LINEAMENT STUDY
PERRY NUCLEAR POWER PLANT SITE

1.0 SUMMARY OF CONCLUSIONS

Lineaments identified from ERTS imagery transparencies for this study can be subdivided according to proposed origin: (1) glacial, (2) existing drainage and buried valleys, and (3) vegetation. Lineaments fall within more than one category. The area of investigation has been extensively glaciated and many of the lineaments (3, 4, 5, 10, 16, 19) are controlled by the distribution of deposits associated with glaciation and deglaciation (moraines, kames, strandline deposits). The occurrence of these deposits was influenced by pre-glacial bedrock topography, ice movement and deglaciation drainage.

Lineaments produced by existing drainage systems (1, 2, 6, 7, 10, 17, 19) are often closely related to the above described lineaments because the present drainage system was influenced by the distribution of glacial ice and glacial deposits. Drainage lineaments are enhanced to varying degrees by steep valley walls produced by streams downcutting through nearly horizontal strata. Some preglacial valleys filled with glacial deposits (buried valleys) and not subsequently eroded are also responsible for observed lineaments (12, 17, 20).

Enhancement of permeability along an alignment of hydrogically-affected surficial deposits could produce

lineaments visible on the satellite imagery. These conditions may be responsible for certain lineaments of uncertain origin, although it cannot be demonstrated.

Lineaments 13, 14, 15, and 18 appear to be related to cultural or agricultural features. They are the strongest of a north-south trending pattern which terminates at the Pennsylvania-Ohio border. No structural or lithologic features correspond with these lineaments. They trend at an oblique angle to the predominant northeast and northwest trend of gravity anomalies (Cleveland Electric Illuminating FSAR, 1980).

Briefly stated, a one to one correlation of lineaments to known bedrock structures or geophysical anomalies/gradients is not possible. Existing mapping (Stone & Webster, 1978) (Cleveland Electric Illuminating FSAR, 1980) (Berg, 1980) shows no relationship between bedrock structure and the lineaments. A limited number of small scale folds are reported but they lack either vertical or lateral extent and do not control stream orientations or demonstrate any geomorphic expression. Lineaments (8, 11) that are approximately coincident with the hypothesized Wagner-Lytle lines in Pennsylvania (Wagner and Lytle, 1976), terminate more than 20 miles southeast of the Perry site. No surface faulting is known to be associated with the proposed Wagner-Lytle lines in Pennsylvania, nor is it suggested that the Wagner-Lytle lines are capable structures. There is no definitive evidence for a causitive relationship of

lineament 21 with a mapped subsurface fault, a noncapable structure. No surface expression of the observed fault (Stone and Webster, 1978) is reported.

No lineaments were observed on the ERTS imagery within a 5 mile radius of the site.

2.0 INTRODUCTION

In response to a request for analysis of lineaments in the vicinity of the Perry Nuclear Power Plant, Units 1 & 2, Earth Resources Technology Satellite imagery was examined for evidence of lineaments. Bands 4, 5, and 7, commonly utilized for geological and lineament interpretation, were selected for viewing. ERTS transparencies were studied on a light table and lineaments plotted on an acetate overlay. The observed lineaments were compared to available surface and subsurface geological and geophysical data of northeastern Ohio and northwestern Pennsylvania. The lineaments were designated by numbers which are referenced to the descriptive and interpretative text that follows.

3.0 GEOLOGIC SETTING

The area of investigation is on the border between the Appalachian Plateau Physiographic Province to the southeast and the Central Lowland Physiographic Province to the northwest. Low amplitude northeast-trending folds die out in northwestern Pennsylvania at the limit of the area affected by the Alleghanian Orogeny to the southeast. Faulting associated with

the strong compression in Pennsylvania also is not evident at the northwestern limits of the Appalachian Plateau (Rogers, 1970). Northwest-trending Wagner-Lytle lines, which may indicate faulting at depth perpendicular to Alleghanian fold axes in west-central Pennsylvania, also appear to die out in the vicinity of the Pennsylvania-Ohio border (Wagner-Lytle, 1976). There is no geologic, geophysical or seismologic basis to suggest these hypothesized zones are capable structures.

Three major folds in southeastern Ohio, the Cambridge and Burning Springs anticlines, and the Parkersburg-Lorain syncline trend N10°W becoming broad low-amplitude folds to the north. These folds may be due to syn-depositional deformation associated with basin arching to the west or later Alleghanian compression from the southeast (Clifford and Collins, 1974). Smaller scale northwestward trending structures are also mapped south of the study area. Subsurface information indicates these northwest-trending structures are of limited extent and are reported to include high angle normal faults (Stone and Webster, 1978). Possible explanations for the origin of these folds and faults include weak Alleghanian tectonism, basin arching, differential compaction, and syn-depositional deformation.

4.0 LINEAMENT IDENTIFICATION

The definition of a lineament as used in this report follows O'Leary et al., (1976) which states "a lineament is a mappable, simple or composite linear feature of a surface,

whose parts are aligned in a rectilinear or slightly curvilinear relationship and which differs distinctly from the patterns of adjacent features and presumably reflects a subsurface phenomenon". Linear and curvilinear alignments were found to correspond to or be approximately coincidental with cultural, topographic, geomorphologic, and geologic features. These included the following specific examples: roads, power lines, vegetation (agricultural), stream valleys, abandoned shorelines, buried stream valleys (associated surficial deposits), lithologic contacts, joints, structural discontinuities (Wagner Lytle lines, Wagner and Lytle, 1976), and fold axes.

Lineament No. 1

Lineament No. 1 is a discontinuous tonal variation trending northeastward for approximately 50 miles from a point 14 miles south of Cleveland to 20 miles east of Perry. This lineament corresponds to the contact between isolated upland remnants of Pennsylvanian sandstone, shale, and limestone (Pottsville and Allegheny), and underlying Mississippian shale, sandstone, and limestone (Waverly and Maxville) (Bownocker, 1965). Segments of Trumbell Creek, Milk Creek, and the northeastern branch of the Chagrin River, generally parallel to the regional strike and lithologic contacts, are responsible for the linear tonal variation (Ohio Edison Co. PSAR, 1977). No mapped faults or fold axes coincide with lineament No. 1. No gravity anomaly or

gradient parallels lineament No. 1 (Cleveland Electric Illuminating FSAR, 1980). This lineament is therefore attributed to drainage patterns controlled and enhanced by bedrock.

Lineament No. 2

Lineament No. 2 traces a discontinuous curvilinear path along a generally northeastward trend from a point 16 miles east of Cleveland to 5 miles south of Perry and then southward to approximately 15 miles south of Perry. The tonal change occurs as a discontinuous dark band of variable width. This lineament corresponds mainly with stream channel sections of the Chagrin, Big, Grand, Paine, Bates, and East Branch Cuyahoga drainages which cut through the Pennsylvanian Pottsville and Alleghany coal, sandstone, shale, and limestone into and through the Mississippian Waverly and Maxville shale, sandstone, and limestone into the underlying Devonian Olentangy and Ohio shales (Bownocker, 1965). The stream erosion of resistant sandstones and limestones results in narrow steep walled valleys which are responsible for the lineament segments. No mapped fold axes or faults coincide with lineament No. 2. Also no gravity anomaly or gradient parallel lineament No. 2 (Cleveland Electric Illuminating Company, FSAR, 1980). The lineament is therefore attributed to a number of steep walled valleys cut by streams through essentially horizontal bedrock.

Lineament No. 3

Lineament No. 3 parallels an east-west trending, meandering segment of the Grand River. The darker toned floodplain is composed of Wisconsin age alluvium. The Wisconsin age Lake Border moraine appears to control the alignment of the drainage in this area (Goldthwaits, 1967). Bedrock topography may have influenced the distribution of the Lake Border moraine and alluvium, however, no fold axes or faults are mapped along the trend of lineament No. 3. No gravity anomaly or gradient are associated with the lineament (Cleveland Electric Illuminating Company, FSAR, 1980). Lineament No. 3 is therefore attributed to the alignment of the Grand River floodplain parallel to the linear Lake Border moraine.

Lineaments No. 4 and 5

Lineaments No. 4 and 5 trend northeastward parallel to the Lake Erie shoreline east of Perry, Ohio, occurring as slight tonal variations and the alignment of stream channels. The abandoned beach ridges of Wisconsin age Lake Warren correspond with these lineaments (Goldthwaits, 1967). Bedrock topography may influence the orientation of the strandlines, however, no fold axes or faults are mapped coinciding with lineaments No. 4 and 5. No gravity anomalies or gradients are associated with the lineaments (Cleveland Electric Illuminating FSAR, 1980). Lineaments No. 4 and 5 are attributed to the topographic expression of the beach ridge deposits.

Lineament No. 6

Lineament No. 6 is a light-toned curved lineament extending from Meadville, Pennsylvania northwestward along Cussewago Creek, then northwestward to westward along Conneaut Creek. The northwest-trending lineament parallels a segment of the Cussewago Creek cutting Pocono Group conglomerates and sandstones down to the Oswayo Formation shales, siltstones, and sandstones (Berg, 1980), forming steep valley walls of dark tones. Minor synclinal and anticlinal axes are mapped in the area, however, their limited extent and the lack of any associated gravity anomaly or gradient (Cleveland Electric Illuminating Company FSAR, 1980) indicates that these possible structures would be limited in scale as commonly reported for this region. The lineament is attributed to narrow stream valleys cutting through the essentially horizontal bedrock.

Lineament No. 7

Lineament No. 7 trending northwestward, parallel to a segment of Muddy Creek, is likely of the same origin as Linement No. 6, described above.

Lineament No. 8

Lineament No. 8 extends northwestward from the upper Shenango River in Pennsylvania to Geneva on the Lake, Ohio. The discontinuous lineament occurs as a faint light tone which does not coincide with topographic alignments. This lineament possibly connects southeastward with an area of hypothesized

structural discontinuities, (Wagner-Lytle lines), described as "narrow zones or trends along which fold axes terminate diminish or change direction", Wagner and Lytle (1976). Briggs and Kohl (1976) report that no surface faulting has been recognized along the hypothesized Wagner-Lytle lines which suggests that deformation took place in broad zones over long periods of time during which the rocks were able to adjust to stress with many minor fractures rather than mappable faults. Lineament No. 8 could be attributed to possible enhanced fracturing resulting in associated anomalous groundwater conditions, although its origin is uncertain.

Lineament No. 9

Lineament No. 9 has been eliminated.

Lineament No. 10

Arcuate lineament No. 10 was mapped along a section of Crooked Creek extending from Greenville northward and northwestward to Pymatuning Reservoir. The tonal variation is attributed to Wisconsin age kame deposits and recent alluvium filling the valley. The Shenango River drainage parallels the general strike of the limits of the Pottsville Group sandstones and conglomerates in the area (Berg, 1980). The lineament is attributed to glacial deposits filling a valley that may be lithologically controlled.

Lineament No. 11

Lineament No. 11 is drawn from a discontinuous dark toned line which extends northwestward from Mercer, Pennsylvania into Ohio. This lineament appears to connect to the southeast with

an area of hypothesized structural discontinuities (Wagner-Lytle lines) described under Lineament No. 8. Therefore lineament No. 11 could be attributed to possible enhanced fracturing resulting in associated anomalous groundwater conditions although its origin is uncertain.

Lineament No. 12

Lineament No. 12 is a discontinuous light tonal variation which extends from south of Ravenna along a section of the West Branch of the Mahoning River, northeastward to south of Pymatuning Reservoir. The southwestern segments correspond to a buried river valley filled with alluvium and Wisconsin age "valley train" deposits (Cummins, 1959). The middle and northeastern segments appear to correspond to the strike of lithologic contacts between the upland Sharon Conglomerate/ Connoquessing Sandstone and the lower Cuyahoga Group shales in the valleys (Berg, 1980). Structural discontinuities (fold axes or faults) are not reported parallel to the trend of lineament No. 12. No gravity anomaly or alignment parallel the trend of lineament No. 12 (Cleveland Electric Illuminating FSAR, 1980). This lineament is attributed to the coincidental alignment of a buried river valley and lithologic contacts.

Lineaments No. 13, 14, 15, and 18

These lineaments are the stronger of many generally north-northeast trending lineaments forming one axis of a rectilinear pattern in northeastern Ohio, formed by variations

in vegetation (wooded versus open). In one case, (Lineament No. 15), the vegetative lineament corresponds with a finger of Wisconsin age lacustrine deposits filling the buried Grand River valley. The regular rectilinear pattern is likely due to the type of agriculture present in this area. This pattern is abruptly terminated at the Pennsylvania border to the east indicating that the pattern is most likely controlled by cultural influences. No mapped structural alignments (fold axes or faults) or gravity anomalies correspond to these lineaments (Cleveland Electric Illuminating FSAR, 1980).

Lineament No. 16

Lineament No. 16 is plotted based on a weak discontinuous tonal pattern, darker on the northeast end, light in the center, and parallel to the drainage of the Cuyahoga River on the southwest end. This lineament cuts across lithologic contacts. The more distinct sections coincide with linear glacial outwash deposits (valley trains) preserved as terraces in the Cuyahoga River valley. The northeastern section parallels an end moraine deposit south of Ashtabula. Bedrock topography may influence the occurrence of the glacial deposits, however, no fold axes or faults are mapped corresponding to lineament No. 16. No gravity anomaly or gradient correlate with the trend of the lineament (Cleveland Electric Illuminating FSAR, 1980). This lineament is attributed to the alignment of linear glacial deposits.

Lineament No. 17

Lineament No. 17 trends northeastward parallel to the Upper Cuyahoga River. The drainage cuts Wisconsin age lacustrian deposits filling a buried river valley. The valley is probably controlled by the strike of lithologic contacts in this area, cutting through upland Pottsville and Allegheny shale, sandstone, and limestone to Waverly and Maxville shale, sandstone, and limestone (Bownocker, 1965). The buried river valley is likely responsible for the location of the existing Cuyahoga River, and no fold axes or faults are presently mapped parallel to the trend of the lineament. No gravity anomaly or gradient correlate with the trend of lineament No. 17 (Cleveland Electric Illuminating FSAR, 1980). Lineament No. 17 is attributed to a buried river valley controlled by lithologic contacts mapped in the area.

Lineament No. 19

This lineament is mapped as a tonal change which parallels part of Eagle Creek and the Grand River. Sections of end moraine and valley train deposits plus the contact between Pottsville and Allegheny sandstone, shale, and limestone and Waverly and Maxville sandstone, shale, and limestone (Bownocker, 1965) form the tonal patterns. The axes of minor synclines and anticlines are mapped in the area, however, their limited extent and the lack of any associated gravity anomaly (Cleveland Electric Illuminating Company FSAR, 1980) indicates

that these possible structures would be limited in scale as commonly reported for this region. This lineament is therefore attributed to glacial deposits but is also coincident with lithologic contacts.

Lineament No. 20

Lineament No. 20 forms an abrupt change from light to dark tone on a short linear section between Warren and Ravenna approximately parallel to the West Grande River. Alluvial deposits fill a buried northeast-trending preglacial valley at this locality. No structures (fold axes or faults) are mapped which correspond to lineament No. 20. No gravity anomaly or gradient correspond to the lineament (Cleveland Electric Illuminating Company FSAR, 1980). This lineament is attributed to a buried river valley filled with alluvial deposits.

Lineament No. 21

Lineament No. 21 is traceable as a faint light tonal variation trending northwestward between Alliance and Akron, Ohio. This lineament corresponds to a N 54° W. trending high-angle bedrock fault mapped in the subsurface. The maximum vertical displacement is 100 feet upthrown on the southwest side. Structural contours and isopachs of the Middle Devonian age Delaware-Dayton Formations confirm the existance of the fault first noted by Janssens (1977) (Stone and Webster, 1978). The location, subsurface occurrence, and limited extent of this fault and the lack of any known associated seismicity

indicate no potential hazard. There is no evidence to indicate that the subsurface fault is responsible for lineament No. 21, and no correlative fault scarp or surface rupture are reported (Stone and Webster, 1978).

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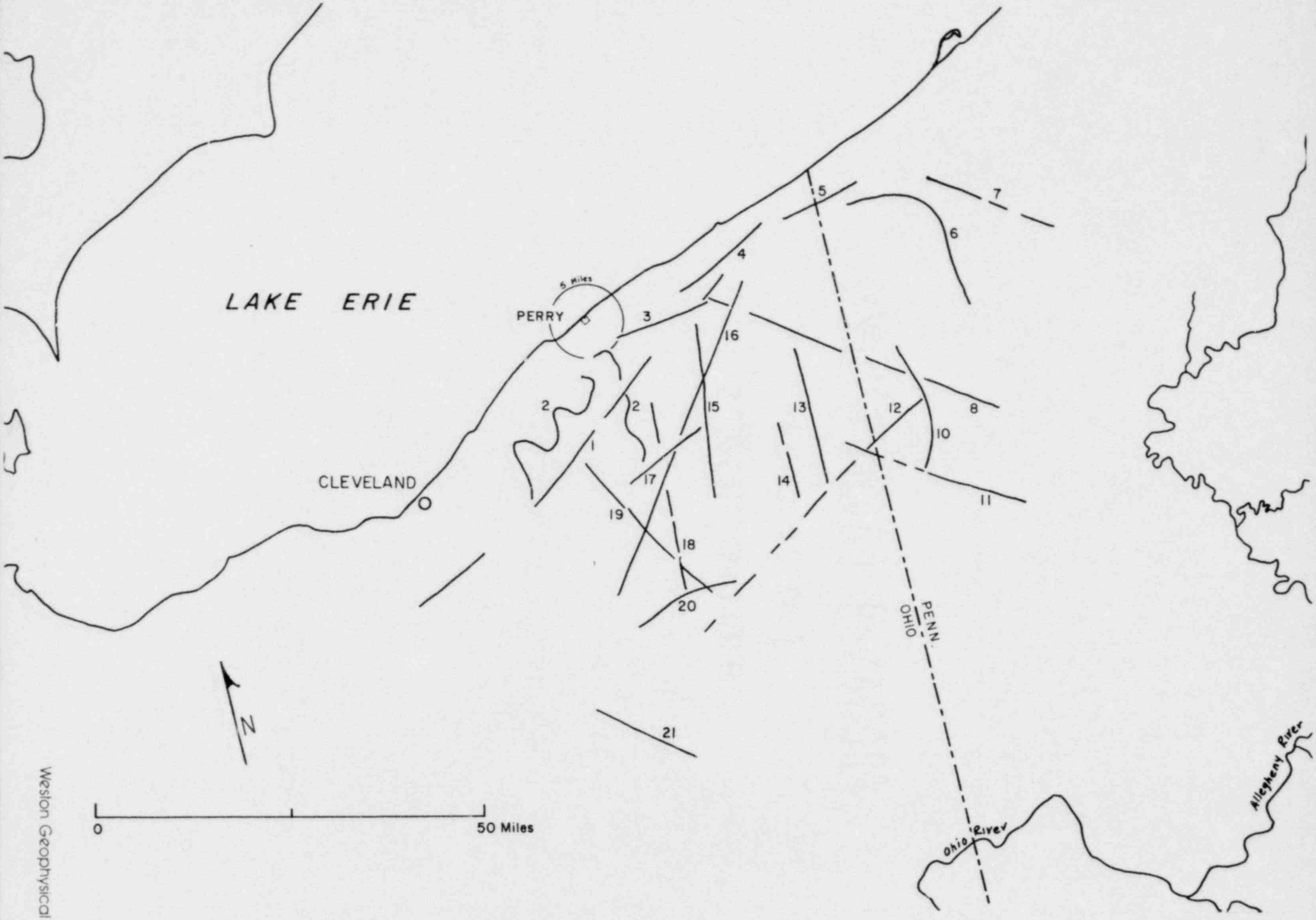

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