

BLOCKSTREAMS AT MILLBROOK MOUNTAIN,
TOWN OF GARDINER, ULSTER COUNTY, NEW YORK

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PURPOSE

To raise questions concerning the origin of the features found in the scree below Millbrook Mountain.

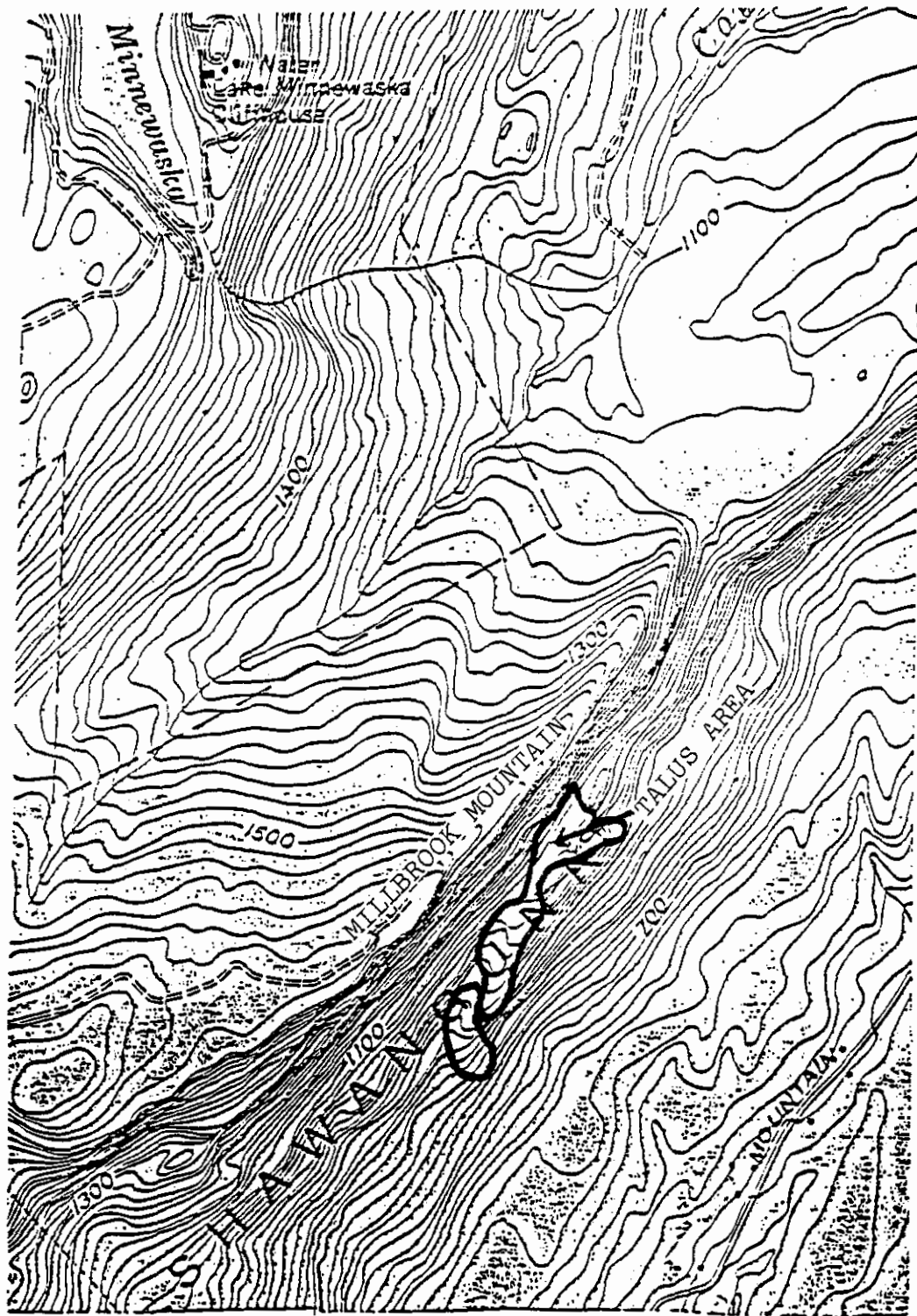
INTRODUCTION AND DESCRIPTION

Millbrook Mountain is a three quarter mile long anticlinal structure forming a topographic high (elevation 1620 feet, 495 m.). It is located about one mile south-southeast of Lake Minnewaska in the Shawangunk Mountains (figure 1). This anticline is truncated on the east side by a 350 foot (107 m.) cliff and is composed entirely of Shawangunk conglomerate dipping up to 55 degrees to the northwest. While the vista from the top offers a commanding view of the Wallkill valley and Shawangunk Mountains, the most unusual and engrossing geomorphic features lie 500 feet below in the talus at the foot of the cliff forming Millbrook Mountains' south-east face. Instead of forming the 25 to 35 degree straight talus common to the Shawangunks, this scree displays a varied mixture of steep slopes, block streams ramps sub-parallel to the cliff face, rampart-like ridges, valleys and closed depressions (figure 2).

These features are composed of blocks of Shawangunk conglomerate averaging five to ten feet cubed (1.5 to 3 m.³, with some blocks forty feet (12 m.) in length (Robson, 1972). These blocks are significantly larger than those in the scree presently being deposited at the base of Millbrook Mountain. Block streams are largely lacking vegetative cover, exposing the bright, white surfaces of conglomerate to view; this is what initially aroused the curiosity of Dr. Russell Wainess who encouraged the initial studies of these talus features by Robson and Cunningham in 1972.

The block streams generally slope from one to ten degrees along their long axes, while the adjacent rampart-ridges slope at greater than thirty degrees. The steepest slopes are on the main rampart (figure 2) and attain a maximum angle of repose of 41 degrees (Cunningham and Robson, 1973). Mature hemlocks up to three feet (1 m.) in diameter growing in several feet of humus cover the slopes and tops of the ramparts indicating a long period of stability. The block stream ramps, valleys, and depressions are barren rock with occasional small shrubs and sparse pines of small diameter. The newer talus forming at the foot of the cliff, and spreading onto the larger blocks supports mixed deciduous and coniferous trees of moderate size.

The steep, vegetated slopes, topped by the rampart-like



CONTOUR INTERVAL 20 FEET
DATUM IS MEAN SEA LEVEL

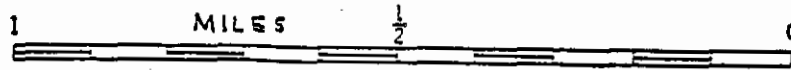


FIGURE 1 A portion of the U.S.G.S.
7.5' Gardiner, N.Y. Quadrangle

ridges sit east of relatively unvegetated high valleys (figure 2). Block streams A and B descend up to 0.5 miles (0.8 km.) north and south from valleys 2 and 3 respectively. Block stream C descends from valley 4 extending to the south then to the southeast. These contrasting surface features offer good evidence that this block scree has been redistributed about the base of Millbrook Mountain.

In the northern part of the area the heavily vegetated slopes have apparently remained stable, while the scree behind the main ramp-art has presumably migrated to the north and south leaving shallow valleys (2, 3) separated by a saddle.

Another feature occurs south of block stream C where a mass of scree, set out from the cliff face occurs as a domal structure (figure 2) with blocks dipping outward in all directions. A small vegetated area separates this structure from the unvegetated block stream to the north.

On the steep eastern face of block stream B, is an alignment of several thin, unvegetated crescents of scree trending horizontally and surrounded by vegetated slopes (figure 2).

THEORIES OF FORMATION

Why is there such a pronounced difference in size between the scree forming the new talus, and that found in the block streams, ramparts, and other features formed from a presumably older scree deposit? It seems likely that existing joint sets in the Shawangunk conglomerate were weakened by ice and frost wedging and loading-unloading processes during and after the last glaciation, causing the cliff face to waste into large blocks. It may be that the older, coarser scree was released relatively quickly after glaciation from Millbrook Mountain after a long period of weakening during glaciation. Newer, finer scree seen here and along the Shawangunk ridge is smaller because forces of smaller magnitude are working on the cliff surface today.

If the stable surface of the main rampart represents the remnants of an earlier talus, then that talus must have reached a higher elevation on the cliff face than the presently forming talus sitting west of this rampart. Using an estimate of 33 degrees as an average angle of repose, the talus would have reached an elevation of 1400 feet (427 m.), 120 feet (37 m.) above the elevation of the presently forming talus (figure 3-a). Using the maximum angle of 41 degrees found on the stable vegetated slope would bring the proto-talus elevation to 1500 feet (458 m.), 120 feet (37 m.) below the mountain top (Figure 3-b). A conservative estimate for the amount of material moved if the talus sloped at 33 degrees would be about 2 million cubic yards (1.54 mcm.), which with 25% porosity would weigh about 3.35 million tons. If all this material was derived solely from Millbrook Mountain at its present elevation, it would represent a recession of the cliff face of about 80 feet (Robson and Cunningham, 1972).

THEORIES OF MOVEMENT

How did this material move? Some sort of mass wasting process seems likely. Evidence can be found for both rapid movement, i.e; angular blocks of conglomerate located east of the main mass of talus, or block stream surfaces tilting toward

PHYSIOGRAPHIC MAP

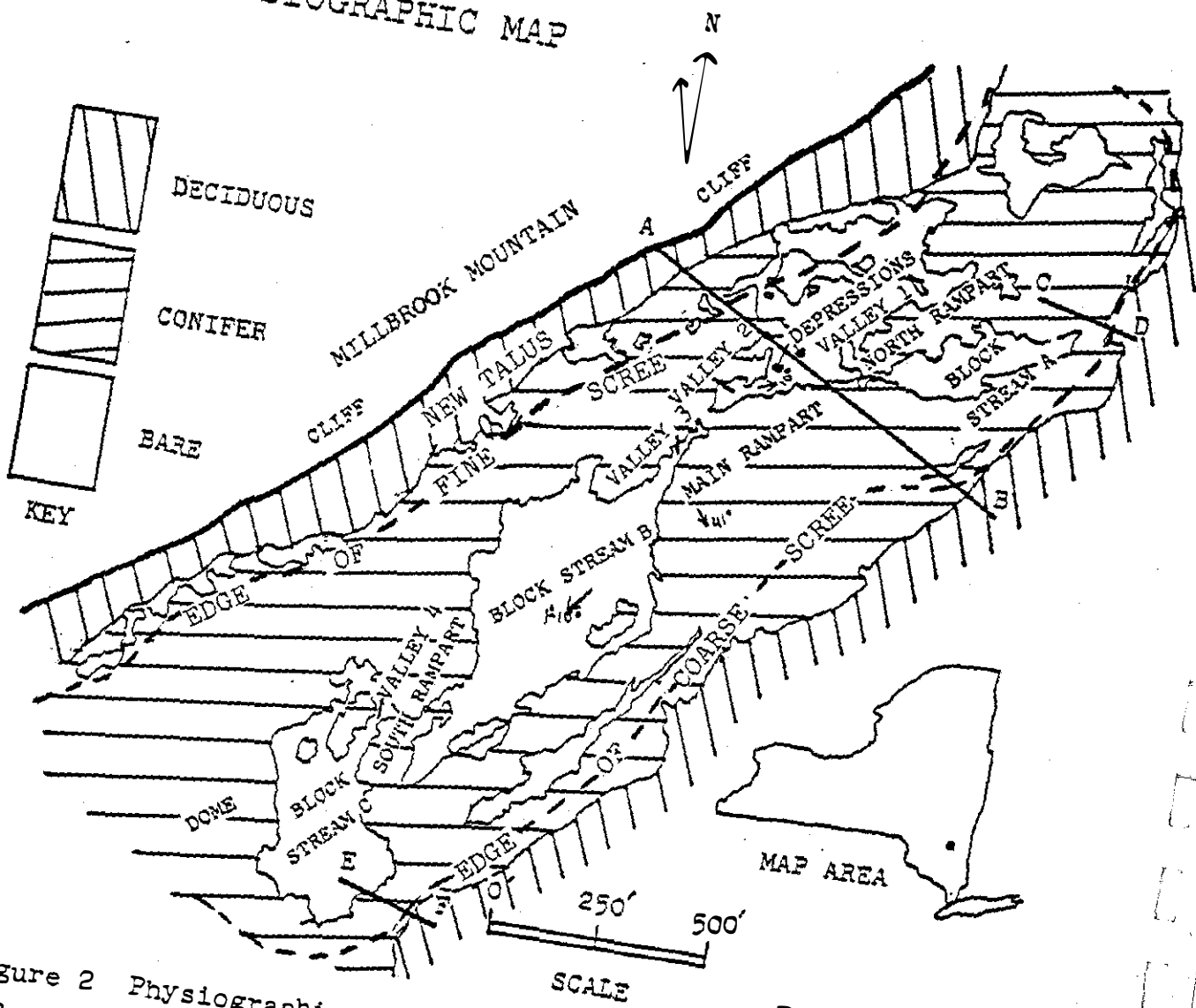


Figure 2 Physiographic Map showing lines of traverse A-B, C-D, E-F, lower limits of coarse and fine scree, block streams, ramparts, valleys, depressions and dome, and areas vegetated by coniferous or deciduous trees, or barren of vegetation

Figure 2

Millbrook Mountain. Alternatively, more evidence can be found suggesting slow, cohesive flow. In places the scree stops on downslopes exceeding 30 degrees where fragments of Martinsburg shale can be found in the subjacent soil. Further evidence may indicate possible pressure ridges and apparent arcuate alignment of elongate blocks in block stream C.

Rapid movement could have been initiated by several mechanisms.

- 1) Over-steepening by differential post-glacial rebound eventually overcoming the force of friction.
- 2) A large rock fall from Millbrook Mountain triggering movement of scree which had attained a maximum angle of repose.
- 3) Failure of shales (probably underlying the scree) due to excessive loading and/or excess groundwater.
- 4) Activation by an earthquake causing the fluidization of possible underlying glacial deposits or slippage of scree.
- 5) If the scree contained a great amount of interstitial ice and/or water, one of the aforementioned actions could have set off a rapid flow.

Slow movement could have been the result of several sets of circumstances.

- 1) The larger blocks could be remnants of debris formed on stagnant glacier ice at the base of Millbrook Mountain. Blocks of Shawangunk conglomerate, weakened by periglacial processes may have dropped onto the glacier and been deposited at their present positions. Some of the debris may have entrapped masses of clean ice. This might relate the depressions in the block streams to relict kettles. The ramparts may be merely a veneer of 'drift' overlying shale ridges (figure 3-b). Such ridges are common on the slopes below the talus.
- 2) These might be rock glaciers which contained much interstitial ice, either relict from the Pleistocene ice sheet, or formed during one of the colder time intervals since Pleistocene glaciation, i.e; the 'Little Ice Age' of the 17th to 19th centuries.
- 3) These could be rock streams as in the Hickory Run, Pennsylvania boulder field as described in Bloom, 1978, p.360,361, driven by gelifluction and frost creep, even though these blocks are much larger and more angular.
- 4) Groundwater might have carried away fine shale fragments, and/or stratified drift possibly underlying the scree a little at a time causing a gradual, but relatively steady settling effect. This is unlikely, because there is no evidence of this material being deposited at the foot of the talus. In addition, this would probably not cause devegetation of the block streams.

The ultimate truth here might involve a complex of processes including varying rates of flow, and a combination of any of the above circumstances. While pondering these suggestions, it must be kept in mind that except for the lobe of talus directed southeastward at the south end of block stream C, the unvegetated block streams trend near-parallel to the cliff face rather than

CROSS SECTIONS

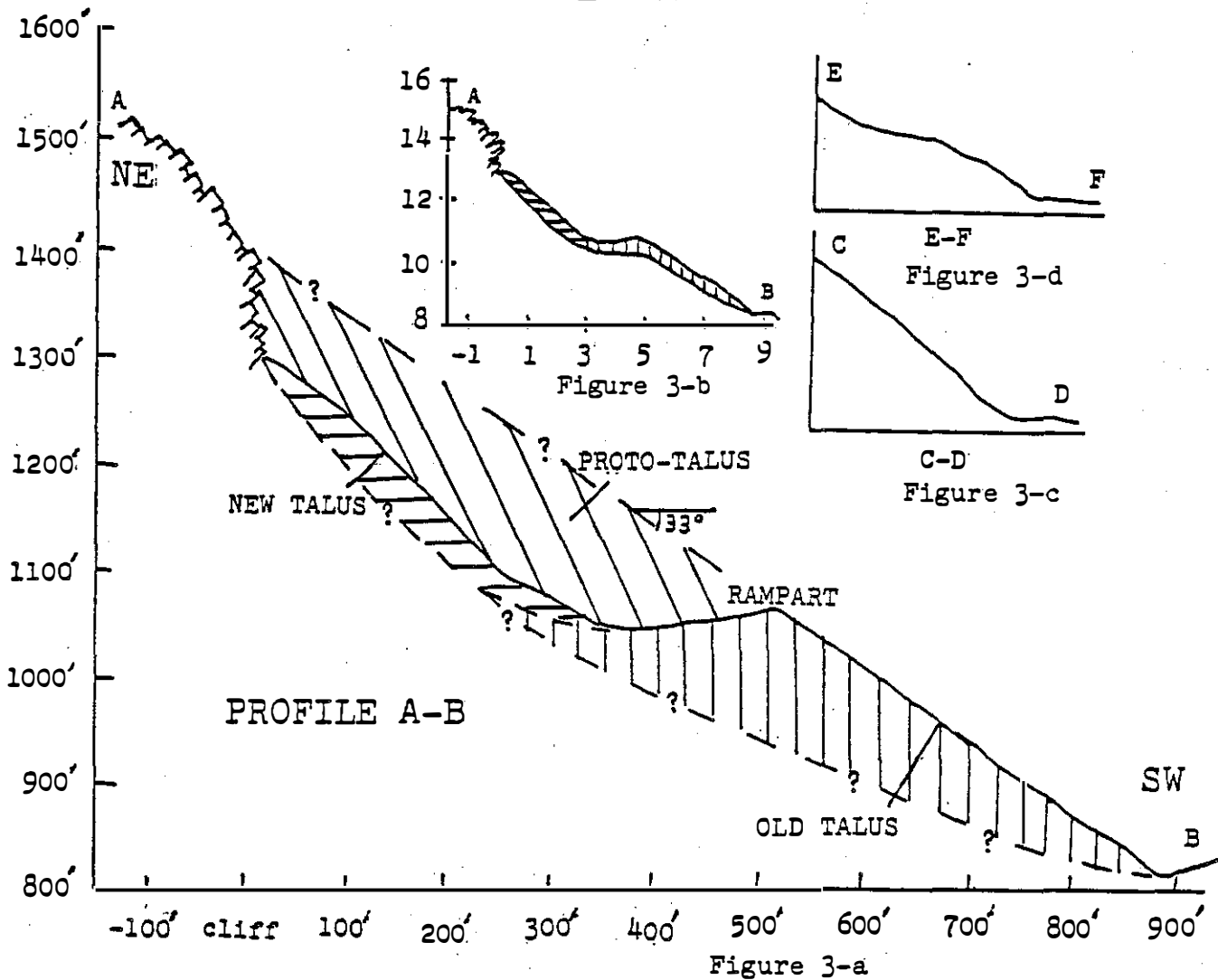


Figure 3-a Profile of Traverse A-B showing approximate contacts of coarse, old talus with new finer talus and probable slope of proto-talus before movement. This is shown over steeply sloping bedrock. 1 inch equals 170 feet

Figure 3-b Same as 3-a except scree shown as veneer over bedrock ridge with proto-talus removed. 1 inch equals 600 feet

Figure 3-c Profile of traverse C-D. Length equals 250 feet.

Figure 3-d Profile of traverse E-F. Length equals 250 feet.

down the steep slopes. Is this a function of unseen, underlying topography or was movement hemmed in on the east by a barrier such as glacial ice? Was it a sudden adjustment of much of the scree by block rotation, with only minor lateral or downslope movement? Remobilization might occur during subsidence, a slow process, or during an earthquake, a much more rapid process.

QUESTIONS

Why are the block streams unvegetated? Do they represent an early post-Pleistocene readjustment of the talus where the porosities are too great to allow buildup of humus or sediment? Do they represent recent movement where the organics have been 'shaken through the interstices', and the dead vegetation rotted away? Was this area always vegetated regardless of when the movement occurred, until a forest fire oxidized all the organics in the block streams? Off and on observation and arm waving during fifteen years has produced little of substance and evidence of forest fire has been sought in vain.

What of the thin crescents of unvegetated scree on the steep face of block stream B? Are these due to continuing instability in the scree, or just random barren streaks missed by revegetation? Some features like these may be seen in the talus along other parts of the Shawangunks.

Why is the distribution of the block streams varied with respect to the position of the main rampart? Was the initial scree distributed further to the south by flowing ice? Perhaps it was 'bulldozed' to the south by a late glacier readvance. Perhaps when movement took place, the main rampart at the northern end was relatively 'anchored' by an unseen topographic feature, or by the geometry of the blocks comprising the rampart.

IS IT MOVING?

Is this talus moving today? No definitive study has been done to answer this question, although there are several ways in which it could be carried out. Fifteen years experience in this area gives these authors impression of 'no change', but that is still to be proven. It is possible that the talus houses permanent ice, as temperatures measured in crevices in the talus during mid-July (1973) measured as low as 6°C (43°F), probably below ambient ground temperature in this area. This may suggest the presence of permanent ice in the scree but, it is unlikely that it would be of sufficient volume to allow or promote flow of the blocks. A study which might shed some light on the age of this talus movement would involve dendrochronology to see if there is a gradient in tree ages or gaps in ages. In addition, changes of climate might be inferred by ring thicknesses. Geophysical studies designed to determine the underlying bed rock topography and thickness of possible glacial drift would be invaluable in solving questions concerning this area of scree.

As can be seen, many questions remain to be answered about this unique geomorphic feature at Millbrook Mountain. These talus features could be the result of periglacial, tectonic, or more gradual processes which may be continuing to this day. Occasional trips over the past fifteen years appears to have raised more questions than they have answered, but any excursions have raised

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Cunningham, R.W., and Robson, P.A., 1973, Millbrook Mountain, Site of Rock Fall Talus Aprons, Ramparts, and Block Streams, Northern Shawangunk Mountains, Southeastern, New York, in First New Paltz Science Student Paper Presentation, Abs. with Prog., p. 9.

Robson, P.A., 1972, Features in Rock-Fall Talus, Millbrook Mountain, Northern Shawangunk Mountains, Ulster County, New York, (abs.) in 26th Annual Eastern Colleges Science Conference, Abs. in Prog., p. 55.

MAP

_____. 1957, Topographic Map of Gardiner, N.Y. 7.5', U.S.G.S., Scale 1:24,000.

ROAD LOG

When hiking on the talus below Millbrook Mountain good shoes are required! Good physical conditioning and agility are important. Permission of the owner is necessary! He lives just north of the target area up long driveway on the west side of the road.

Approach scree from below (east).

Drive west from Exit 18 of New York State Thruway on Route 299 to New Paltz 1.0 miles.

Continue west on Rt 299 6.4 miles to intersection of Routes 299 and 44-55.

Turn left on Routes 44-55 and travel 1.0 mile then veer right at fork onto North Mountain Road (south).

Travel 1.0 mile and park. Talus features are approximately 0.5 miles west and 600 feet above you. Halcyon Road is 0.1 mile too far.

Approach from over Millbrook Mountain (west) for aerial view only.

Drive west from exit 18 as above to intersection of Routes 299 and 44-55.

Turn right on Routes 44-55. and travel 4.5 miles to entrance to Minnewaska State Park.

Enter park and drive to parking lot near site of old hotel.

Hike about 4 miles along trail to Millbrook Mountain.

Use extreme caution along cliff edge!

Do not attempt to go down!