowing above impermeable till. Glacial till forces groundwater to the surface along the upper part of Ford Glen at site 1a_x and at site A. At site 1a_x the till is visible and at location A brown silt is visible on the leaves which the water flows upon.(fig.11)

Features from the Beinecke Tract and along Ford Glen are evidence of the geological history of this area. Bedrock is predominantly phyllite at higher elevation which was thrust over dolomitic marble during tectonic activity to produce folded and deformed structures and boundaries. Anomalies such as fingers of quartzite or pockets of quartzite are the result of faulting or fluctuations in ancient depositional environments.

Glacial ice covered this area and deposited the tills found throughout the study area as well as erratics such as marble boulders near site number one and a ^{faceted} facied quartzite boulder along Ford Glen which has preserved chatter marks for 15,000 years. (fig.12) Post-glacial environments account for the fluvial terrace at 190m and could explain the large terrace at about 240m. outside the border of Hopkins Forest.

Over 10,000 years of erosion have carved the channel of Ford Glen and other intermittent or low flow brooks at low elevations in the Beinecke Tract. This flow has found the bedrock contact between phyllite and dolomitic marble along Ford Glen and groundwater

reaches the surface at contacts between surficial deposits. Contacts are important boundaries for water flow, slope and perhaps environmental conditions.

How then does geology affect the environment and land use which has most recently altered the population of organisms which exist on the surface? The most obvious geologic factor is simply topography which is the result of macro-geological events such as tectonic activity or glaciation which occur only at long intervals. Different elevations and changes in slope affect the vegetation and animals which inhabit areas and also ^{uniqueness} their use. The Beinecke Tract is special in part because of the stand of old growth trees which cover the steep slope above the dolomitic marble cliffs. According to all known records this stand was never cut, probably because it is on steep slope. As a result, a different community of organisms live in this area. Near many of the outcrops marked on my map, large trees often grow or lay fallen, left there by farmers who could not use the land immediately around the rock exposure.

Although I did not analyze soil or vegetation intensively there may be correlations between different surficial deposits and vegetation growing on them. These trends could result from differences in nutrients depending on till source (i.e. phyllite or dolomitic marble), grain size, hydraulic conductivity, etc.

Ford Glen presents a riparian environment and is host to different vegetation in its flood plain and several mosses along its path. I took water samples at five locations along the waterway, marked A through E on the map, to see if local geological conditions, specifically the change from phyllite to dolomitic marble affect water

chemistry and therefore the environment for organisms along the waterway. I tested pH, ANC, and conductivity and found no significant change in these values. This is probably because the sample area was too short for the dolomitic marble to cause the increases in these values which we found during the ES102 water chemistry lab.

In conclusion, my study area in the Hopkins Memorial Forest has evidence of the major geological events which formed this land. Observations of bedrock, glacial deposits and water flow give an understanding of present topography and allow for further study of environmental conditions such as soil chemistry and vegetation trends.

Will

We saw some good geology and you explained it well. I hope you enjoyed it & learned from the field experience.

Fig 3 looks like original sedimentary layering between marble & gabbro? or different color beds of marble

Fig 4 ... the book does explain the contact ... a fault?

Fig 12 ... nice faceted qtz boulder

A very good geologic map ... I plan to let Paul R see it as he is not familiar with the outcrops.

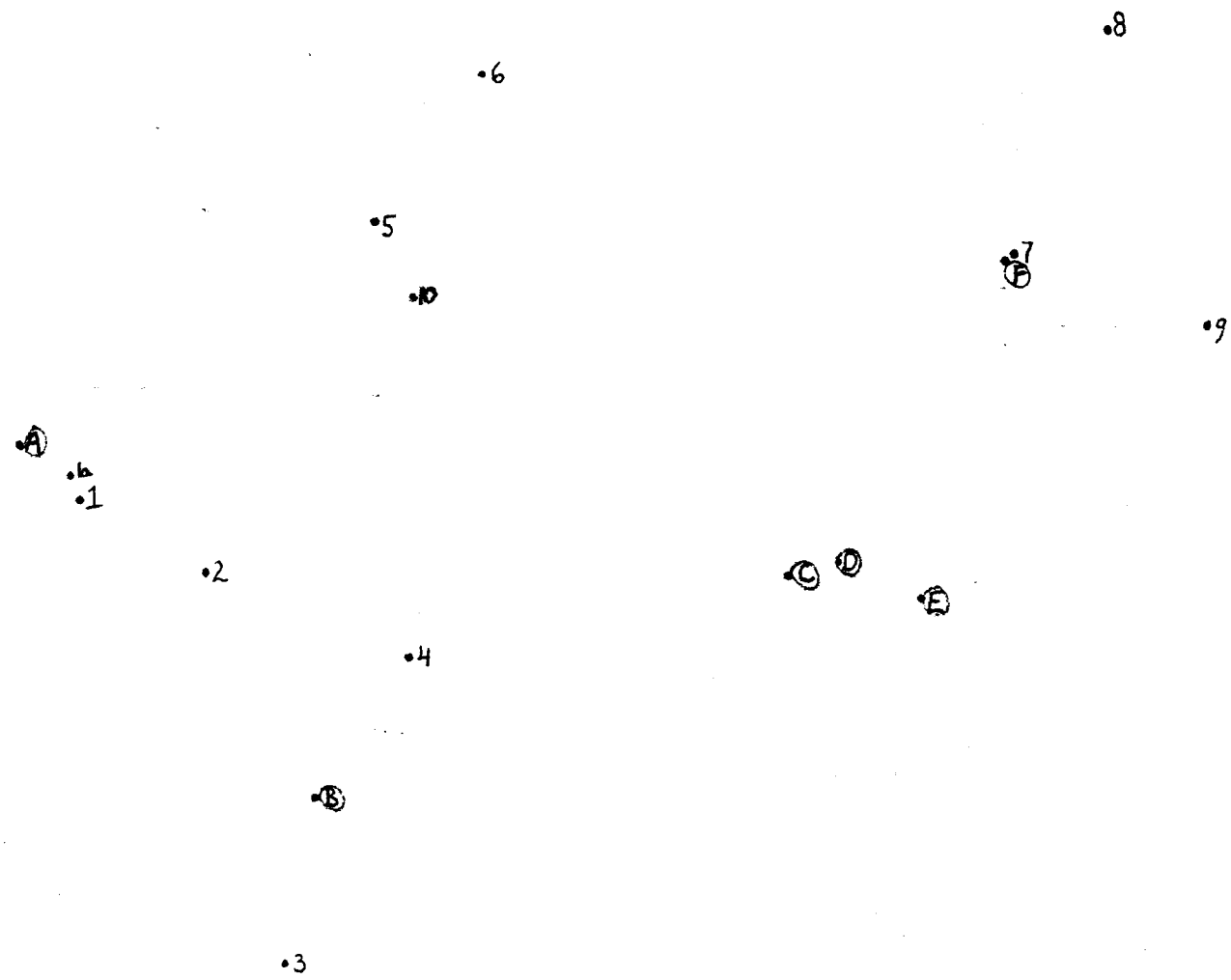
His work and I look forward to working with you again. D

Organizationally, you might have subdivided the text into sections on bedrock geology, glacial geology & hydrology, each with its own heading. I guess if time weren't a problem, a bit more editing and the overlays would have come up a notch? Again, though, really good job!

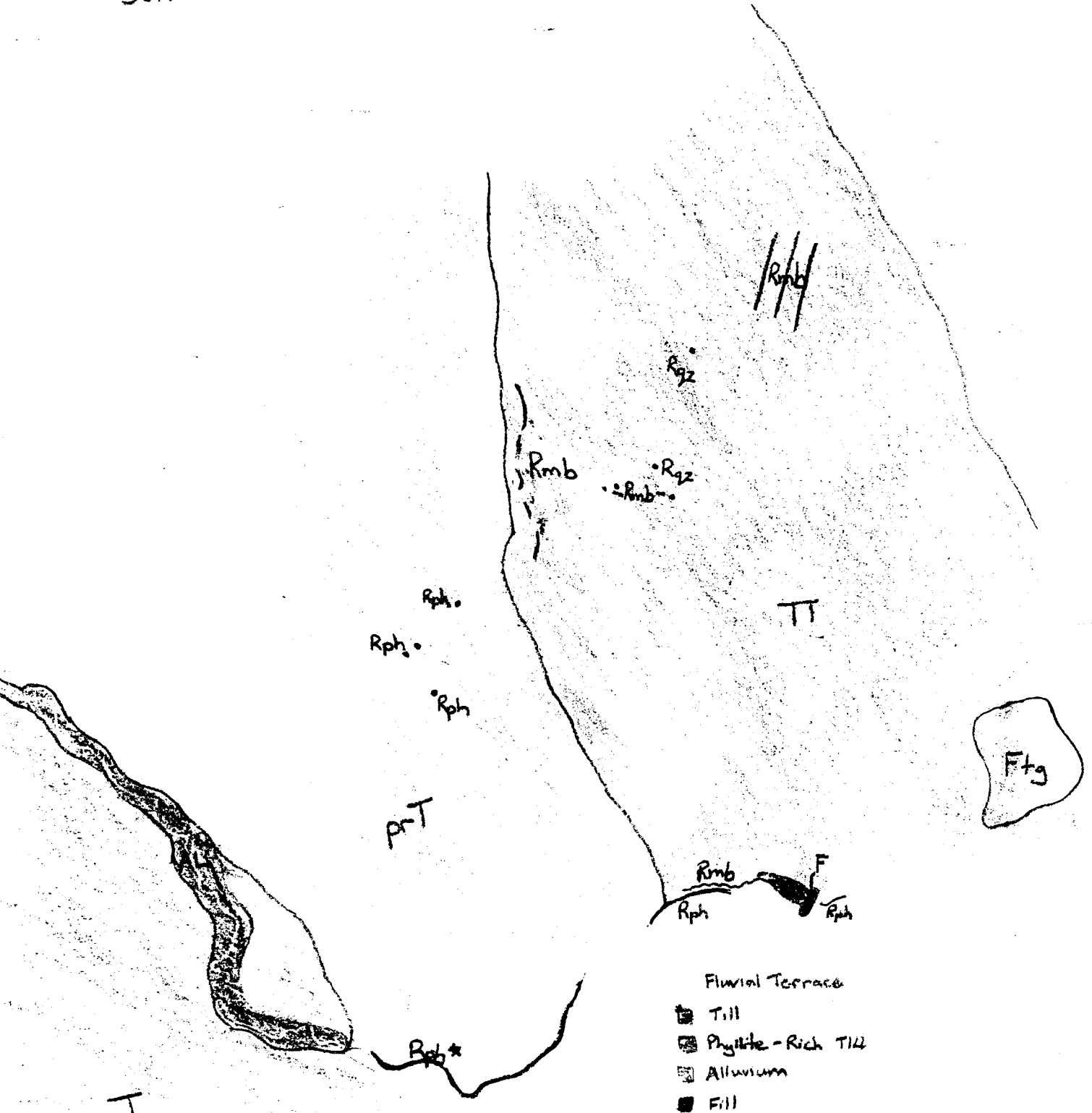
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SOIL PITS, EXPOSURES + WATER SAMPLING SITES

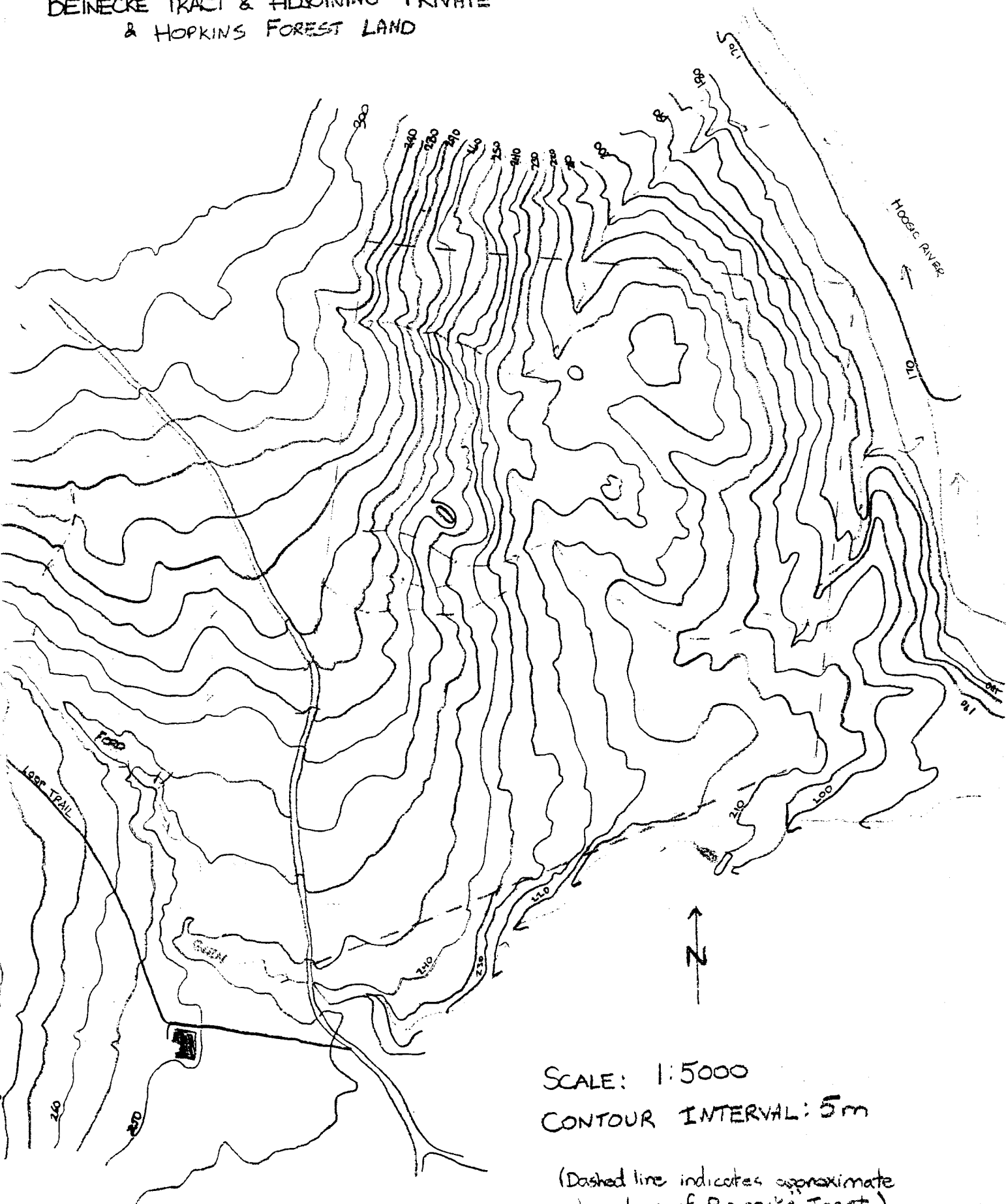
NUMBERS = SOIL PITS OR EXPOSURES
LETTERS = WATER SAMPLING SITES



SURFICIAL DEPOSITS + OUTCROPS



BEINECKE TRACT & ADJOINING PRIVATE
& HOPKINS FOREST LAND



SCALE: 1:5000

CONTOUR INTERVAL: 5m

(Dashed line indicates approximate
boundary of Beinecke Tract)

WM 1993 +



FIG 10

Example of piling
in DE corner of
Bentley Pond



FIG 11

Example of piling
in DE corner of
Bentley Pond
brown rock



FIG 12

Example of piling
in DE corner of
Bentley Pond

Fig 7

Till at site 1a

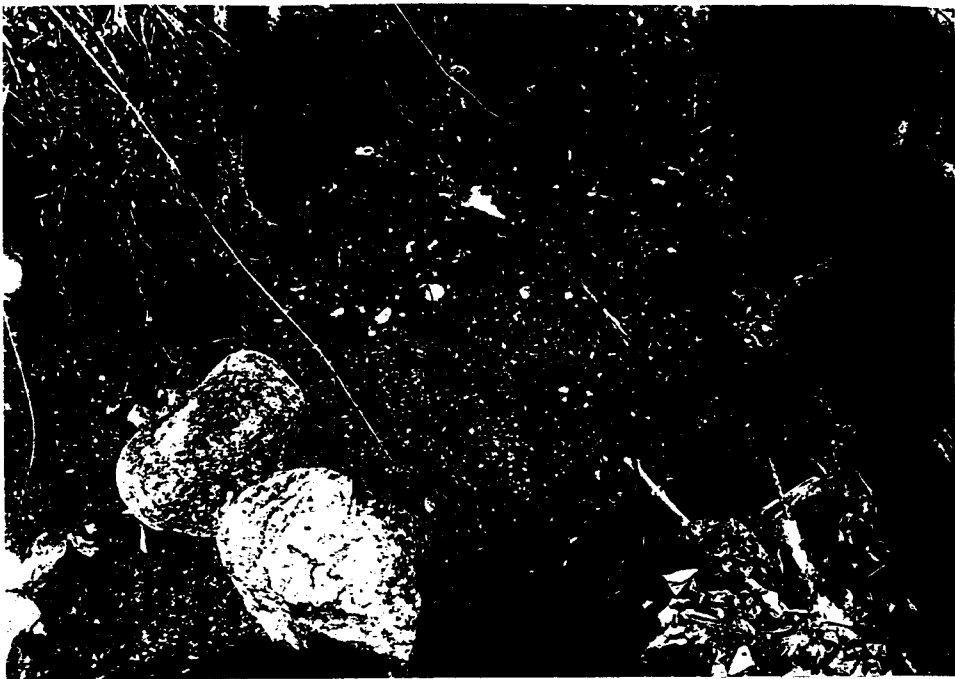


Fig 8

Pond in background
deposition visible
beyond border.



Fig 9

Floodplain of
Ford Glen near
sites 1-1a.





Fig 4

Ford Glen runs
along creek.
Plum trees on left.
Jasminus on right.



Fig 5

Dicentra vernalis
Jasminus on right
Tree



Fig 6

Plum trees on top
of the ridge in
lower left hand
corner of photo

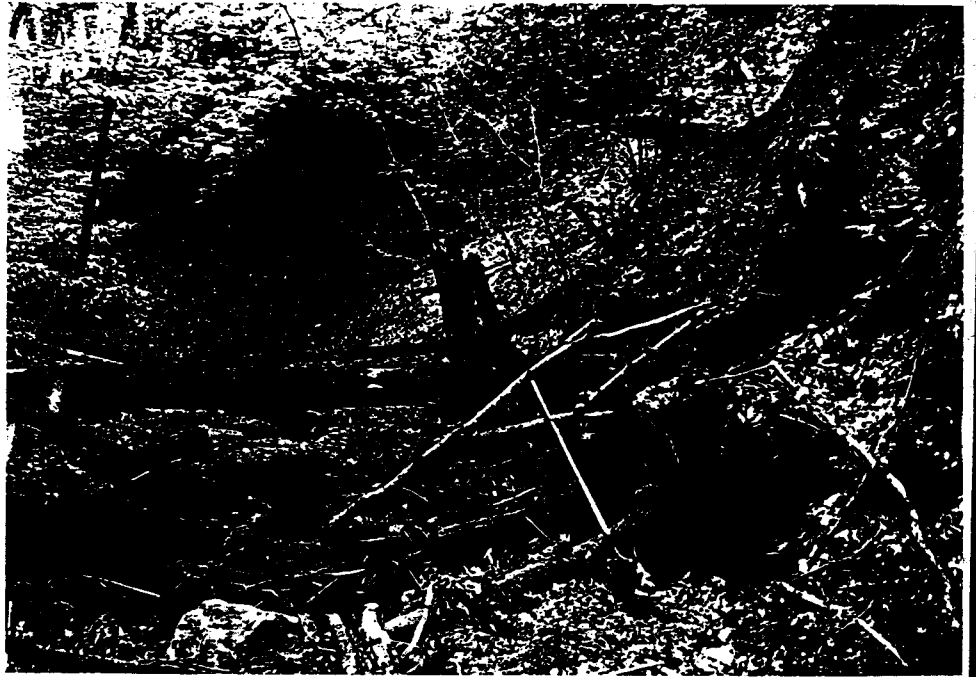
FIG 1

Phyllite outcrop
along Ford Glen.



FIG 2

Contact between
phyllite and
dolomite marble
at level of
horizontal line
in bank.



FIG

Banded dolomitic
marble at
contact

