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# STABILITY OF ROCK MASSES ON EAST SIDE OF ROCKY GORGE, MANITOU FALLS AREA, PATTISON STATE PARK

by

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# STABILITY OF ROCK MASSES ON EAST SIDE OF ROCKY GORGE, MANITOU FALLS AREA, PATTISON STATE PARK

REPORT FOR WISCONSIN DEPARTMENT OF NATURAL RESOURCES

by

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in cooperation with the

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# INTRODUCTION

This geologic study was undertaken to evaluate the stability of the rock masses beneath the scenic overlooks on the eastern side of the rocky gorge of the Black River north of Manitou Falls in Pattison State Park. Study of the vicinity of the overlooks was initiated on September 4, 1974 at the verbal request of Mr. Wayne Gibson who stated that the Department of Natural Resources wished a geological opinion of slope stability conditions. Mr. Gibson specified the area of geologic study and noted that the present overlooks were constructed about 70 years ago.

The study was completed after telephone discussion with Mr. Dominick Mangardi on February 12, 1975, confirmed by letter on the same date and by Reply 8620 on February 18, 1975.

Manitou Falls is on the Black River in SE 1/4 - section 21-T47N-R14W in Douglas County, where the river has cut a 200 foot deep gorge through volcanic rocks of Keweenawan (Late Precambrian) age. The rocky gorge winds north of the falls for about a quarter of a mile, with the river flowing either approximately parallel to or normal to the layering of the lavas since the shape of the gorge is controlled by the layering and the fracturing to which the lavas have been subjected.

The walls of the north end of the canyon are red colored sandstones with interlayers of conglomerate belonging to the Orienta formation of Keweenawan age. The contact between the sandstone and the lavas is the Douglas Fault, a steeply inclined major fracture along which the lavas have been raised and pushed northward. The fault is subparallel to the strike and dip (approximately N55E-55S) of the volcanic rocks. Outcrops of lavas on the east side of the river show that the contact between the sedimentary rocks and the lavas is about 250 feet north of the same contact on the west side of the river, suggesting that the course of the river is controlled mainly by a steeply dipping cross fault zone bearing about N15W.

## METHODS

### Previous Work

Previous studies (cf. References) for The Wisconsin Geological and Natural History Survey and the U. S. Geological Survey have established the general geologic setting of the Park as summarized above but are not at a scale which makes them of use in engineering evaluation.

### Study Methods

Geologic field work to establish the attitude, nature and soundness of the basaltic lavas underlying the overlooks was conducted during September and October 1974. A total of 367 observations of fracture attitudes was made in an area along the east wall of the rocky gorge from a point south of the crest of the Falls to a point north of the northern overlook and from the rim of the gorge to the river below - i.e., within an area approximately 400 feet long and 200 feet deep. Brecciation and fissuring of the rock mass beneath the northern overlook were also examined. Soil cover and very steep slopes prevented uniform study of the entire area. Observations were confined to bare rock exposures accessible without rappelling.

Fracture attitudes were summarized by stereographic plotting on a Schmidt equal area net. Point densities were determined with a Kalsbeek counting net which is subdivided into small triangles. Six of these triangles from a hexagonal area equal to 1% of the total area of the net. The counted point densities are thus represented as the number of points per 1% of net area. Contours of equal point density were then drawn to obtain an objective generalization of the scattered points representing observed fracture attitudes.

## RESULTS

The fracture system in the rock mass in the study area is represented on Figure 1. Table 1 summarizes the principal attitudes represented in Figure 1, as does Figure 2.

Table I

1. Strike N15E; Dip vertical
2. Strike N50E; Dip 45°S approximate layering direction
3. Strike N65E; Dip vertical
4. Strike N15W; Dip vertical
5. Strike N50W; Dip vertical

A subordinate fracture development with a N50E-45S attitude is also apparent in Figure 1.

The fracture sets making up the fracture system of the study area are sympathetic in their attitudes to those of the major fractures known or inferred in the vicinity. Figure 3, taken from Thwaites (1912, Plate 29) shows faults observed by Wisconsin Geological and Natural History Survey workers. Careful examination of U. S. Geological Survey Sunnyside and Patzau 7 1/2 minute topographic maps shows that the drainage pattern in the vicinity of the Park is strongly influenced by the observed fracture attitudes listed in Table 1.

The south overlook is separated from the north overlook by a very steep sided gully which has been eroded along what is probably a major shear zone which has an attitude N55E-55S at the foot of the Falls but which appears to steepen to near vertical up-slope between the overlooks. This fracture set controlls the course of the River from directly beneath the Falls to the

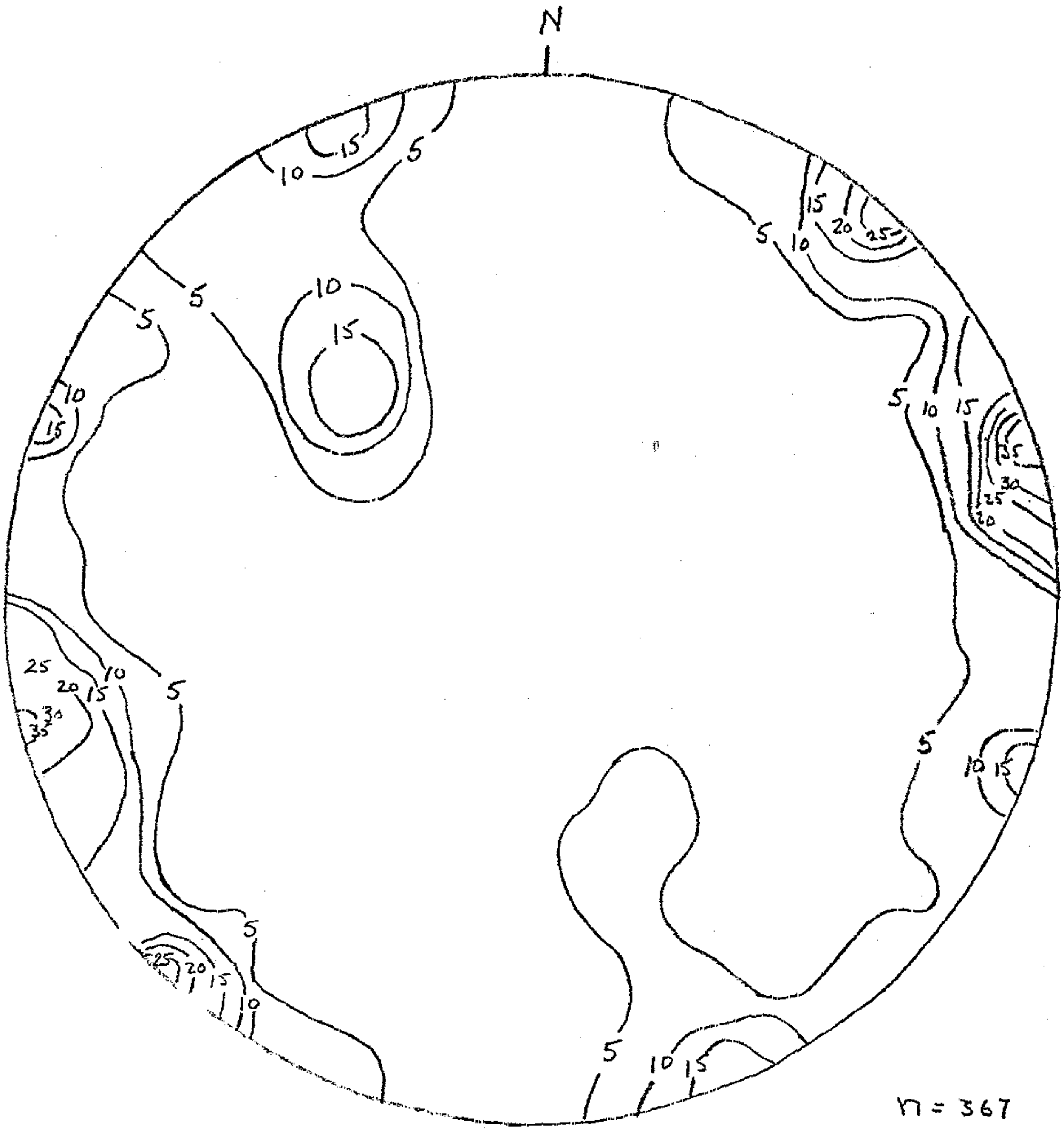



Figure 1.
Fracture System of Rock Masses East Side
Rocky Gorge, Manitou Falls Area

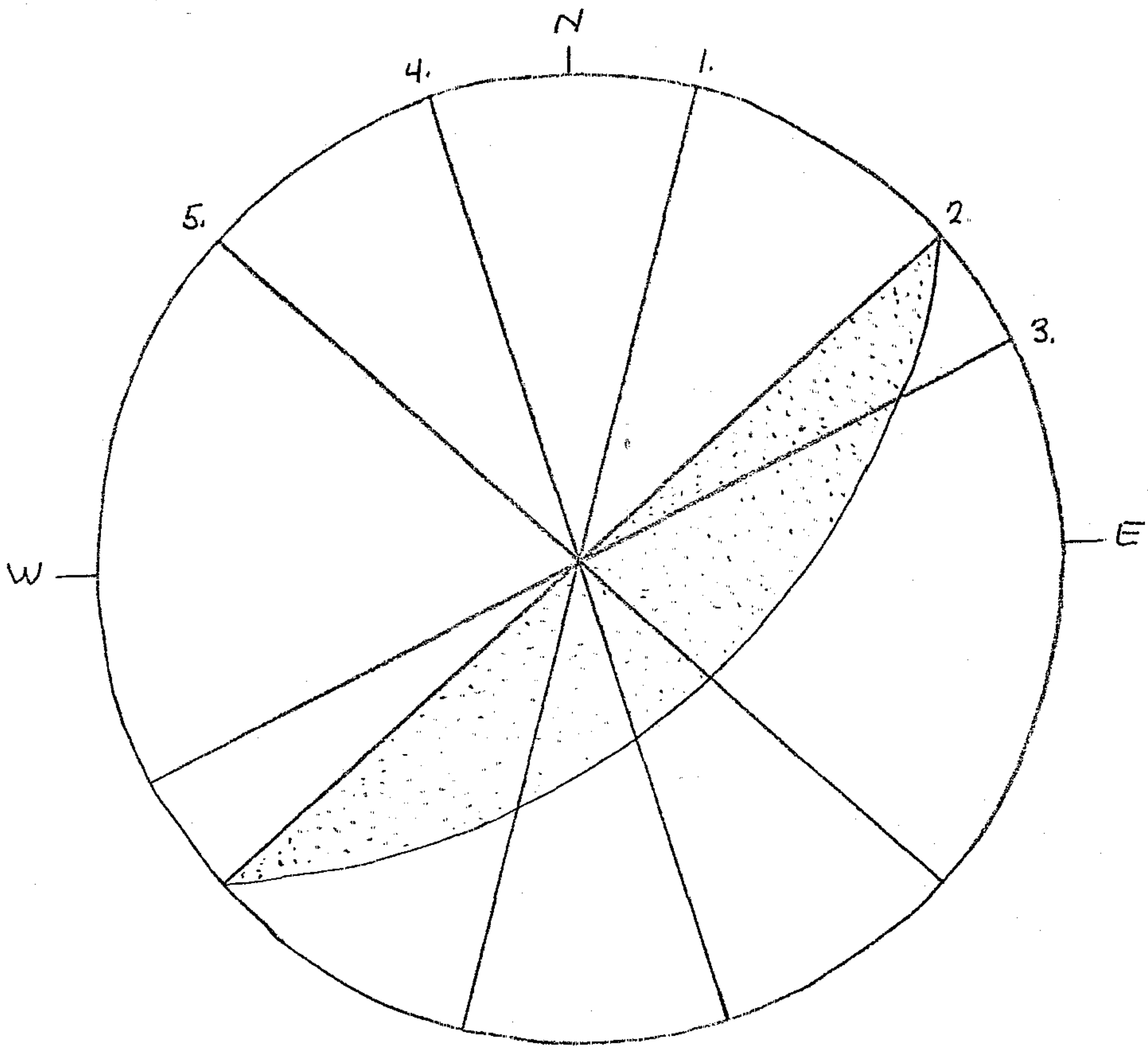
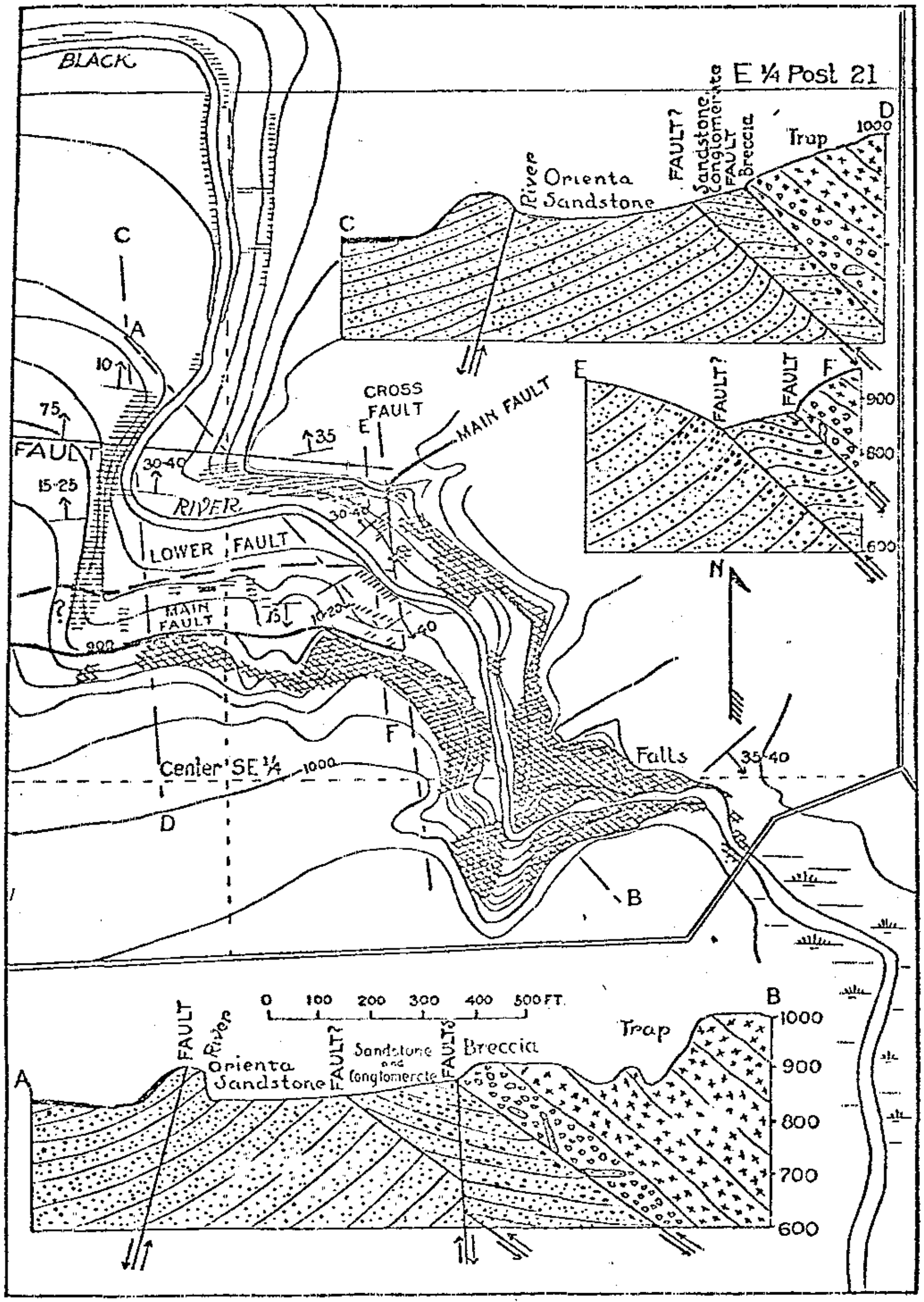



Figure 2.
Generalized Fracture System of Rock Masses East Side Rocky Gorge, Manitou Falls Area




Map of vicinity of Lower Falls of Black River, Douglas County, showing contact of Middle Keweenawan traps and Orienta sandstone. Map by U. S. Grant, 1899; sections by F. T. Thwaites, 1910. Contour interval, 20 feet; elevations, 11 feet too high.

Figure 3.

northerly bend which carries it from the view of the south overlook.

Figure 4 shows the attitudes of fractures observed on and below the south overlook. The general soundness of the rock between fractures, the generally wide gaps of sound rock between fractures and the minor degree to which any fractures are fissured suggest that this overlook will continue to be stable for many years.

Figure 5 shows the attitudes of fractures observed in and below the north overlook. Fewer observations are plotted on this Figure because brecciation of the rock mass in this vicinity prevents making large numbers of attitude determinations. Figure 6 shows the shape of the overlook. Stipple pattern 1 designates an overhanging mass of brecciated lava which is potentially dangerous and should be removed. This brecciated mass probably also threatens the present foundation in this portion of the overlook. Movement of the platform limit 3-6 feet inward from the present railing in this area would alleviate this danger.

Stipple pattern 2 designates an area of fissured overhang. Fissuring in this area is larger but less pervasive than in area 1 and is developed along less steeply inclined fractures. Stabilization of the fissured zone through cleaning and concreting or other means should alleviate the danger in this area.

Both platforms should be kept as watertight as possible to minimize frost wedging and pore water pressure in the fracture-fissure systems.

None of the fracture sets is bonded by cement to any important degree although minor coatings of epidote or chlorite are noted on some and a few tension fractures are infilled with calcite/dolomite. Chlorite development is most common along fracture surfaces that show evidences of shear. These fractures are confined mainly to exposures in the bottom and south walls of the rocky gorge.

The lavas are only slightly weathered or chemically altered by natural

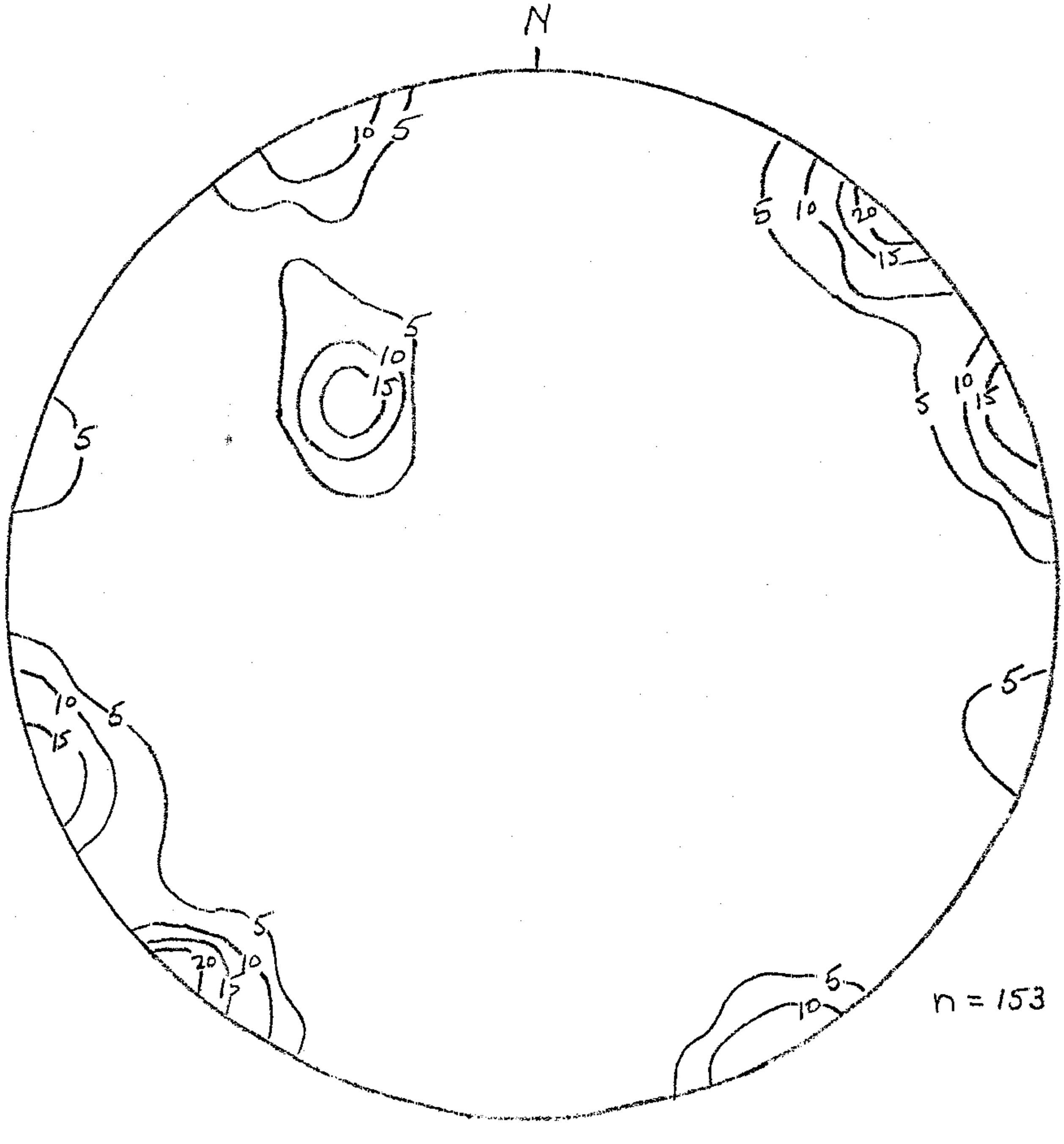



Figure 4
Fracture System on and Below South Overlook

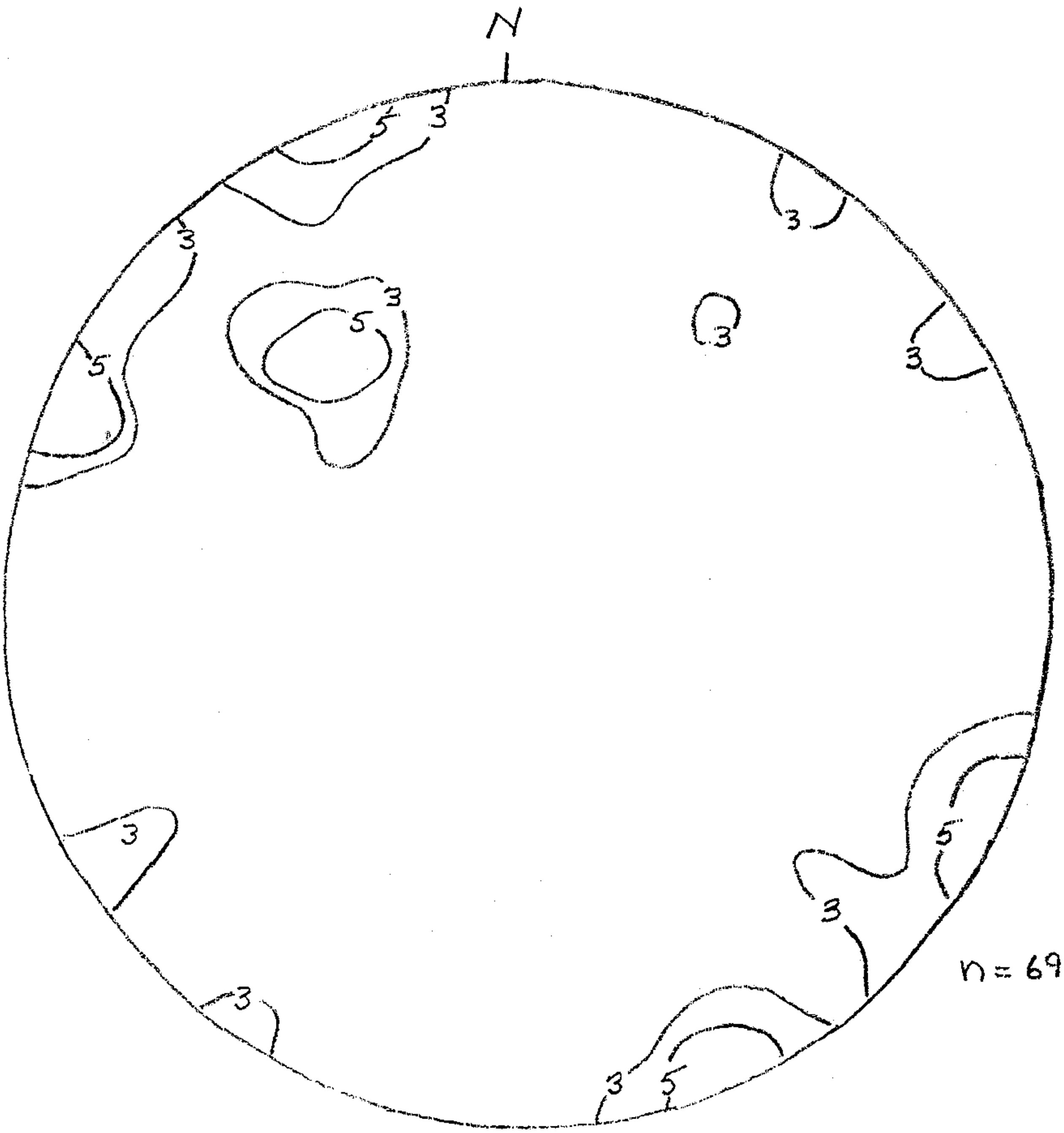



Figure 5.

Fractore System on and Below North Overlook

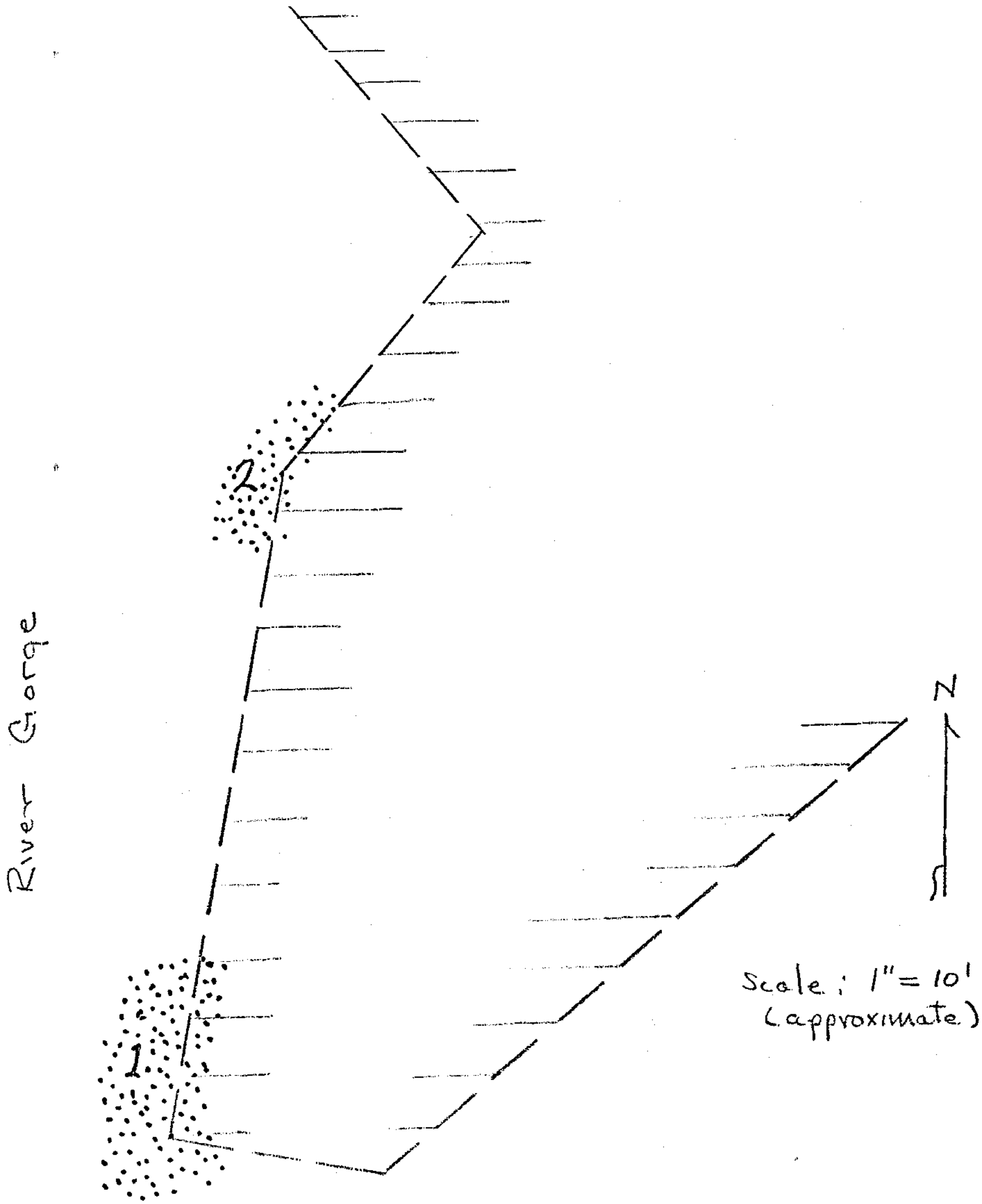



Figure 6
North Overlook Platform Unstable Areas

solutions and can, with few exceptions, be classified as mineralogically sound rox material. Alteration of the lava and disruption of the rock is evident in the vicinity of the lava flow top exposed about 25 feet below the former stairs leading downslope from the north overlook. Infilled bubble holes (amygdules), a thin, discontinuous layer of sandy sediments, and considerable brecciation of the rock in this region is evident.

A close relationship exists between the present platform shapes, as defined by their railing orientations, and the generalized fracture sets shown in Table 1. (Fig. 7) Future failures can be anticipated to be governed by these same principal directions. Fissure development and extension will probably warn of the onset of dangerous weakening of the rock mass as gravity and weathering prepare the outer layer of the wall of the gorge for downslope movement by block falls or rock avalanches. Scars in the vegetation along the gorge walls show these processes are operating but the absence of large or deep scars and the near absence of talue buildup in the valley floor suggest that such failures are uncommon and/or affect only a few feet of the outer part of the slope wurface.

Periodic inspection of the platforms and the slopes beneath should be made and pictures containing reference scales should be taken at intervals to provide a basis for slope stability change evaluation. Development of large numbers of small fissures sufficiently abundant to render the rock a loose brecciated mass and/or development of larger through-going fissures should both be examined for. Incorporation of sufficient reinforcing rods into any future platforms constructed would tend to create rigid land bridges capable of retaining their integrity even if unexpected rock avalanch activity developed along an outer part of one of the overlooks.

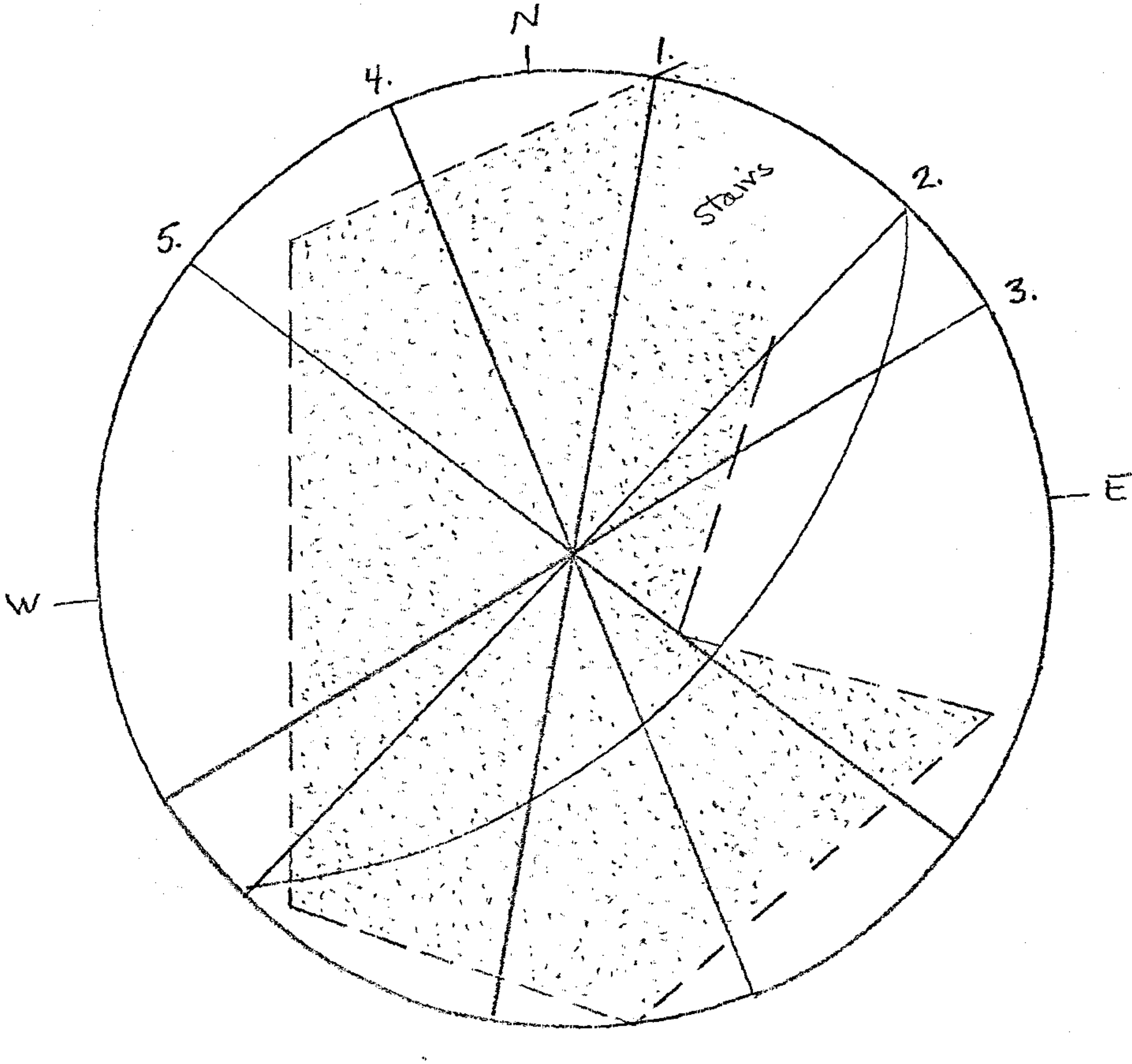



Figure 7.
Fracture System Control of Platform Shape
South Overlook

Platform scale:
1" = 5'

## MAJOR CONCLUSIONS

1. Five major attitudes of fracturing are present in the study area: Four are vertical in dip, these sets strike respectively N15E, N65E, N15W and N50W. A fifth set strikes N50E and dips 45°S. These fracture sets have, and will continue, to control slope failure directions.
2. Slope failure will probably be preceded by small and/or large fissure development and extension, therefore a program of monitoring and recording conditions should be instituted on a regular basis.
3. Slope failure will probably affect a layer of the gorge wall no more than a few feet deep. Design of a rigid land-bridge type platform for both overlooks could probably alleviate danger from undetected worsening of slope conditions.
4. Any platforms should be kept as water tight as possible to minimize frost wedging and pore water pressure.
5. The south overlook is stable as is at the present time; the north overlook needs remedial action before it is stable.

The recommendations and/or suggestions contained in this report represent opinions based on data which are assumed to be representative of the area studied, but because of lack of uniform availability and access to surface exposures, and for other reasons, I cannot warrant conclusions to be typical of the entire site.

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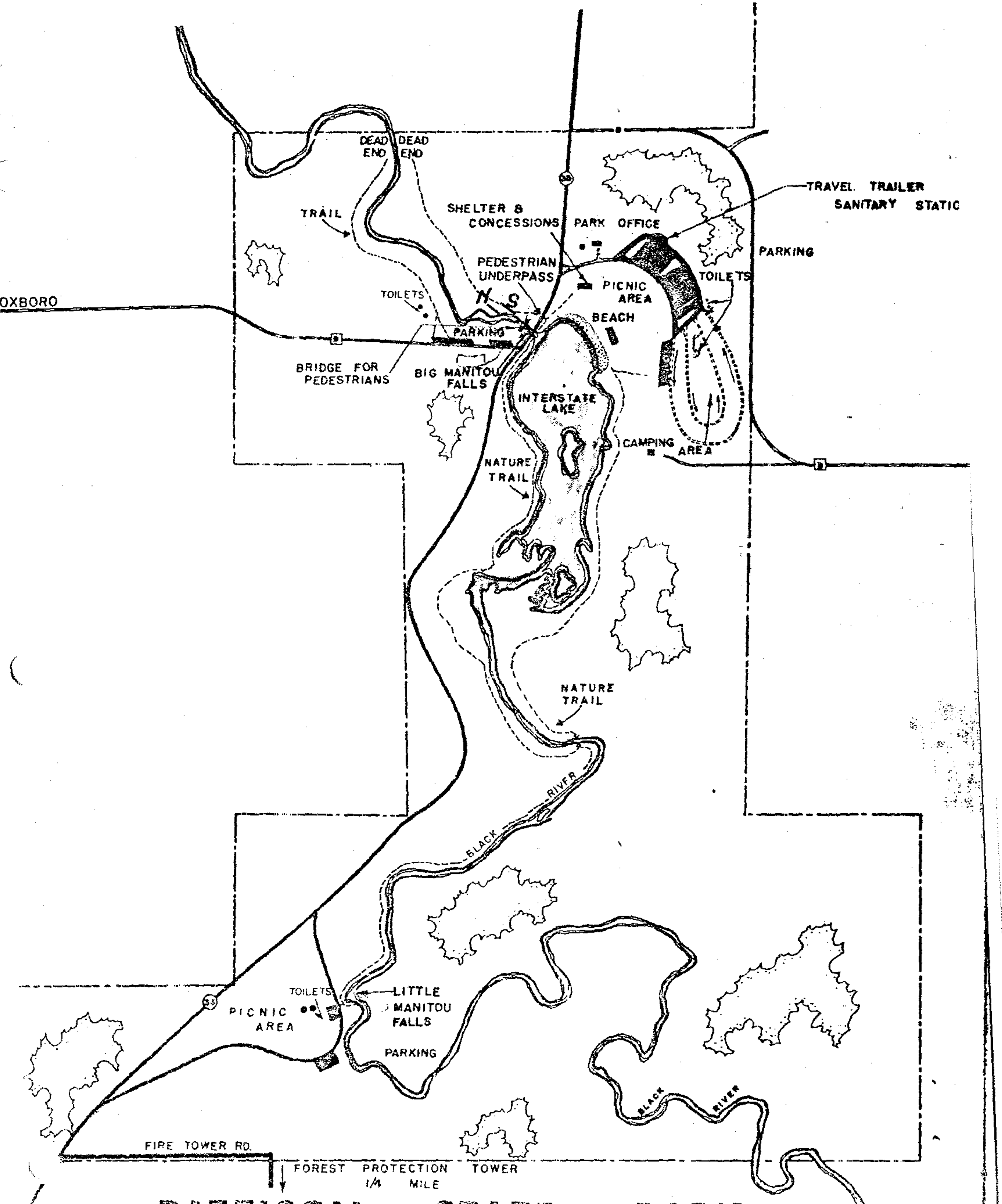
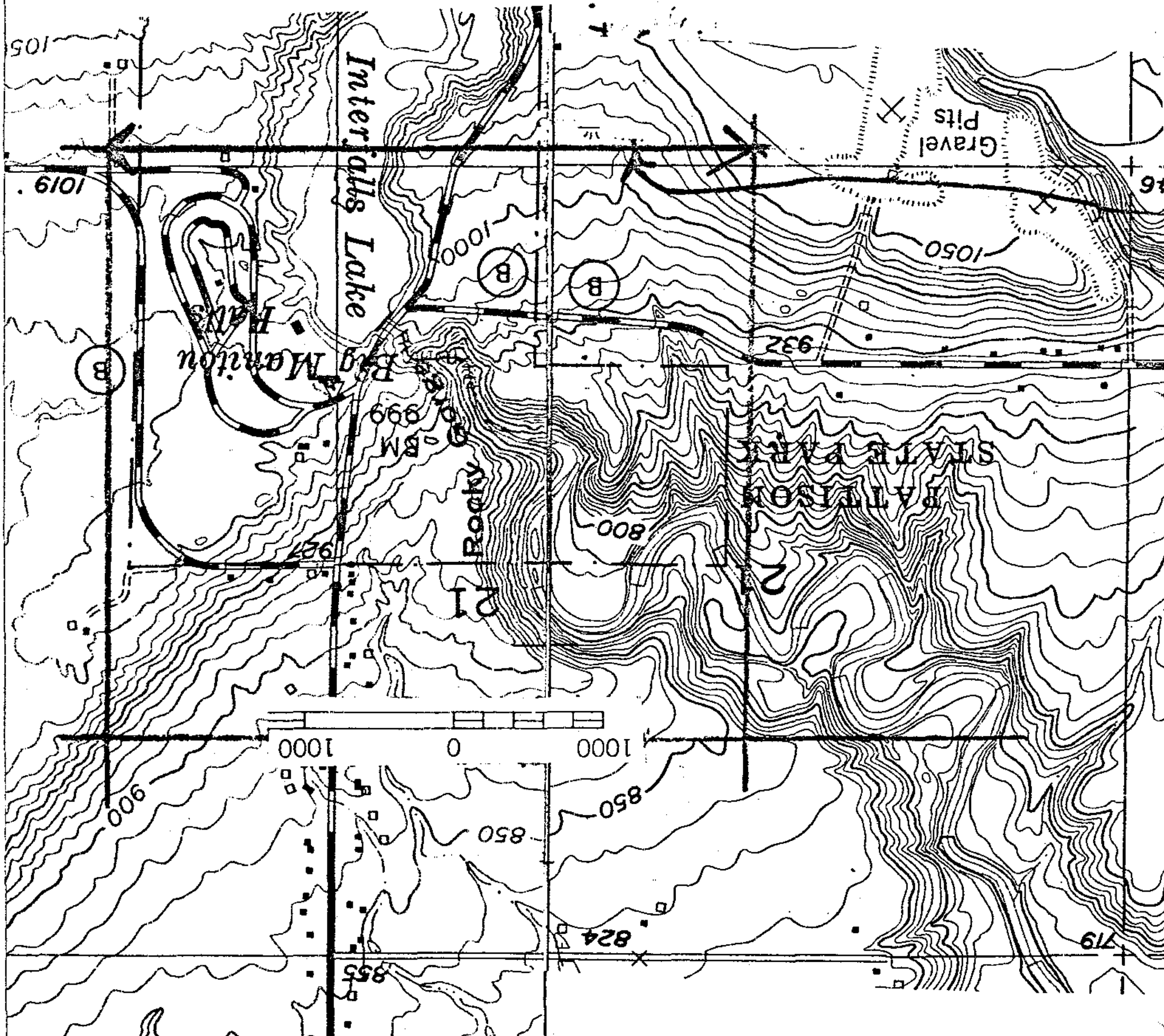



# PATTISON STATE PARK

## WISCONSIN DEPARTMENT OF NATURAL RESOURCES


Interfalls Lake
Big Manitou Falls
PATTISON STATE PARK
Gravel Pits
Rocky
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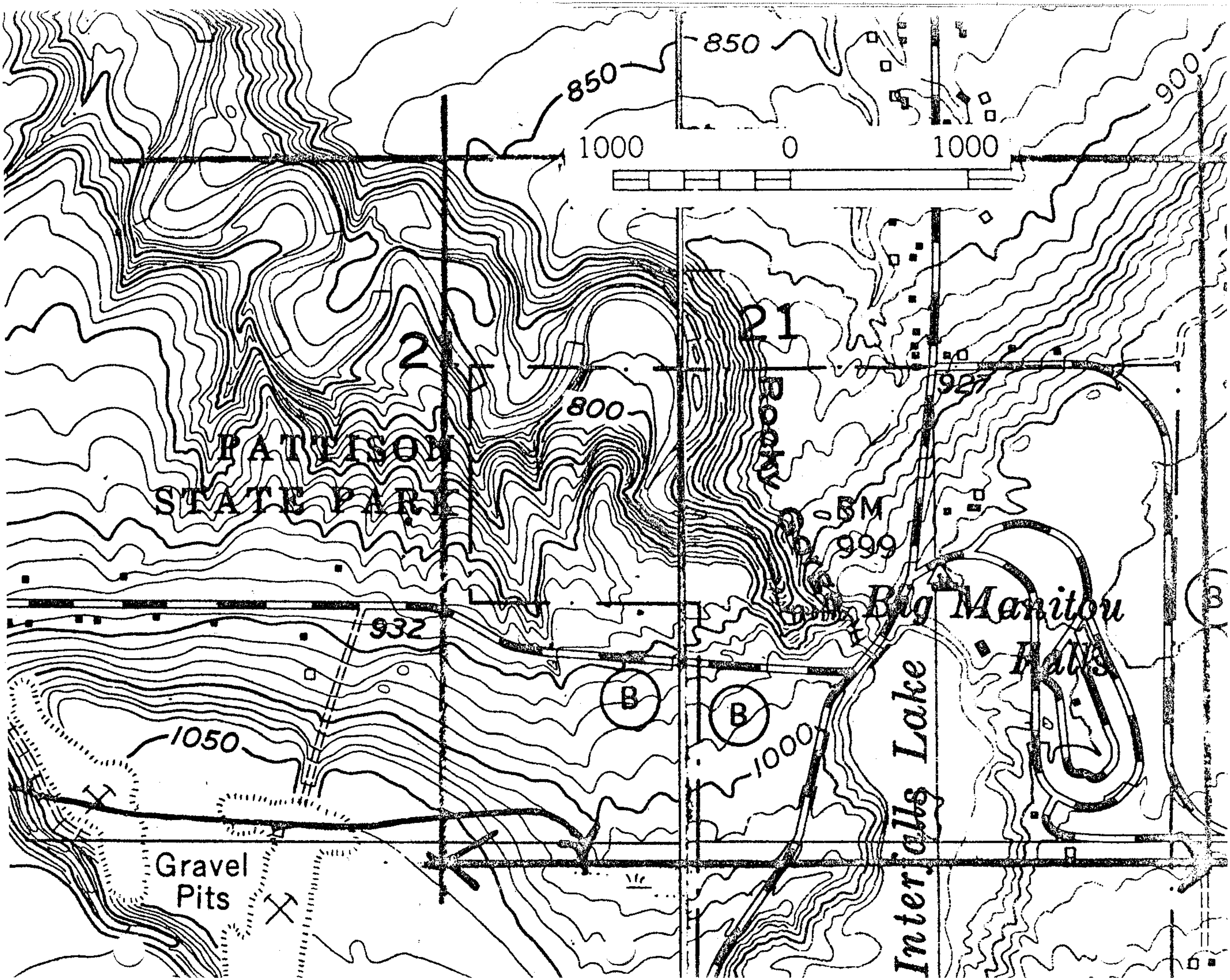
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