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FIRST-LOOK ANALYSIS OF GEOLOGIC GROUND PATTERNS ON ERTS-1 IMAGERY OF MISSOURI*

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ABSTRACT

Examination of ERTS-1 data for selected areas of Missouri revealed not only many of the known geologic features but also a number of unknown linear, circular and arcuate ground patterns. The number of new geologic elements that have been brought to light as well as the sharp definition and probable extensions of several known geologic features point out the importance of multispectral imagery via satellite and the synoptic views which they provide. To date, analysis and interpretations have been a "first-look" visual examination of the unenhanced projected images.

1. INTRODUCTION

The Missouri Geological Survey has received ERTS imagery through involvement in two ERTS-1 projects: (1) An Application and Evaluation of ERTS-1 Data in Environmental Geology and Land-Use Planning in the St. Louis-Kansas City Corridor, Missouri (SR-168) and (2) An Evaluation of ERTS-1 for Mapping Pleistocene Deposits and Landforms in the Midwest and Great Plains (SR-238). This paper is not a progress report for either of these projects but rather an evaluation of the imagery by the Mineral Resources and Stratigraphy Sections of the Survey as to how it may relate to present and future projects. Admittedly, we were somewhat skeptical as to the potential usefulness of ERTS imagery other than providing a synoptic view of major waterways and gross structural features. However, examination of early pictures covering the southeast and northeast part of the state greatly changed this view and generated much enthusiasm.

The ERTS coverage for three areas of Missouri is discussed -- southeast, northeast and central. The frames analyzed are: E-1071-16111 (SE), E-1036-16162 (NE) and E-1073-16221 (C). The principal references used for comparison of imagery features to known geologic data were the Geologic Map of Missouri (McCracken, et al., 1961) and Structural Features of Missouri, map & report (McCracken, 1971). The geologic setting of the areas ranges from Ordovician through Pleistocene in the central and northeast areas and from Precambrian through Mississippian, with a large area of Cretaceous, Tertiary and Quaternary deposits in the southeast. Multispectral enhancement plus the synoptic view has allowed in some cases the tracing of certain structural linear elements across several of these geologic boundaries.

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2. SOUTHEAST MISSOURI (NASA-E-1071-16111)

Evaluation of this imagery resulted in the identification of many geologic features, some of which are suspected to be part of the basic structural framework of the Midcontinent Platform. Three factors led to the examination of this area: (1) Southeast Missouri is a major North American lead-zinc-copper, iron Metallogenic Province; (2) the St. Francois Mountains are the principal Precambrian outcrop in central United States; and (3) the imagery received for this area was very sharp and free of cloud cover. Features noted and described are shown on Figure 1.

Ozark Escarpment: This prominent physiographic feature forms the boundary between the Ozark uplift (McCracken, 1971) and the Mississippi embayment. Its trace on the imagery is primarily defined by a change in vegetation and topography and is not distinct everywhere along its extent. A short distance south of the escarpment and rising above the level terrain of the embayment are two physiographic highs, Crowleys Ridge and Benton Hills. The bedrock of Benton Hills is Ordovician, Cretaceous and Tertiary and its boundaries are exceptionally well defined. Crowleys Ridge is underlain mainly by Tertiary and Quaternary deposits, and its outline is only weakly suggested. An abandoned channelway (K) is thought to be an Ohio River drainageway (stage B) shown by Fisk (1944).

Farmington Anticline: This northwest-trending fold is the most prominent structural feature on this image. A disturbed area with some 75 diatremes present at the south end of the fold is not readily apparent. From the imagery, an anticlinal structure plunging toward or with closure at the south end would be suspected.

Ste. Genevieve Fault System: One of the major fault zones in Missouri, this complex structure is part of a major east-west continental fracture pattern, the 38th Parallel Lineament (Brock & Heyl 1961; Snyder & Gerdemann, 1965; and Heyl, 1972). The fault is most prominent on the Illinois side and for a short distance after it changes direction from northwest to west in Missouri. A second directional change back to the northwest is not apparent.

Unknown Feature A-A: Among the more prominent linears on the image, this feature extends about 50 miles in a slightly east-northeast direction crossing two major fault systems, the Palmer and Simms Mountain, plus the Farmington anticline without any apparent break in the trace. It appears to terminate just west of the Ste. Genevieve fault system, but a faint suggestion of its continuation is present in Illinois. The Dent Branch volcanic structure lies on the trace. Extending the trace westward beyond the frame, it lies 5 miles south of the Crooked Creek cryptoexplosive structure. The lineament has not been field checked nor compared with available subsurface data; however, the initial assumption is to relate it to the 38th Parallel lineament and attribute it to the Precambrian expression of this continental fracture.

Simms Mountain Fault System: A major and complex fault zone in the St. Francois Mountains area, it is poorly defined on the imagery. A weak,

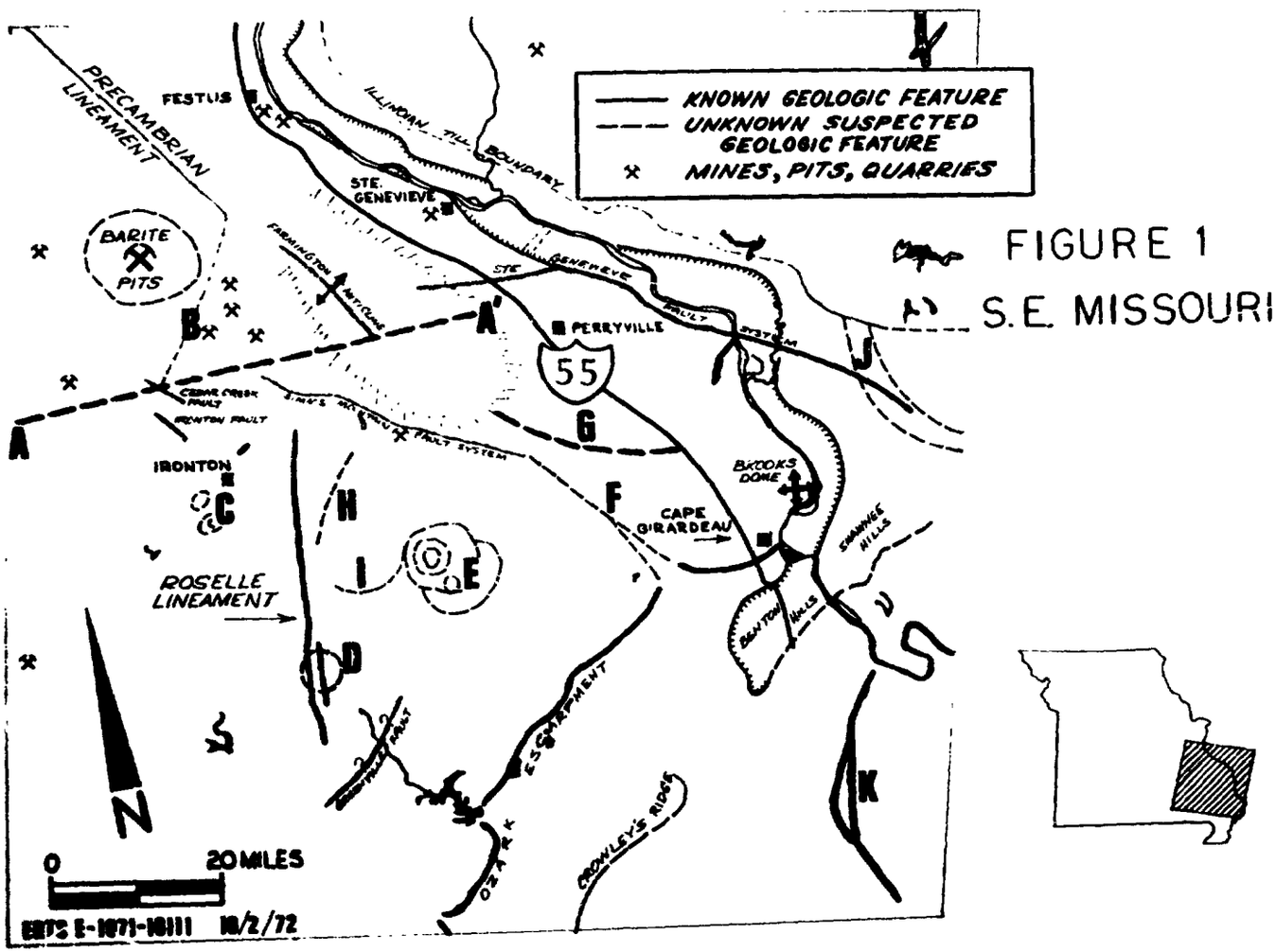

FIGURE 1

S.E. MISSOURI

relatively straight trace only roughly follows the major trend of the system. From the imagery, a linear would be suspect but not a major fault system.

Precambrian Lineament: A weak but recognizable linear, it extends for 30 miles on a northwest trend and coincides with a possible Precambrian lineament proposed by Hayes (1962) which recent drilling tends to confirm (Eva Kisvarsanyi, personal communication, 1973). A lineament would be postulated from the imagery.

Feature F: This linear might be a continuation of the Simms Mountain fault system or possibly an extension of the previously described Precambrian lineament. The trace is prominent but the bifurcation at the southern end is weak and suspect.

Roselle Lineament: The feature is clearly shown on the ERTS imagery and lies along three parallel faults mapped by Amos & Desborough (1960). Gillerman (1968) recognized it on SLAR imagery and named it the Roselle lineament. The short double trace and circular pattern (D) at the south reflects a Precambrian igneous knob (Mudlick Mtn.) and drainage pattern. Extension north of the Simms Mountain fault system was not indicated on the ERTS imagery examined. The curved line (H) can be attributed to the course of the St. Francis River for most of its extent.

Circular Features C & E: A number of circular patterns, some superimposed, are discernible on the imagery for this area. Feature C is one of the largest and coincides with one described by Gillerman (1968). Their origin is unknown but could range from volcanic calderas to astroblemes. Many of these suggest a reflection of a structural attitude in the Precambrian.

Feature B: This linear extends from the Precambrian lineament to the linear (A-A') and roughly follows the strike of the Big River fault. It separates the "Old" Lead Belt from the Washington County Barite District.

Ironton and Cedar Creek Faults: The imagery traces of these structures show only a small portion of their total extent. The Ironton portion is a questionable fault along the southwest flank of a Precambrian high (Buford Mtn.). Neither trace is exceptionally strong.

Brooks Dome: This structure, which has been verified by drilling, is accentuated by drainage, vegetation and relief. From imagery alone, a dome would be suspected.

Greenville Fault: This fault, in an area of thick residuum, has been postulated from drill hole records (McCracken, 1971). The linear on the imagery is weak and lies about 5 miles southeast of the fault trace. That the offset may exist has been suggested by several Precambrian drill holes (Eva Kisvarsanyi, personal communication, 1973).

Feature G: A semi-arcuate line which extends a distance of about 25 miles, it lies some 5 miles northeast of the Simms Mountain fault system. There are no known structures in the area.

Feature I: A strong arcuate trace that reflects a portion of the drainage pattern of Twelve Mile Creek, this feature is in part along the contact between Precambrian igneous rocks and Cambrian sediments.

Illinoian Till Boundary: On the imagery this boundary is weak but could be placed tentatively in the area shown by Weller (1945). The significance of lines J is not known.

3. CENTRAL (ERTS-E-1073-16221) & NORTHEAST (ERTS-E-1036-16162)

Northern Missouri is covered by till, which would be expected to hide evidence of the underlying structural features. However, certain linear traces are recognized and mapped in spite of the surficial cover. Information obtained on the Pleistocene deposits is not specifically verified; however, the ERTS-1 coverage does provide a rational base for defining a study of the surficial deposits north of the Missouri River. Figure 2 shows and identifies the features discussed for this area.

Lincoln Fold: The most prominent feature on the northeastern imagery, it was initially thought that the trace reflected the steep southwestern flank. Comparison with Precambrian test holes indicates that the imagery trace is on the crest (Kisvarsanyi, personal communication, 1973). In the area of its intersection with the Cap au Gres fault, the fold swings to the east. Its relationship to the fault is hazy, as the Cap au Gres itself is poorly expressed.

Mexico Anticline: Normal to the majority of structural trends in north-central Missouri, the imagery indicates the structure extends beyond the presently recognized limit to the northeast and appears to merge with the Sangamon arch in Illinois (Whiting & Stevenson, 1965). It is intersected by an east-west arcuate trace (B-B') which is a probable recessional moraine.

Mineola Structure: Originally described as a domal structure, it is shown on the imagery as a northwest-southeast trace that intersects the Mexico anticline at right angles. Further north it intersects the arcuate features (E) a reflection of the Middle Salt Fork drainage and possibly a Nebraskan Till boundary. The southern extension of this feature (D-D') is indicated by a light trace on the imagery. It is paralleled by the line C-C' which cannot be seen when the till cover thickens. Line D-D' is approximately 90 miles long and crosses Ordovician, Devonian, Mississippian, Pennsylvanian, and Quaternary deposits.

Stratigraphic Boundaries: Several stratigraphic boundaries are quite obvious. The most prominent is between the lower Ordovician Roubidoux (Or) sandstone and dolomite and the Jefferson City-Cotter (Ojc) dolomite. The trace closely approximates the mapped boundary and is enhanced by a topographic break and change in vegetation from timber to pasture and cropland. The Ordovician (Ojc)-Mississippian (Mk-o) boundary is less distinct. Enhancement of this contact is caused by a change in rock types and soils.

Postulated Pleistocene features: Lines shown on Figure 2 as B, E, F, and G are thought to be related to moraine features of early Pleistocene age. West of the Missouri River, the southernmost line of B-B' defines the boundary between loess-covered till and Pennsylvanian shales. Further east till of suspected Kansan age is recognized south of the line. Due to highly dissected terrain the southern limit of the till sheet has not been recognized on the imagery. In this area the line represents a suspected recessional moraine. At least two till units are recognized north of the line, whereas to the south there is only one till unit that has been presently verified. Extension of line B-B' east of the Lincoln fold was not considered feasible because of a dubious interpretation of imagery data; however, it terminates directly west of the Kansan till border in Illinois (Willman & Frye, 1970). Along Line B-B', in the center of Figure 2 there are two minor flexures which reflect the Mexico anticline to the east. Features indicated by E lie just south of the Nebraskan Till boundary (Heim 1963). The Salt Fork River has an arcuate pattern that may be an expression of a terminal moraine of Nebraskan age. No significance can be attached to the faint lines indicated by letters F and G.

4. CONCLUSIONS

The analysis of the imagery is preliminary; however, the following summary is offered:

(1) ERTS-1 MSS coverage provides a valuable recon tool for geologic investigations; however, it demands a rather wide knowledge of field data and exhaustive image review.

(2) There are indications that certain structures may be relocated or extended beyond their presently known limits. Linears may reflect deeply buried structural elements.

(3) Review of the imagery provides an effective method for planning and defining areas for concentrated field investigations.

(4) Utilization of satellite imagery can play a major part in studies of mineralization and mineral resource potential.

(5) Repetitive coverage is mandatory for more comprehensive evaluation of structural, stratigraphic, geomorphic, and cultural features.

(6) Geologists at the Missouri Geological Survey as well as those from mining companies and the University of Missouri - Rolla are enthusiastic about the geologic details that can be delineated on the imagery.

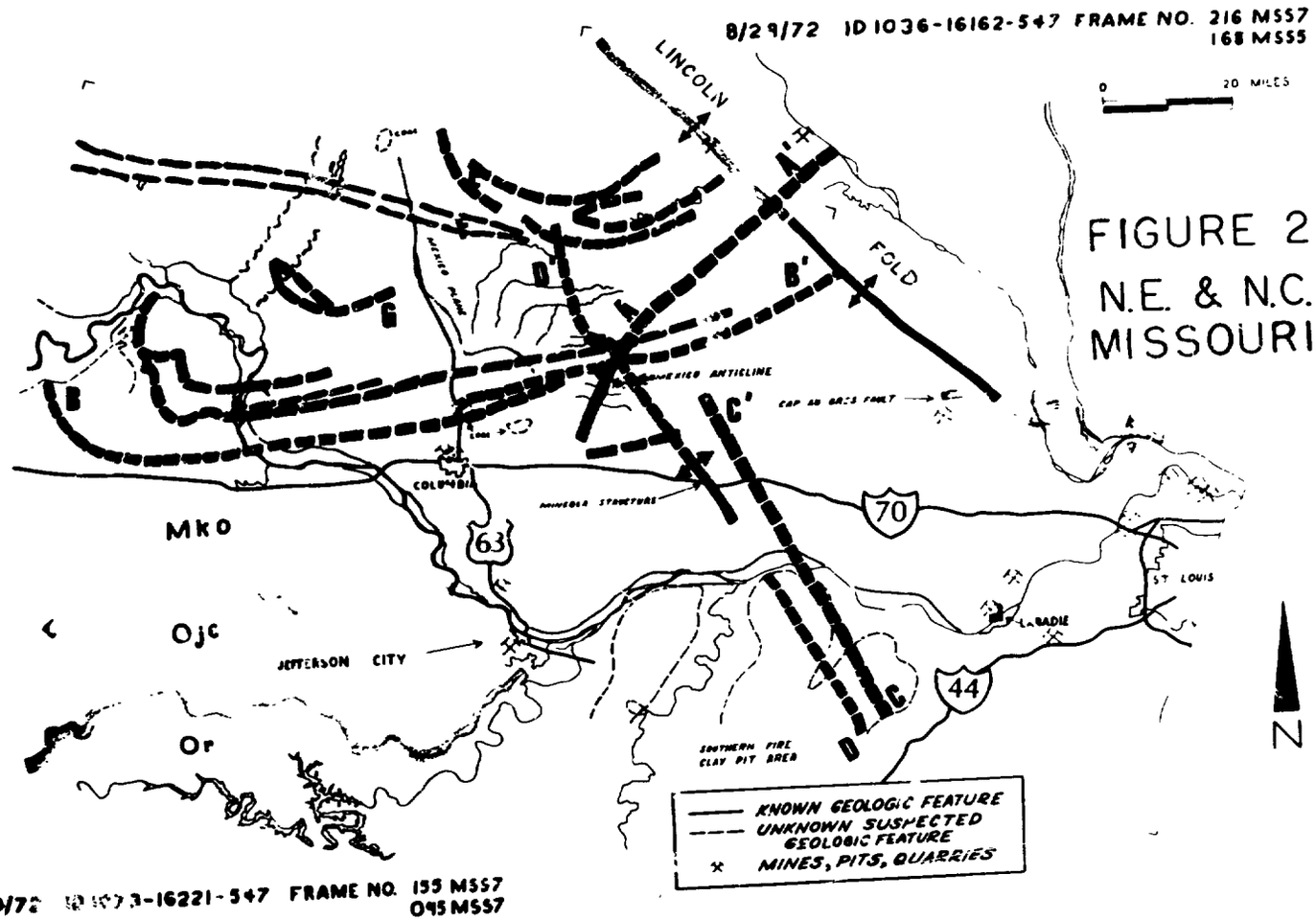

FIGURE 2
N.E. & N.C.
MISSOURI

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