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Subject: April-October, 1978 Semi-Annual Report
Contract NSG-5270

Date : November 1, 1978

(E79-10066) [DATA COLLECTION AND INTERPRETATION OF THE LITHOLOGIC CHARACTERIZATION OF THE CRYSTALLINE BASEMENT PROVINCES OF THE EASTERN UNITED STATES] Semiannual Report, Apr. - Oct. (Pittsburgh
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During the past six month period ending October 15, 1978, considerable progress has been made on data collection and interpretation of the lithologic characterization of the crystalline basement provinces of the eastern United States.

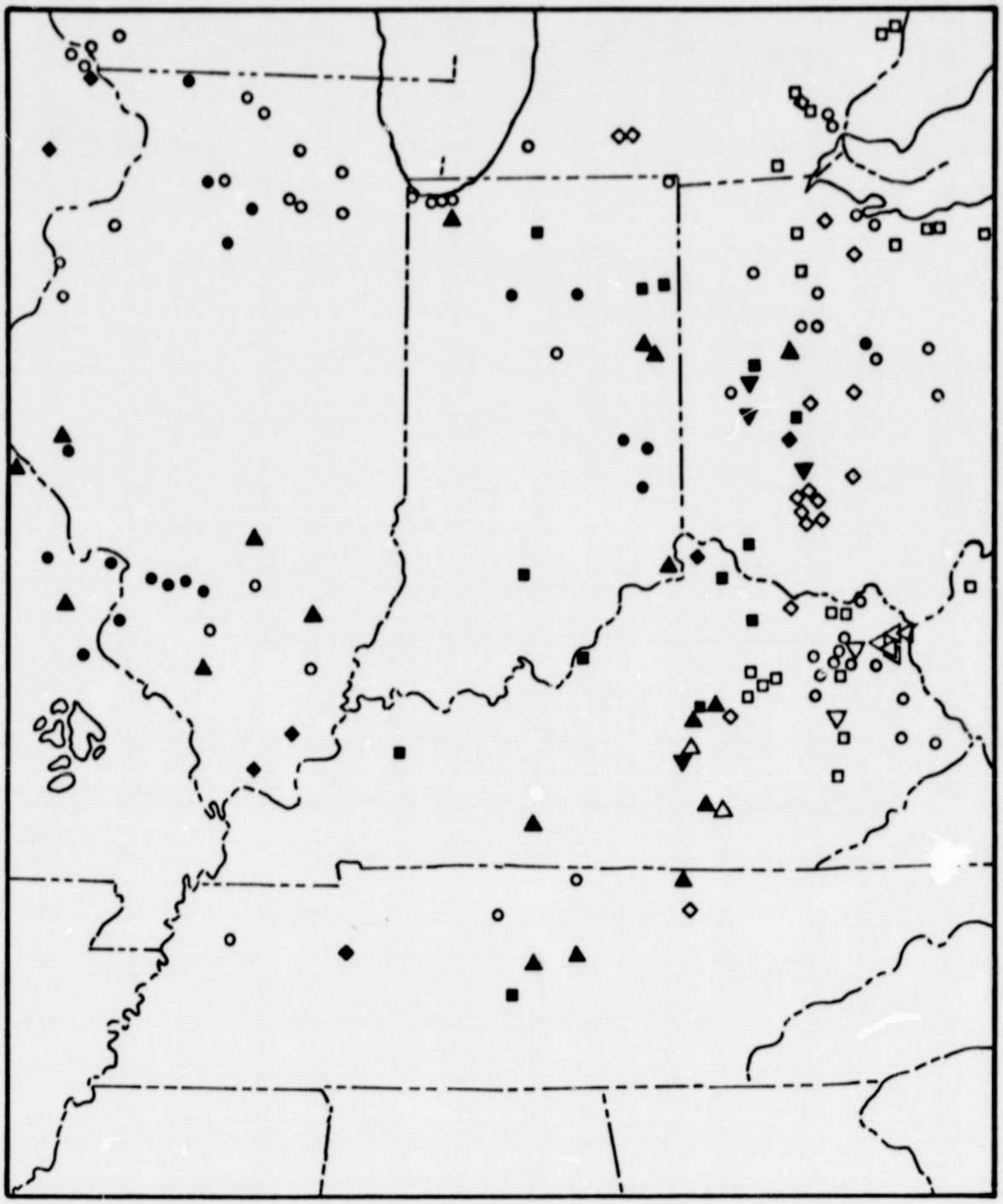
A revised basement rock work map of the entire interior of the United States (scale 1:2,500,000) has been prepared and is attached as Plate 1. This map is based on all data available prior to 1977 and represents the first compilation made on this large region since the publication of the original Basement Rock Map of the United States in 1968 by Bayley and Muehlberger (U. S. Geological Survey Publ.). It is hoped that this map will be of immediate use in the satellite data program.

Samples of available basement rocks in the eastern midcontient region have been obtained and detailed petrographic studies have been conducted on them. The sample distribution and predominant rock types are shown on Figure 1.

A preliminary basement rock lithologic map of the eastern midcontinent has also been prepared and is presented as Figure 2. This map is based on Figure 1 and preliminary qualitative correlations of rock type with small-scale regional Bouguer gravity anomaly maps. Revision of this map is continuing as new samples and data become available.

Work is also progressing on geochronologic, geochemical, and magnetic studies of basement samples shown on Figure 1. As noted in the original proposal, these studies are instrumental in helping to define the various basement rock provinces and their geophysical signature.

Two abstracts on research directly related to the basement rock project were presented at meetings during the fall of 1978. A paper on "Ring Magnetic Anomalies in the Central Midcontinent" by Hinze, Richardson, Braile, and Lidiak was read at the Midwest AGU in September. A second paper entitled "Rifting in the Midcontinent, U.S.A." was presented by Lidiak, Keller, Braile, and Hinze at the 1978 International Symposium on the Rio Grande Rift in October. Abstracts of these papers are attached.



Sedimentary Rock ◆
Basalt ■
Rhyolite ▲
Trachyte ▼
One-Feldspar Granite ●

Anorthosite ◁
Gabbro or Diorite ▽
Two-Feldspar Granite ○
Low Grade Metamorphic Rock △
Medium Grade Metamorphic Rock ◇
Granitic Gneiss □

Figure 1. Distribution of Wells to Basement and Basement Rock Type, East-Central United States

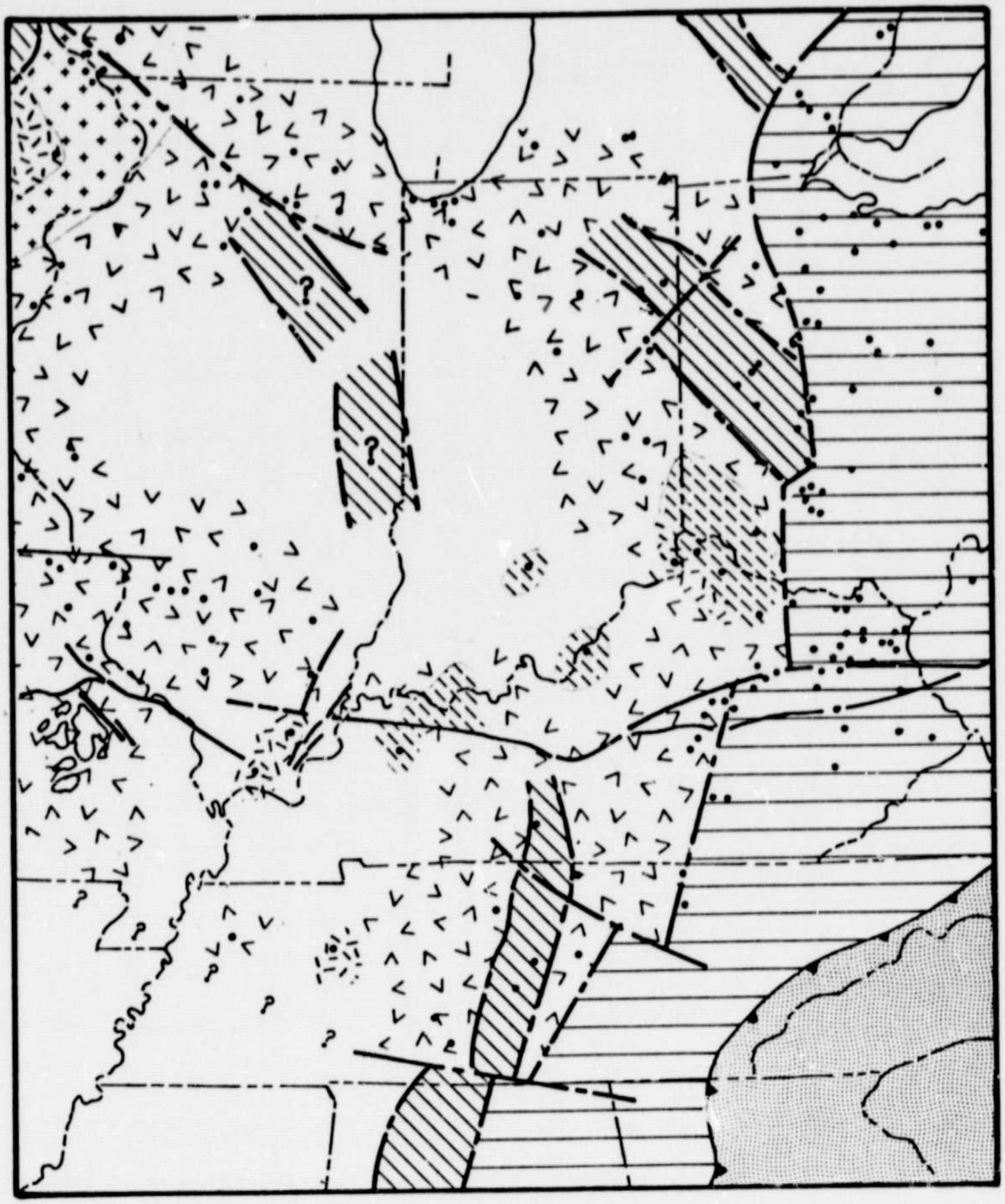


Figure 2. Preliminary Basement Rock Map, East-Central United States

EXPLANATION FOR FIGURE 2

(stippled box)	Appalachian System
(horizontal-line box)	Subsurface Grenville Province
(dashed-pattern box)	Sedimentary Rocks
(fine diagonal-line box)	Mafic Igneous Rocks
(diagonal-line box)	Basaltic Rift Zones
(v-pattern box)	Granite-Rhyolite Province
(cross-pattern box)	Plutonic Complex
▼▼▼	Thrust Fault (Barbs on Upthrown Side)
——	High-Angle Fault
— — —	Inferred Basement Fault
●	Well to Basement
?	Doubtful

1978 AGU MIDWEST MEETING

September 25-27, 1978

The 1978 AGU Midwest Meeting is being held at St. Louis University in St. Louis, Missouri, from September 25 to 27. All sessions will be in the United States Room at the Busch Memorial Center on Grand and Laclede avenues. The meeting is cosponsored by the Defense Mapping Agency and Washington University.

Convened by Otto Nuttli St. Louis University, St. Louis, Missouri

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RING MAGNETIC ANOMALIES IN THE CENTRAL MIDCONTINENT

W.J. Hinze
R.B. Richardson
L.W. Braile (Dept. of Geosciences, Purdue Univ., W. Lafayette, IN 47907)
E.G. Lidiak (Dept. of Earth & Planetary Sciences, Univ. of Pittsburgh, Pittsburth, PA 15260)

Four circular magnetic anomalies have been identified on the revised magnetic anomaly map of Indiana. They consist of a series of discontinuous positive magnetic anomalies generally bordered by negative anomalies and ringing a central minimum which approaches regional magnetic levels. The positive anomalies have amplitudes of the order of 200 gammas although locally they attain amplitudes in excess of 1000 gammas. All four anomalies occur in the eastern half of the State, east of a north-south linear trend which terminates the easterly striking anomalies to the west which characterize the anomaly pattern to the north of this area. The most dominant of the ring anomalies is the elliptical-shaped Fort Wayne anomaly which has a correlative 50 mgal anomaly. The three remaining anomalies, each 50 km in diameter, have no correlative gravity anomalies on the available gravity anomaly maps. Modeling the anomalies and their circular pattern suggest that these anomalies are caused by relatively thin volcanic rock deposits or ring dike complexes. In either event the anomalies are probably related to calderas and the Fort Wayne anomaly overlies an elliptical stock of mafic composition rocks. A similar ring magnetic anomaly occurs in southwestern Illinois and a somewhat larger feature occurs in southeastern Indiana astride the Ohio boundary. The interpreted caldera magnetic signatures are believed to be related to anorogenic igneous events dated at about 1.3 to 1.5 b.y. in the basement Central Province.

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Conference Proceedings

Special Distribution
Issued: September 1978

1978 International Symposium on the Rio Grande Rift

October 8-17, 1978

Santa Fe, New Mexico, USA

Program and Abstracts

Kenneth H. Olsen, Convener
Charles E. Chapin,* Program Chairman

*New Mexico Bureau of Mines and Mineral Resources, Socorro, NM 87801.

RIFTING IN THE MIDCONTINENT, U.S.A.

LIDIAK, E. G., Department of Earth and Planetary Sciences, University of Pittsburgh, Pittsburgh, Pennsylvania 15260; KELLER, G. R., Department of Geological Sciences, University of Texas at El Paso, El Paso, Texas 79910; BRAILE, L. W., and HINZE, W. J., Department of Geosciences, Purdue University, West Lafayette, Indiana 47907

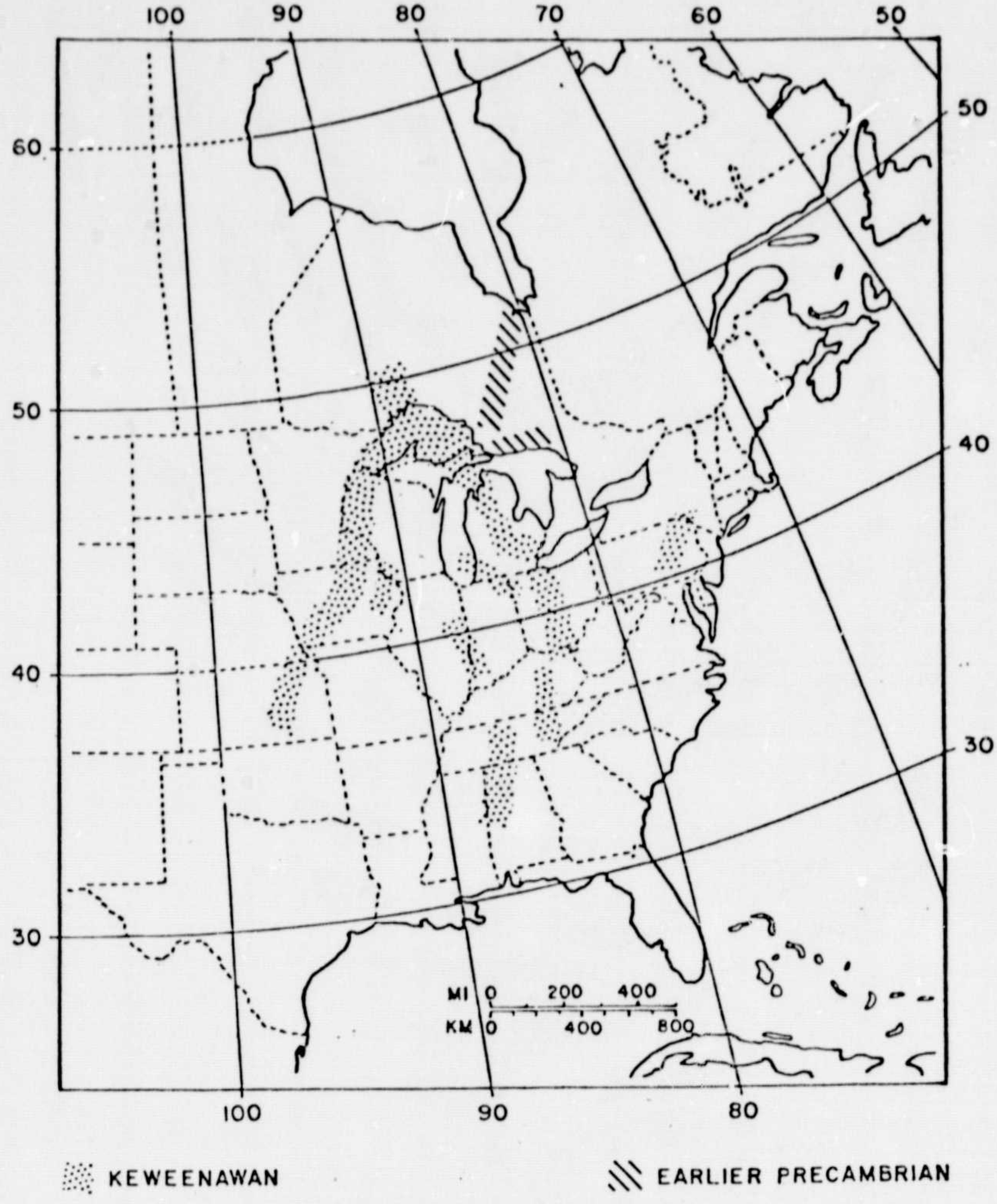
Rifts are important tectonic features that are developed both along continental margins and in continental interiors. They have a significant role in deciphering tectonic history, including pre-Mesozoic plate tectonics, basinal development, and resurgent tectonics, and in localizing earth resources.

Rift zones are probably more common in the midcontinent of the United States than generally realized. However, they may be difficult to recognize because of burial beneath younger deposits, superimposed structures, and subsequent changes in the properties of the underlying crust and upper mantle. Because of these difficulties a review of the geological and geophysical characteristics of the main continental rifts was made. Geologically, many rifts are characterized by a complex linear graben structure in which normal predominates over reverse and strike-slip faulting, by a similar width (35-60 km.), by compositionally diverse but generally bi-modal igneous activity, by transgressive sedimentation except in initial stages, and by an apparent moderate geothermal gradient that results in appreciable metamorphism only in the deeper structural zones. Rift valleys are present only in the younger active structures; older rifts occur mainly as structurally complex zones without primary topographic expression. The rifting process generally involves both the basement and the overlying strata. The geophysical characteristics are equally distinctive. Active rifts are commonly underlain by an anomalously hot crust and mantle. They are characterized by a thin crust ($\leq$ 35 km.), low Pn velocity (< 8.0 km./sec), crustal low velocity layers, long wavelength Bouguer gravity lows on which are superimposed local maxima due to igneous activity and minima due to sedimentary graben fill, shallow Curie temperature depths, complex magnetic anomaly patterns, linear bands of shallow seismicity, extensional earthquake foci, and linear heat flow highs.

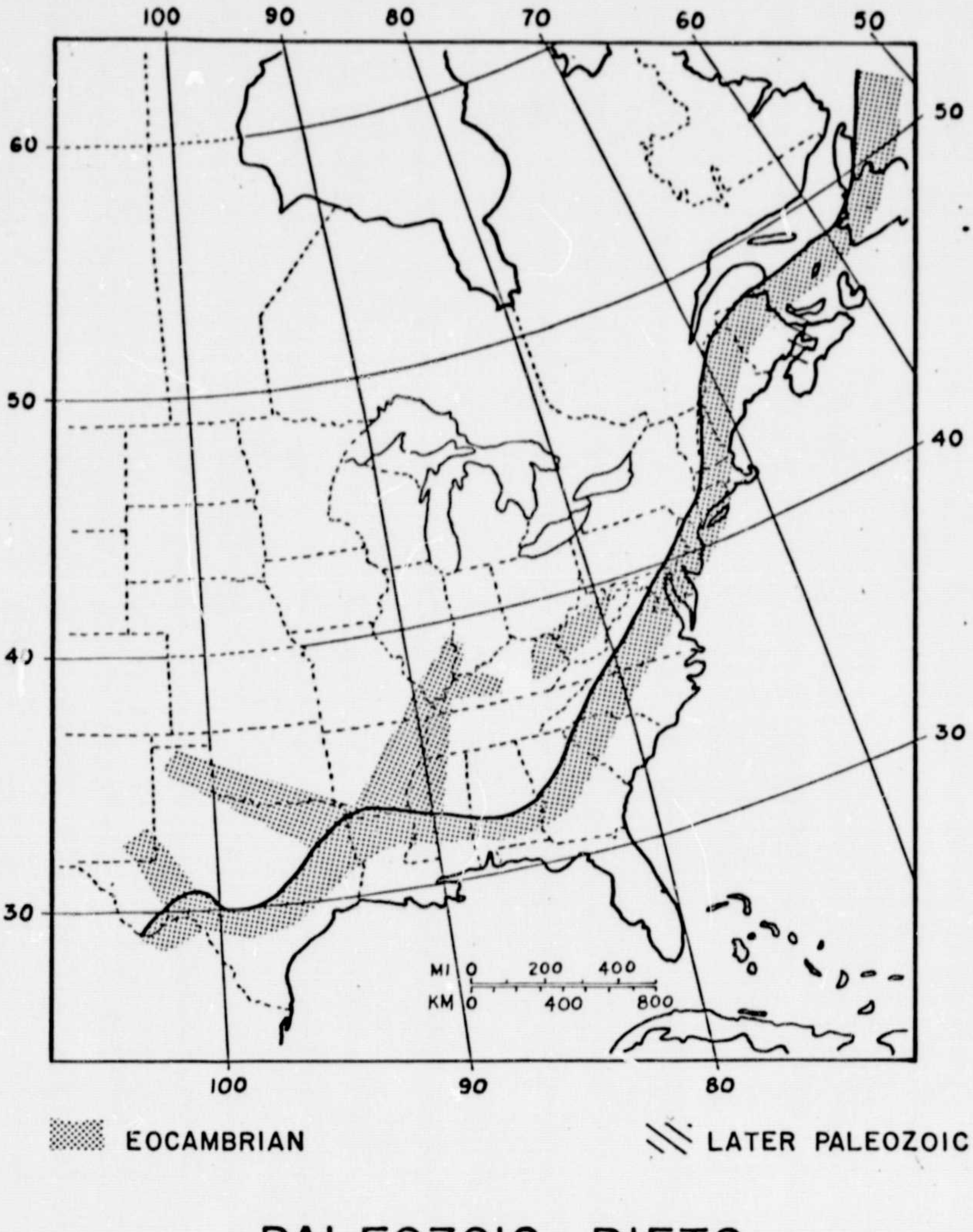
Complexities in the geological and geophysical expression of rifts are also present and are due to stage of development at arrestment, age, depth of erosion or burial, and mode of origin. For example, older, dormant rifts may be underlain by a more normal, thicker crust and thus lack many of the characteristics of active rifts. Other rifts may be in an intermediate stage of development with the result that the geological and geophysical signatures may vary accordingly. Another factor is that many older rifts, particularly those of Precambrian age, differ from younger rifts in being associated with Bouguer gravity highs rather than lows. This difference generally reflects more voluminous basaltic vulcanism or exposure of deeper crustal layers. It may also be important to distinguish between rifts formed by different mechanisms. For example, "dynamic" rifts formed by forces originating from mass transfer within the asthenosphere are expected to have different deep crustal properties than "passive" rifts caused by forces originating within the lithosphere. Vertical movement in the mantle is of prime importance in the development of "dynamic" rifts, and normal faulting and volcanism are manifestations of this larger feature which involves doming and thinning of crust. Such rifts apparently form by one or more of the following mechanisms: development of large thermal anomalies in the mantle, penetration of an oceanic ridge beneath a continent, formation of aulacogens, complete or incipient break-up of a continent, or spreading behind an active continental margin or island arc structure. In contrast, "passive" rifts form primarily as a result of horizontal movement of lithospheric plates. Such rifts may form by the collision of irregular continental margins or by the complex accommodation of microplates to the movement of larger lithospheric plates.

Although dating of rifts is subject to considerable uncertainty, a chronological catalog of recognized rifts of the central and eastern midcontinent has been prepared based on a variety of geological and geophysical evidence. The list which includes more than 20 rifts exclusive of late Precambrian and Triassic grabens along the continental margin at time of break-up shows that late Precambrian and Eocambrian rifts are more common, more widely spread and are marked by greater igneous activity than subsequent rifts.

Lidiak, Keller, Braile, and Hinze (1978)

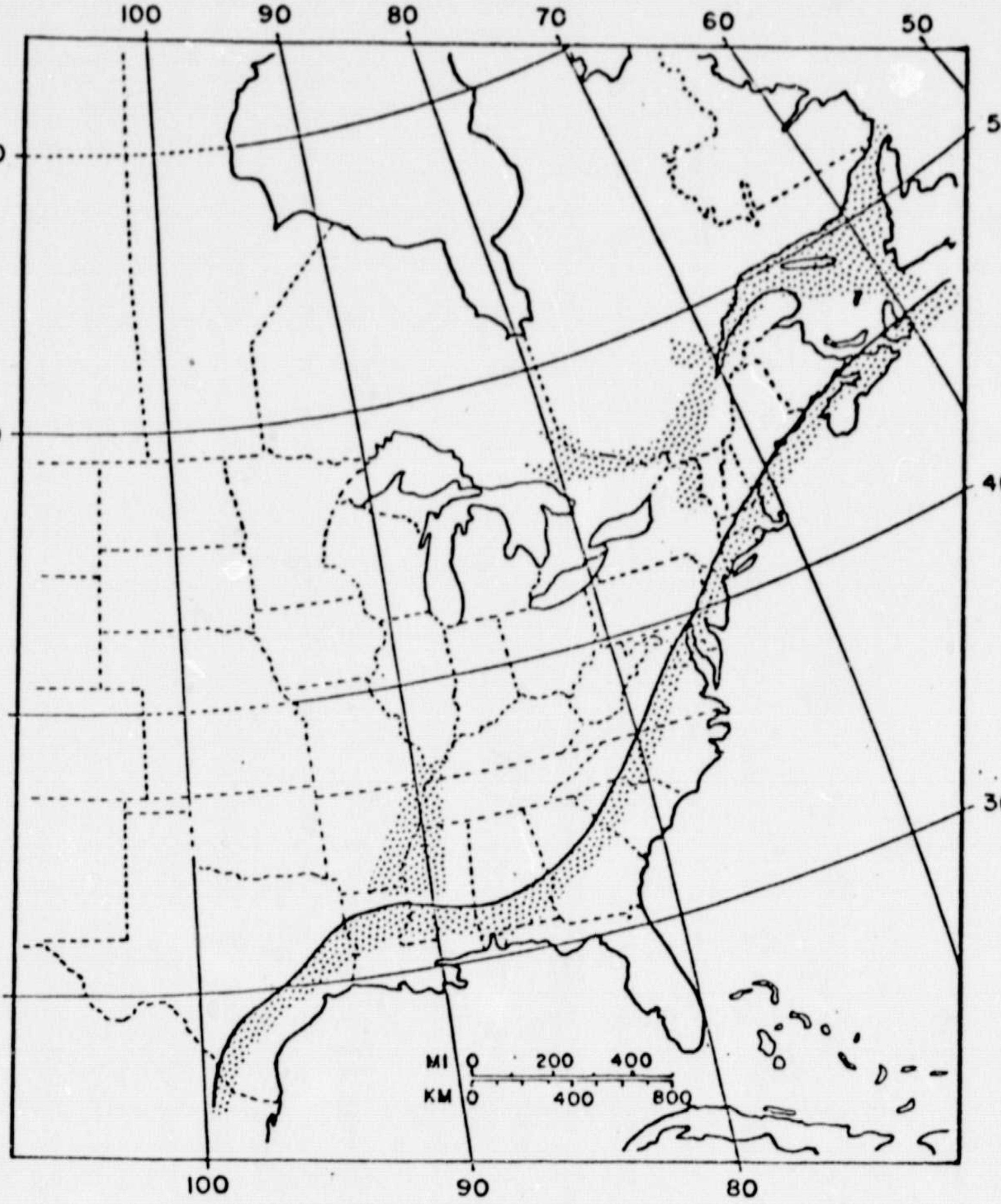


PRECAMBRIAN RIFTS



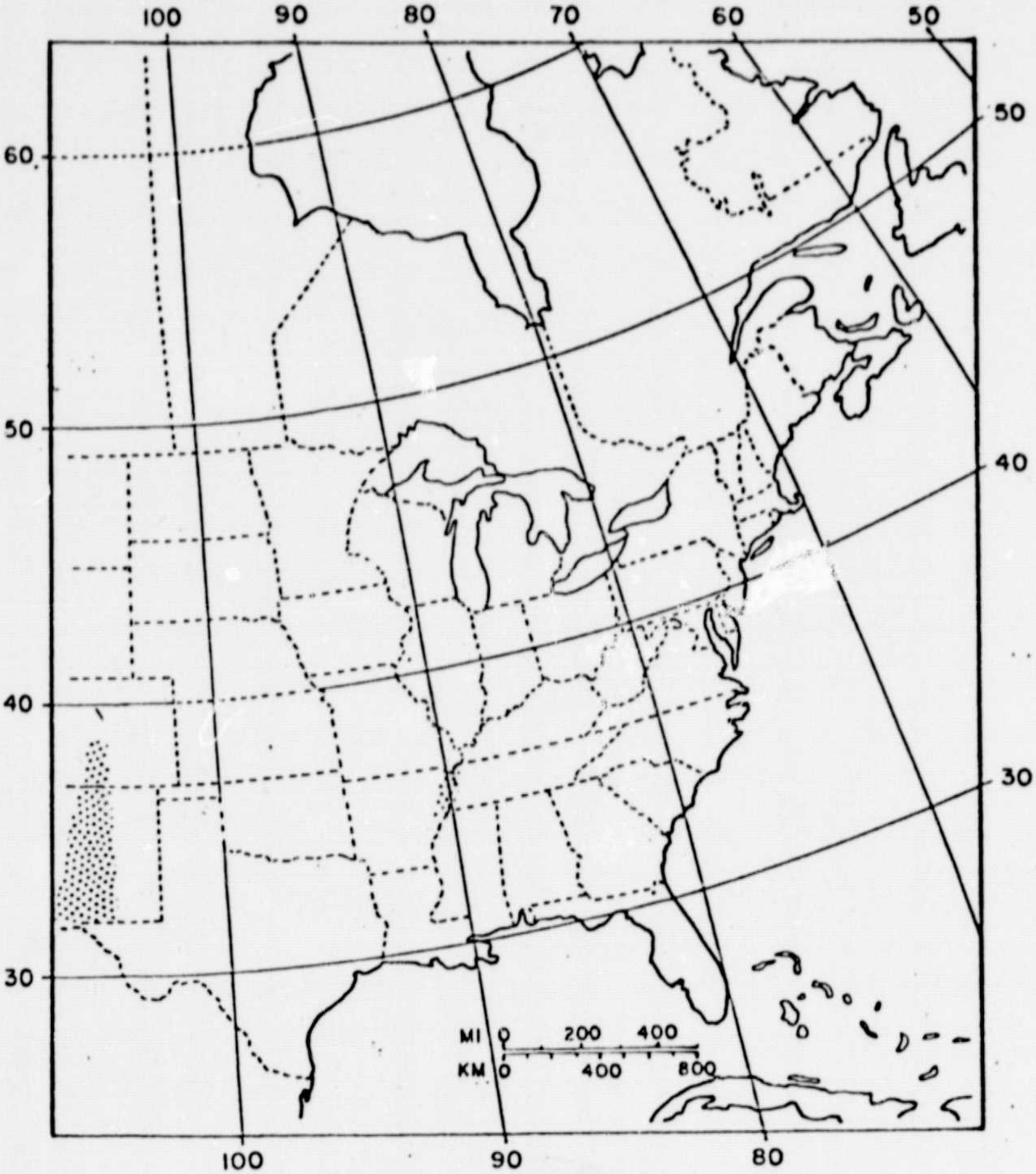
PALEOZOIC RIFTS

Lidiak, Keller, Braile, and Hinze (1978)



MESOZOIC RIFTS

Lidiak, Keller, Braile, and Hinze (1978)



CENOZOIC RIFTS

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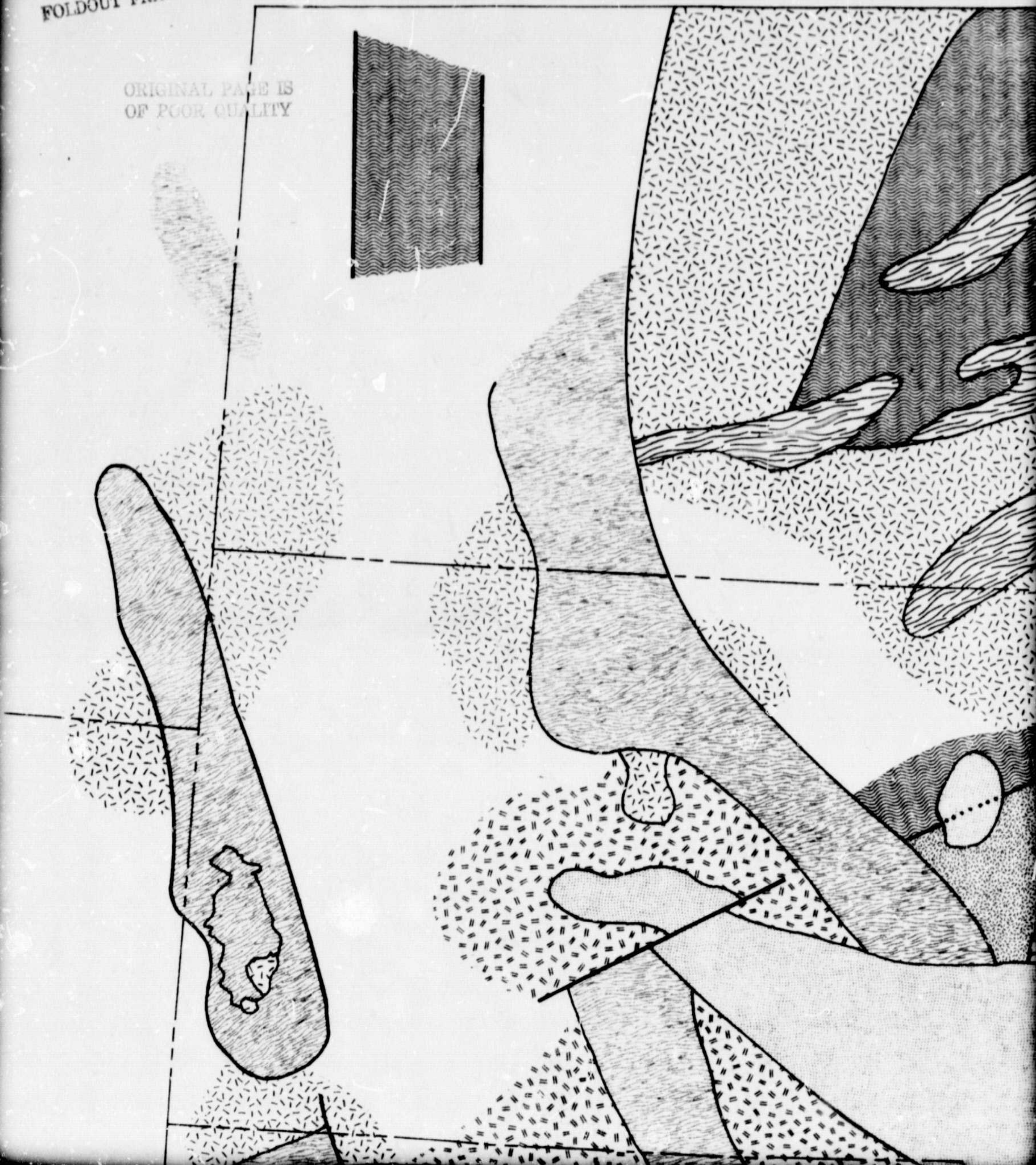

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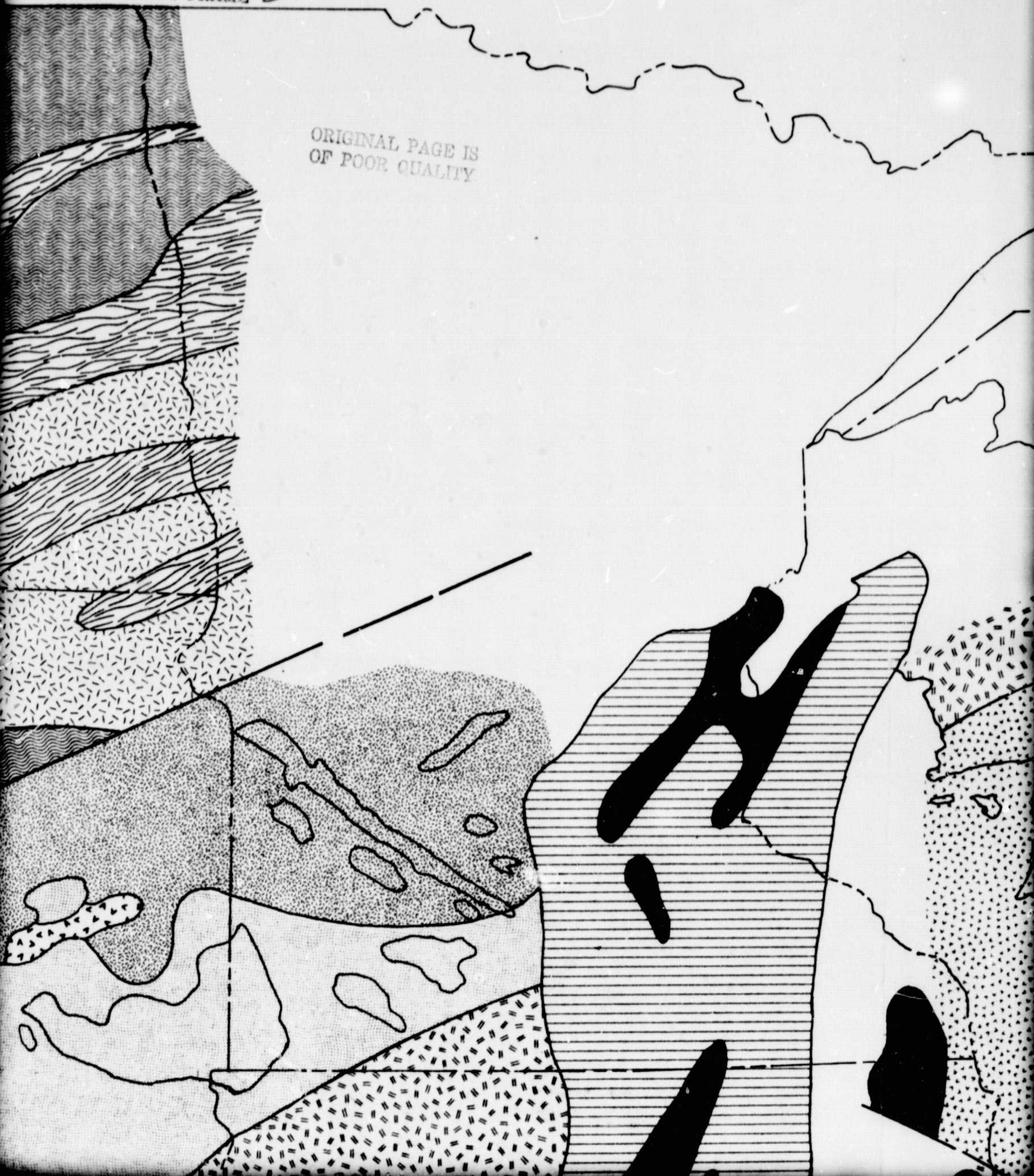

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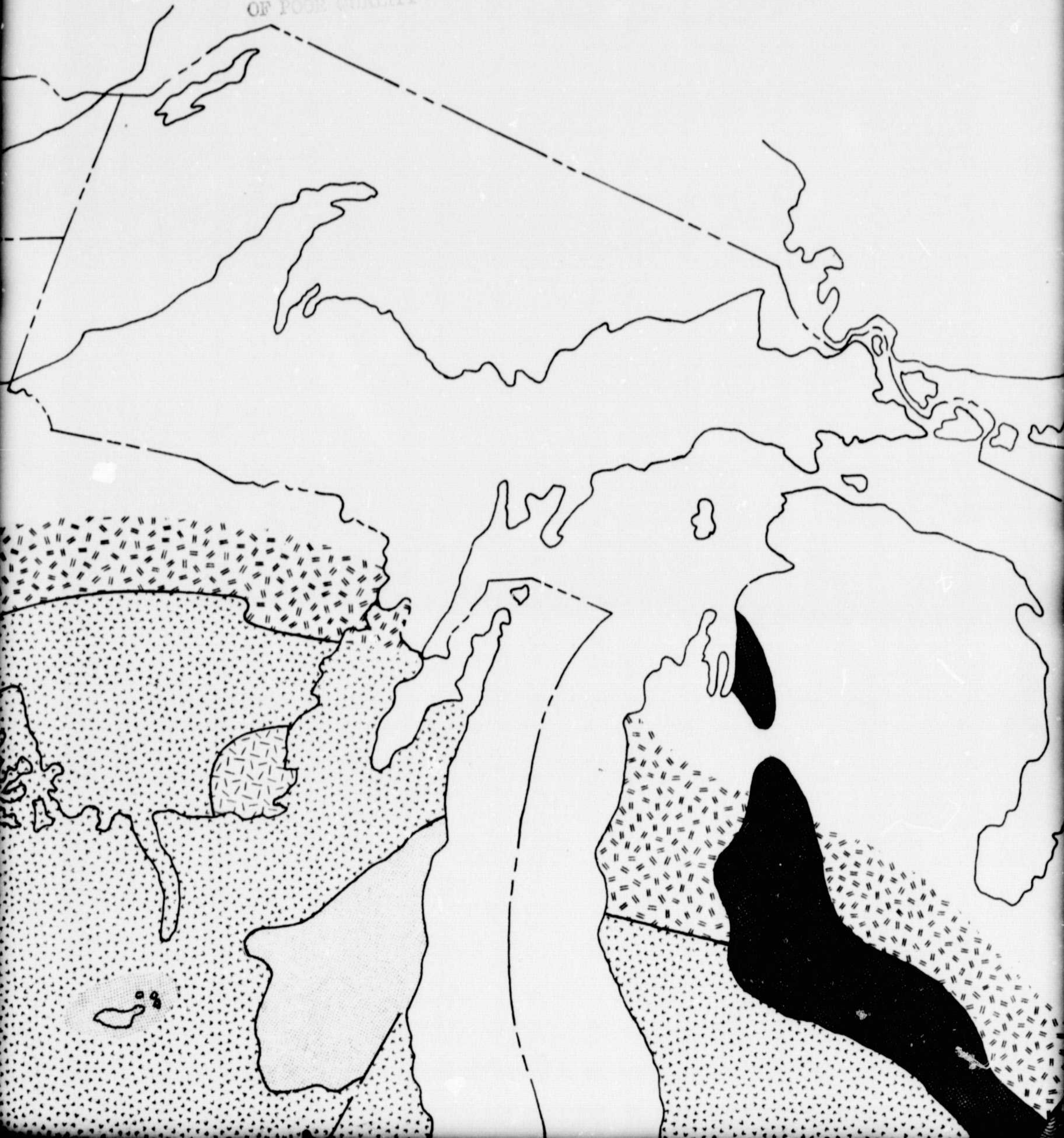

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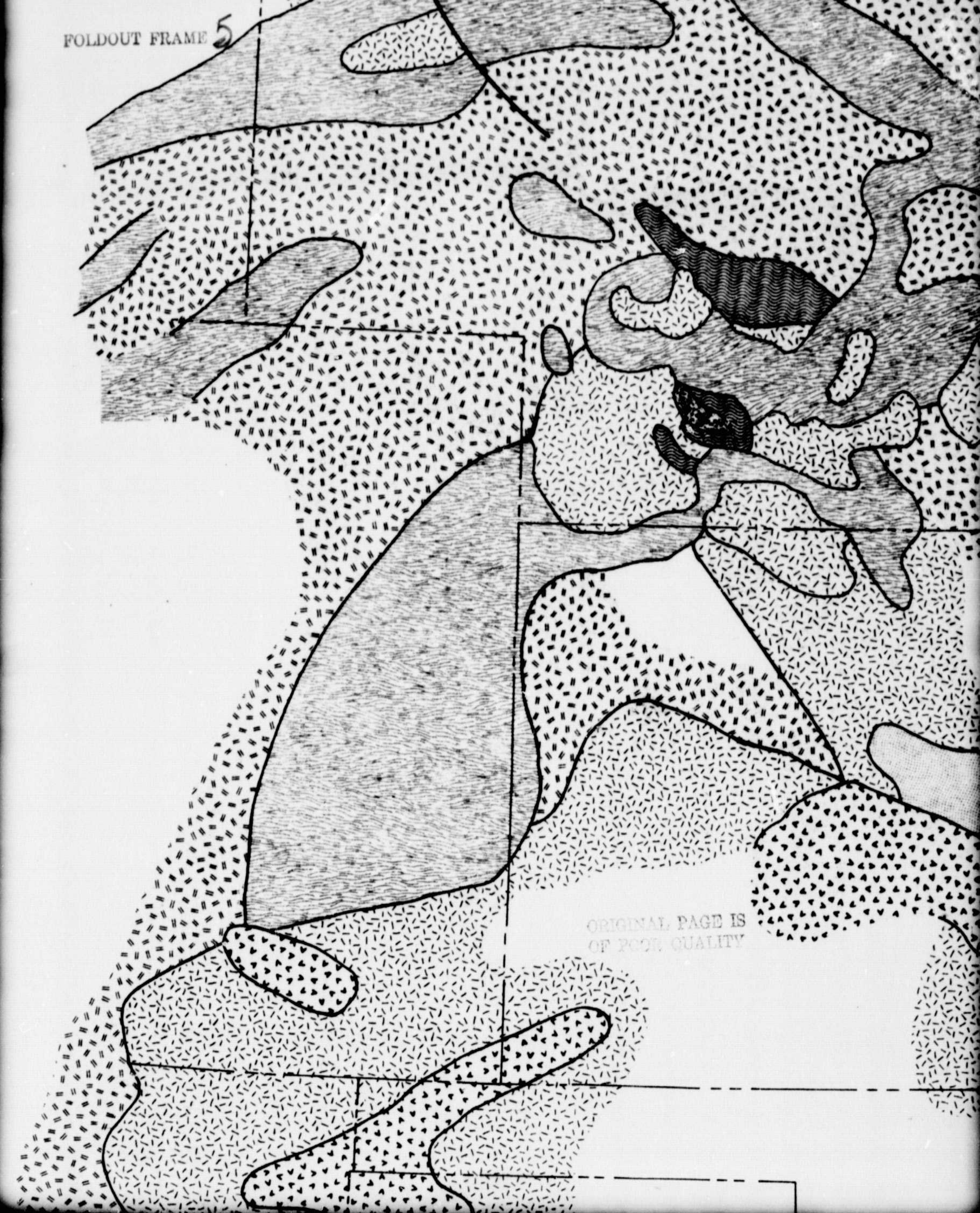

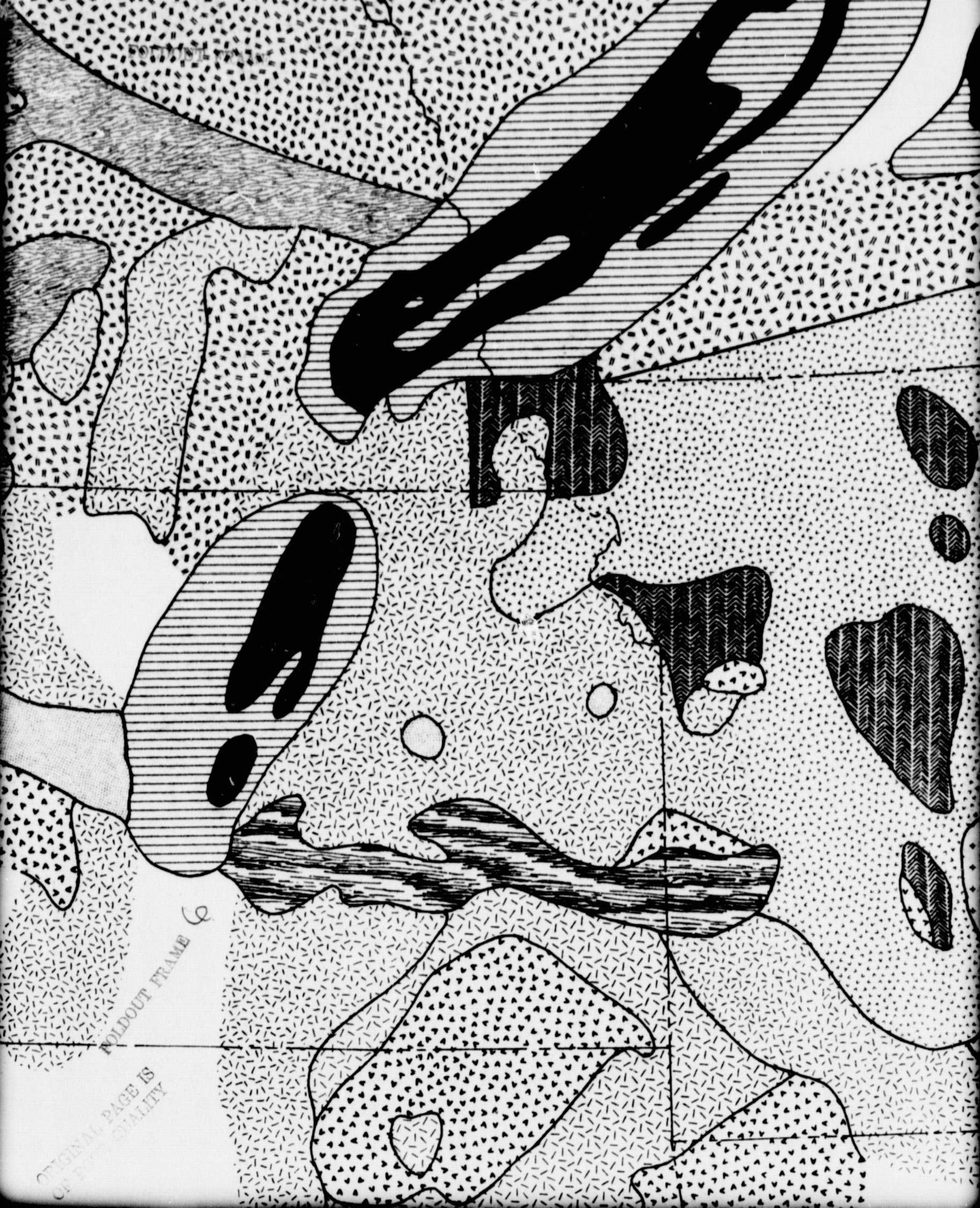

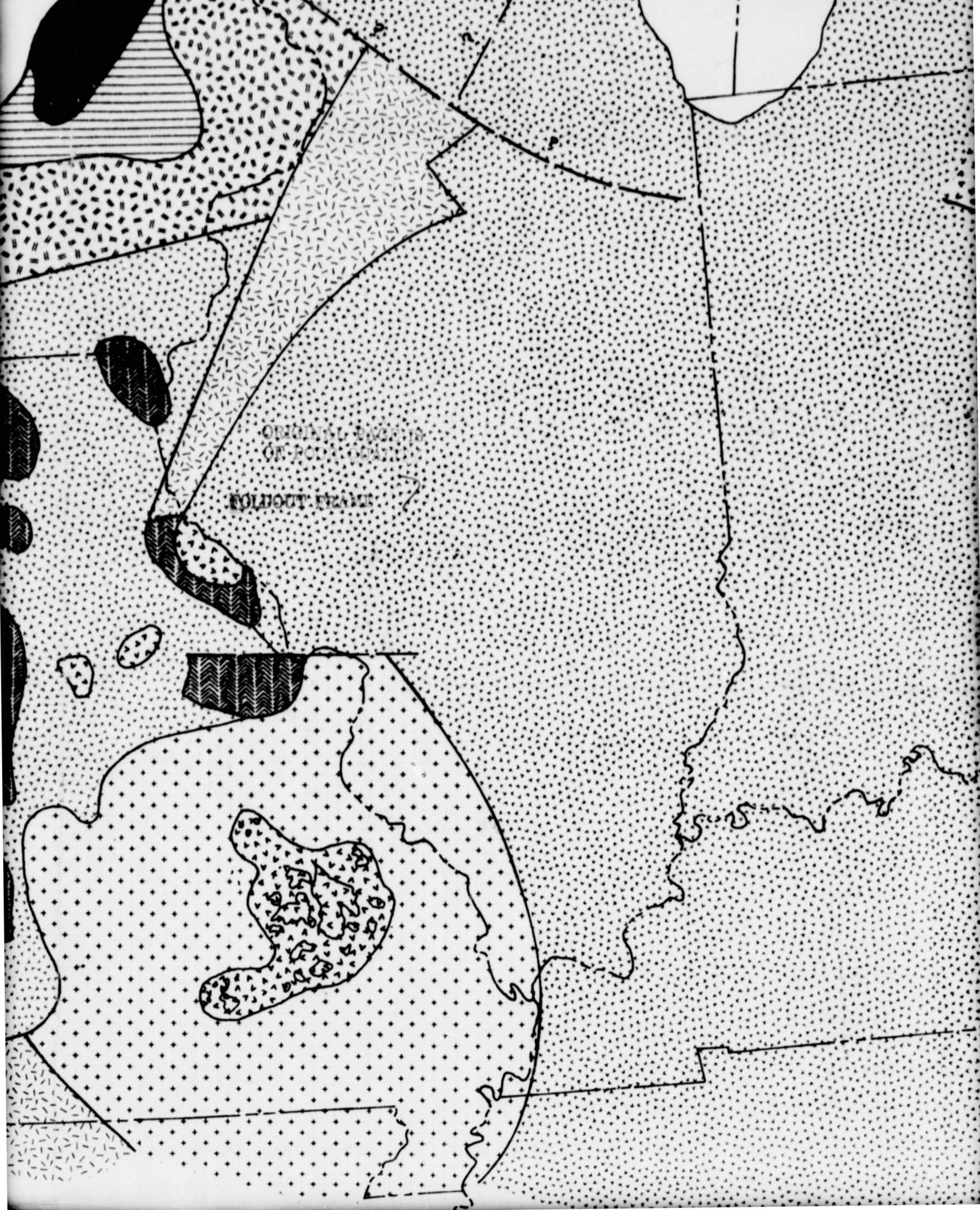
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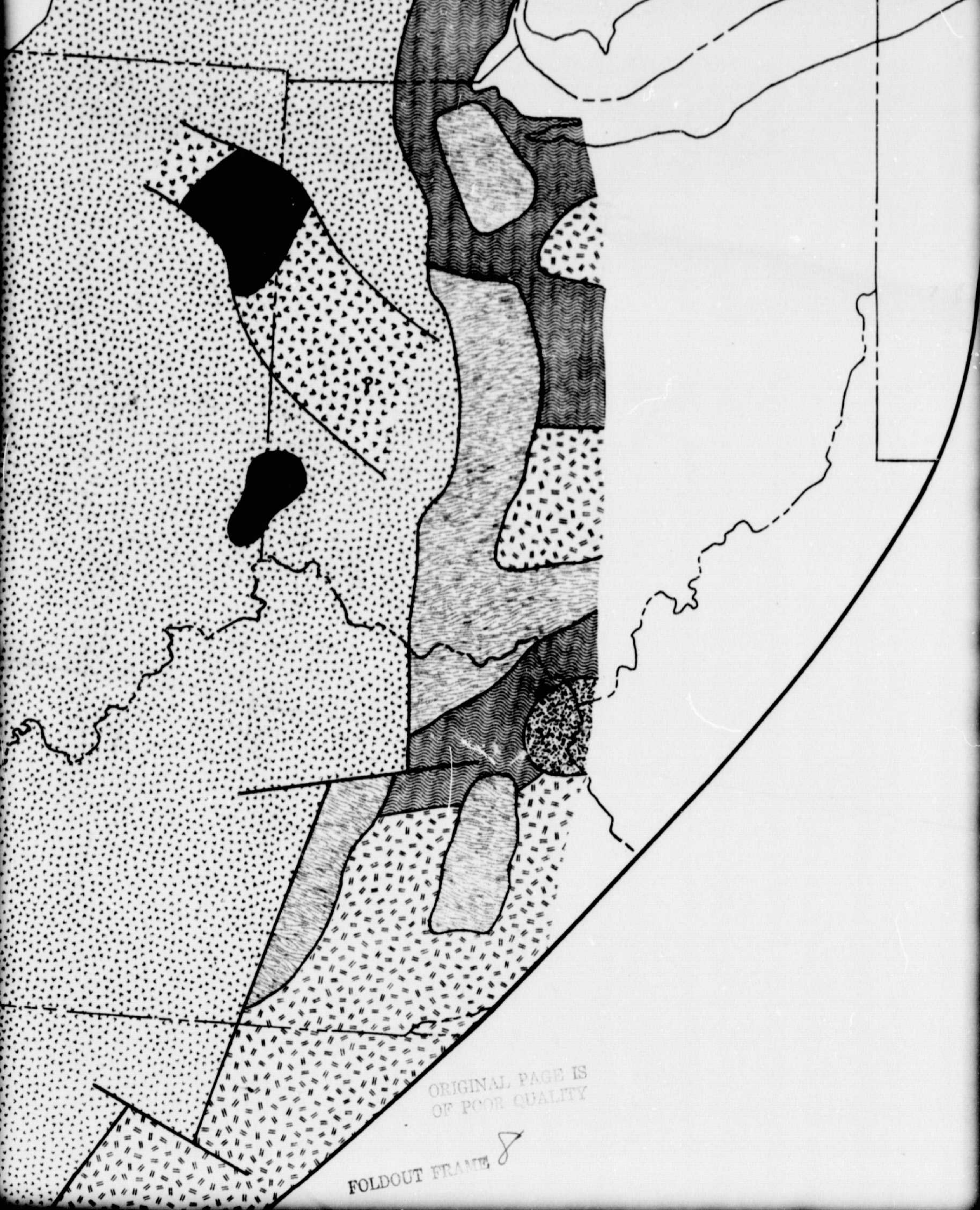

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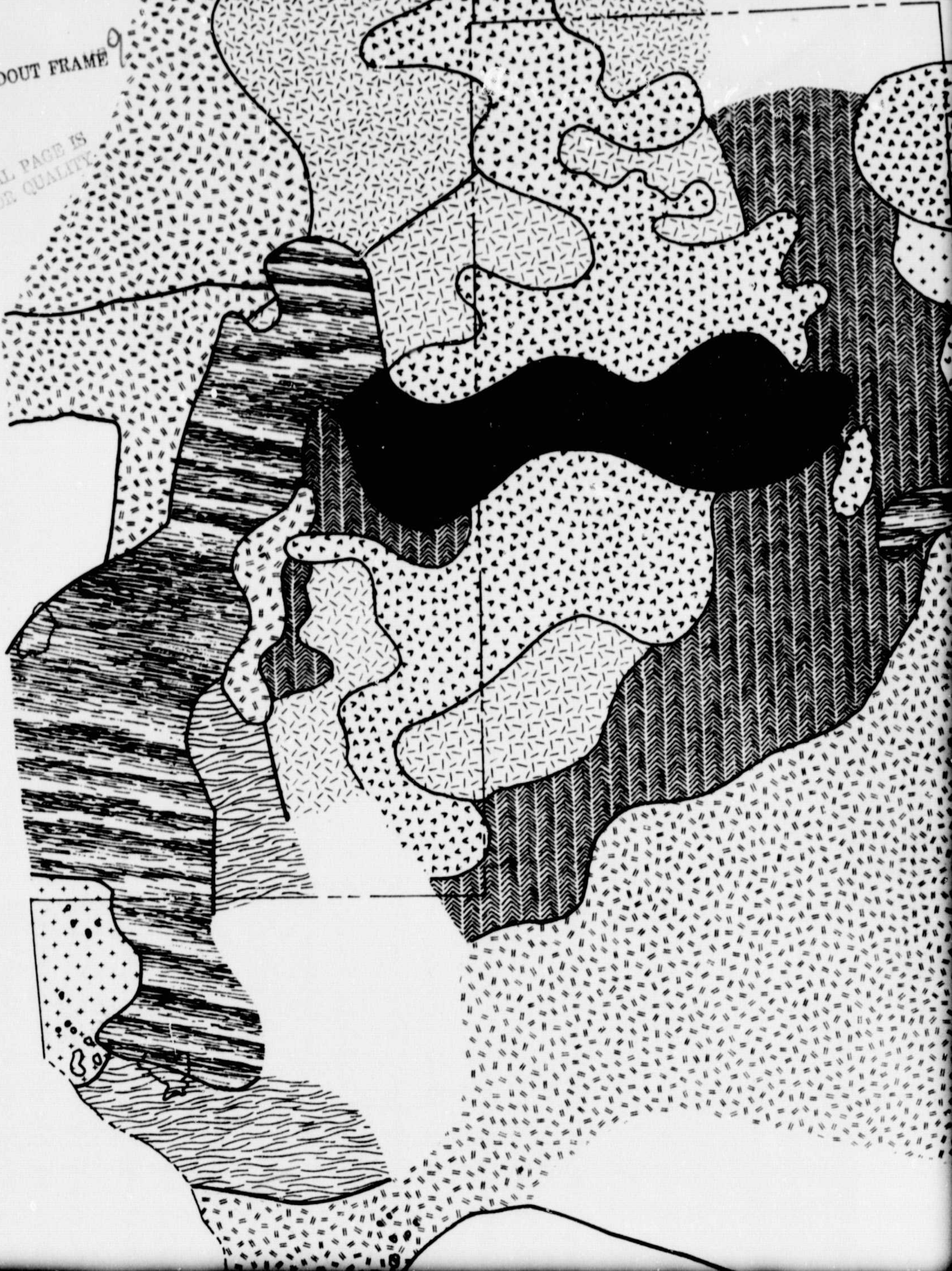

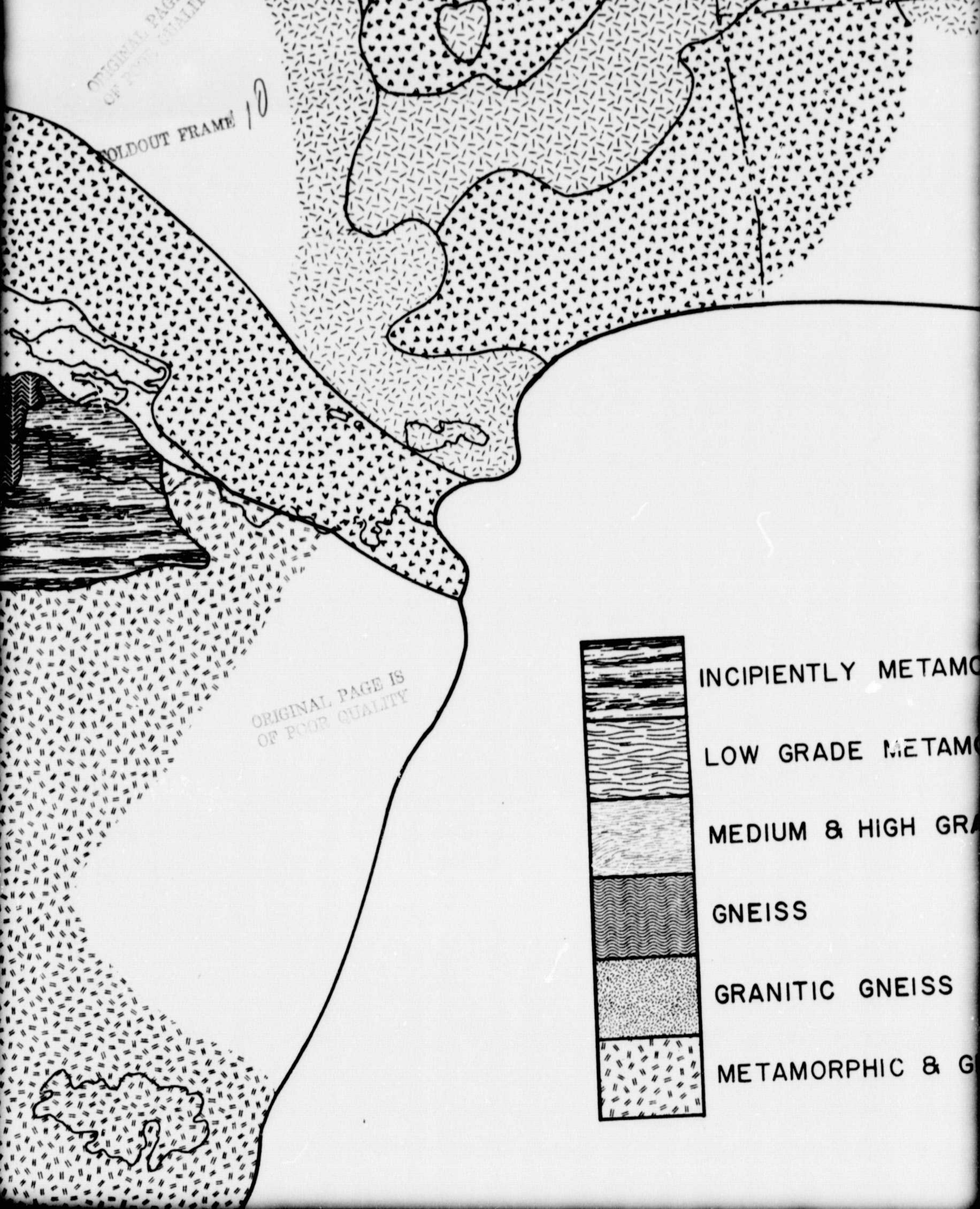
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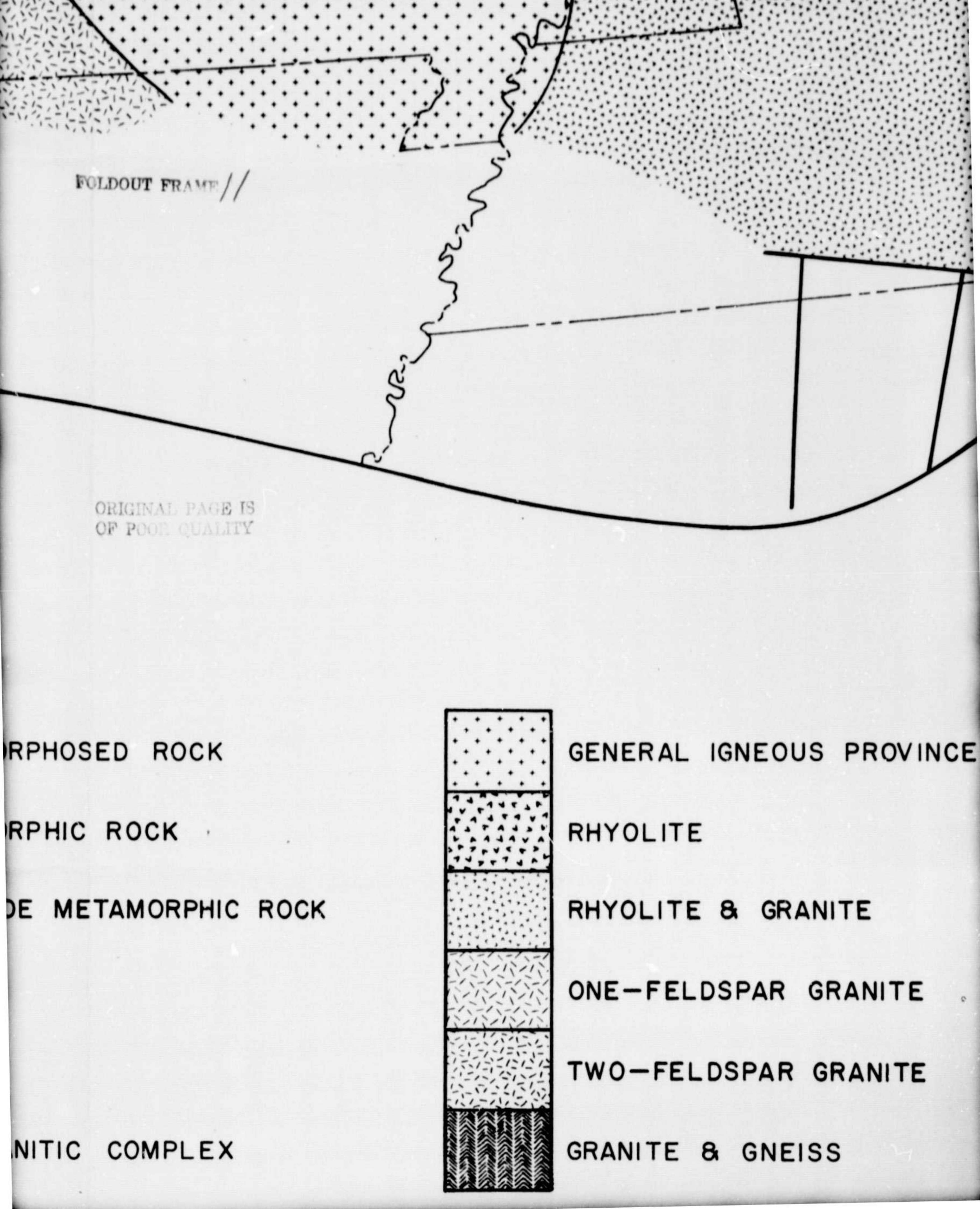
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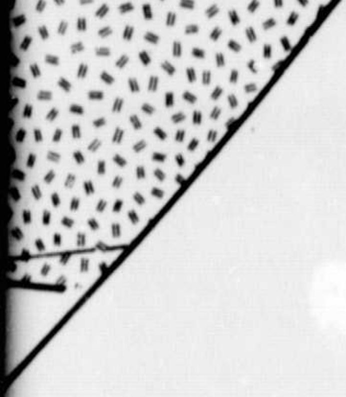
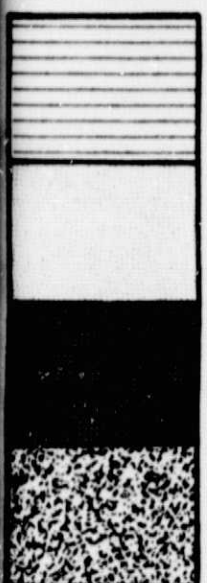


Based on Data Obtained
Prior to 1977.

Compiled by E. G. Lidiak.



SEDIMENTARY ROCK

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MAFIC IGNEOUS ROCK

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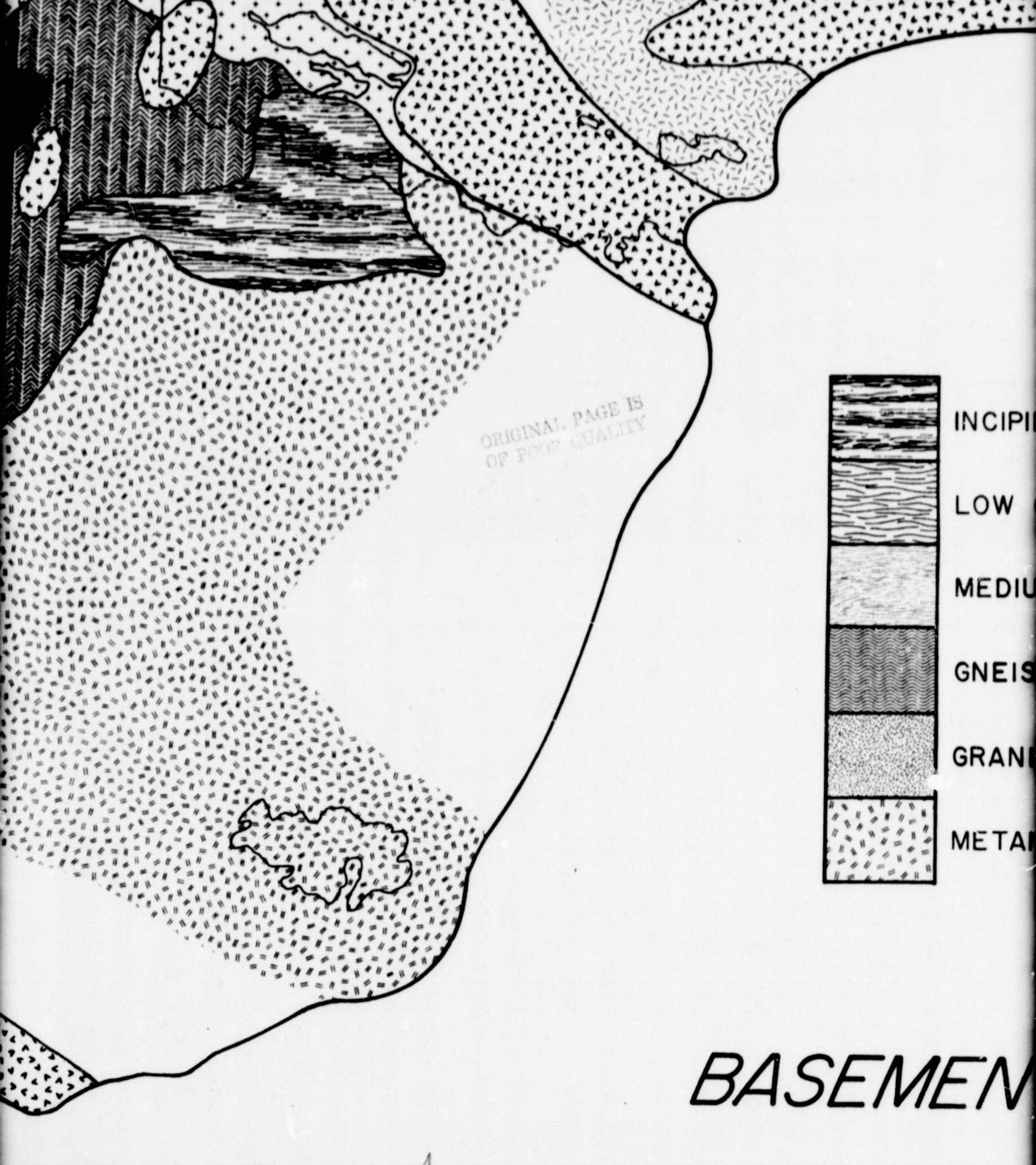
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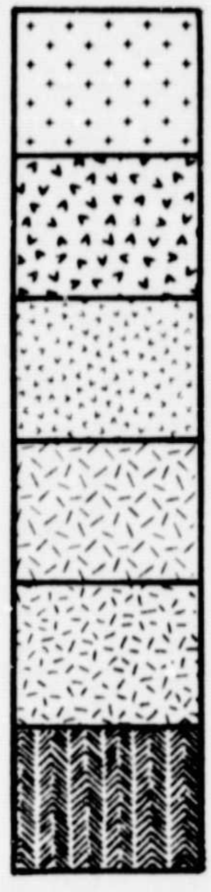

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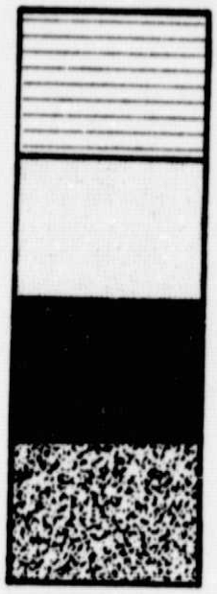

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