KINEMATICS AT THE INTERSECTION OF THE GARLOCK AND DEATH VALLEY FAULT ZONES, CALIFORNIA: INTEGRATION OF TM DATA AND FIELD STUDIES

LANDSAT TM INVESTIGATION PROPOSAL TM-019

PROGRESS REPORT: JANUARY, 1986 TO JANUARY 1987

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JANUARY 15, 1987

Overview

Work during the past year has concentrated on several areas: literature work, data acquisition, field work, data processing and analysis. Each of these topics are described in more detail below. Work to date has allowed us to eliminate one of the original geologic hypotheses we proposed to test for the kinematics of the fault intersection. On-going activities are concentrating on acquiring the necessary information to test the other geologic hypotheses using the TM data, TIMS data, and field mapping and observations. Work is progressing satisfactorily; due to delays in implementing the UC Davis contract, a no-cost extension of 6 to 9 months may be requested to complete the project.

Literature work

A thorough search was done of the geologic literature for studies on the kinematics of intersecting faults. The appropriate references were ordered (where necessary) and a synthesis is being assembled of theories and models pertinent to this study. This part of the project provides the theoretical basis for testing our interpretations and hypotheses on the Garlock/Death Valley fault intersection. Conflicting models for rotation of the Mojave Block by Garfinkel and Bird (the former proposes counterclockwise rotation, the latter proposes clockwise rotation) are testable based on our data interpretation.

Data acquisition

Thematic Mapper data for the test areas have been received from the TM science office. One frame of TM-4 data had severe striping in three bands, presumably due to either improper sensor decalibration or malfunctioning detectors. These data were

unusable as the striping is no longer along a single line due to the geometric rectification and resampling of the data done by Goddard to convert the raw data to P format. The problem was taken care of by Maria Mackey at the Landsat Science Office by providing substitute frames.

Thermal infrared multispectral scanner data (TIMS) arrived from AMES Research Center. The data are of excellent quality. The two flight lines cover a long east-west swath along the Garlock fault eastward to past the intersection with the Death Valley fault east of the Avawatz Mtns., and a north-south line along the east side of the Avawatz Mtns.

Field work

Three field trips have been completed to various test sites in the study area. Mapping is underway in the Soda Mtns. as part of a graduate student's thesis. This area is one of the control areas for the project, and further detail on active faulting and alluvial fan lithology is being investigated. Examination of the East Bristol Mtns. southeast of the Soda Mtns. indicates the presence of Quaternary faulting directly on strike with the Mule Springs fault zone. The extent of this zone is being determined with the aid of the TM data to determine if it forms part of a more extensive through-going tectonic feature. Work in the Halloran Hills and Shadow Mtns. east of the intersection revealed the presence of an extensive section of Tertiary continental sediments in a peculiar tectonic setting. The sediments are upturned vertically and appear to lie in a graben. Nearby, thrust or gravity faulting was seen to bring Precambrian rocks over

Tertiary sediments. The implications and areal extent of these features is being evaluated. Two field trips to acquire ground spectral reflectance measurements had to be cancelled due to a freak snow storm, and an unexpected meeting in Washington.

Data processing

Image processing of the TM data is well underway. All scenes have been examined and evaluated for data quality and usefulness. Photographic products have been produced for the Halloran Hills/Shadow Mtns. area, a digital mosaic for the Soda Mtns. area, the Avawatz Mtns. and the immediate area of the fault intersection, mosaics of two entire TM scenes for regional analysis. For each area, several products were created: high-pass filtered images were generated to extract and enhance the spatial information in the data. Data processing to enhance lithologic variations for rock type mapping was done using decorrelation stretching and band ratioing. Various color composites were generated for interpretation at scales of 1:62,500 and 1:250,000.

The TIMS data were logged and calibrated to convert the data values to thermal radiance. The data were digitally registered to the TM data to have the same geometry and for statistical analysis. Color photographic products were produced to display emissivity differences of the surface materials.

All image products were duplicated and distributed to the co-investigators for analysis.

Results

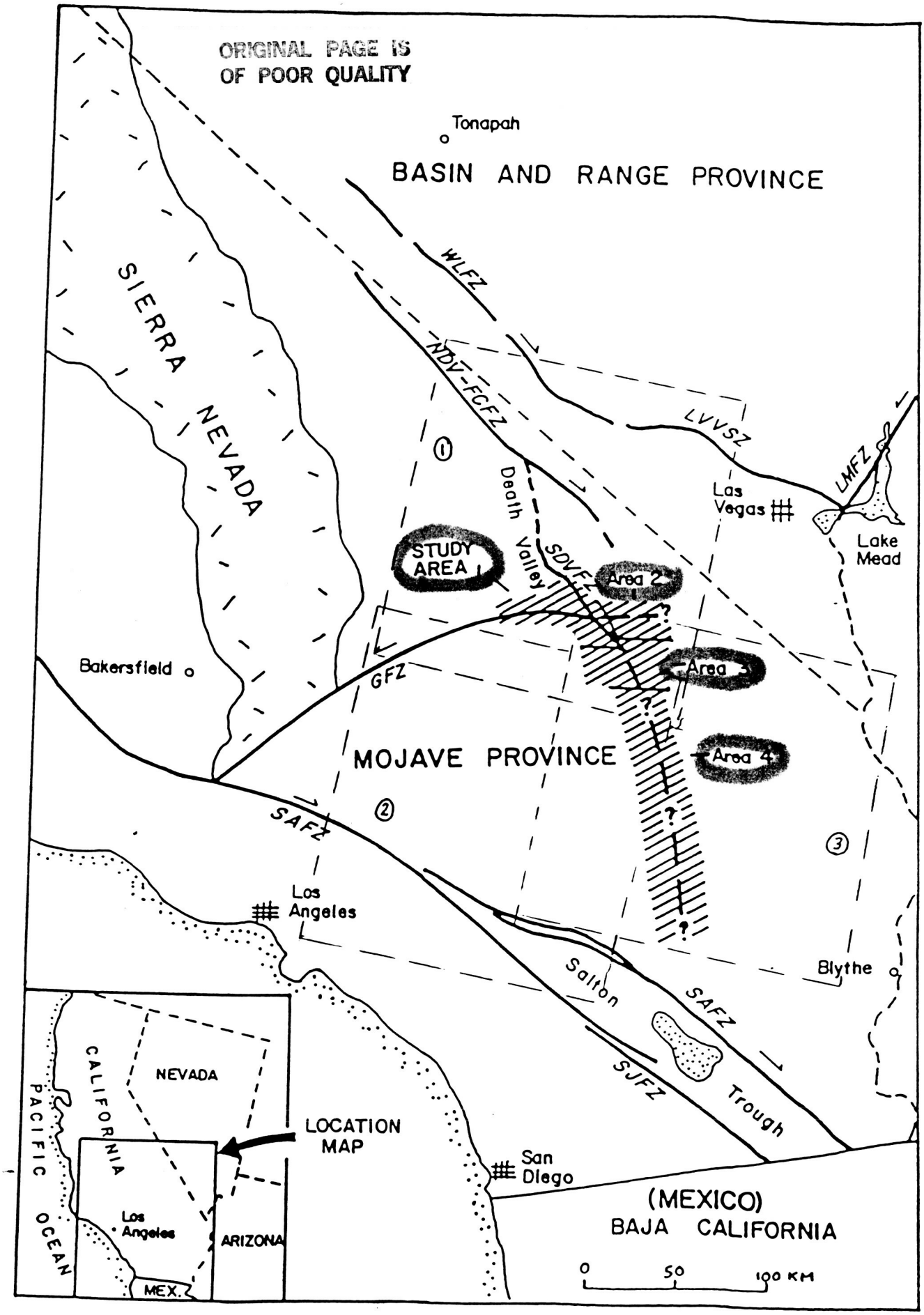
Results from image interpretation and field work confirms our belief that the proposed methodology is indeed the appropriate one. Specific results and conclusions are:

1) Field work, image analysis, and literature surveys lead us to conclude that the Garlock Fault does not extend eastward through Kingston Wash. The evidence from the images shows no offsets of bedrock on either side of the wash; field work confirms this interpretation; literature reports of seismic profiles, and reexamination of these profiles by us shows no evidence of a break in the bedrock which would indicate the presence of a major fault. This is one of the four hypotheses we proposed to evaluate, and we have completed this part of the work.

2) Examination of a possible southeastward offset of the Garlock fault along the projection of the Death Valley fault (area 4 in Figure 1) has led us to consider a fault in Ivanpah Valley, with mappable left-lateral displacement, as a candidate. The TM iamge for this area (Figure 2) and a sketch interpretation (Figure 3) indicates the tectonic relationships proposed. Field examination of the areas where this fault would cross bedrock, particularly in the New York Mtns., will help us decide whether this hypothesis is correct. The TM data strongly indicate that this fault exists.

3) Mapping from the TM images and field work in the Shadow Mtns. which shows the presence of thrust or detachment faults placing Precambrian rocks on top of Tertiary sediments indicates a late Tertiary episode of compression or extension in this region just east of the fault junction. Dating of this episode and careful field mapping of geologic relations in regions identified on the TM data will aid in understanding the overall tectonic deformation history.

FIG. 1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Tonapah
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NDV-FCFZ
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Death Valley
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Area 4
Bakersfield
GFZ
MOJAVE PROVINCE
SAFZ
Los Angeles
Salton Trough
SJFZ
Blythe
San Diego
(MEXICO)
BAJA CALIFORNIA
PACIFIC OCEAN
CALIFORNIA
NEVADA
ARIZONA
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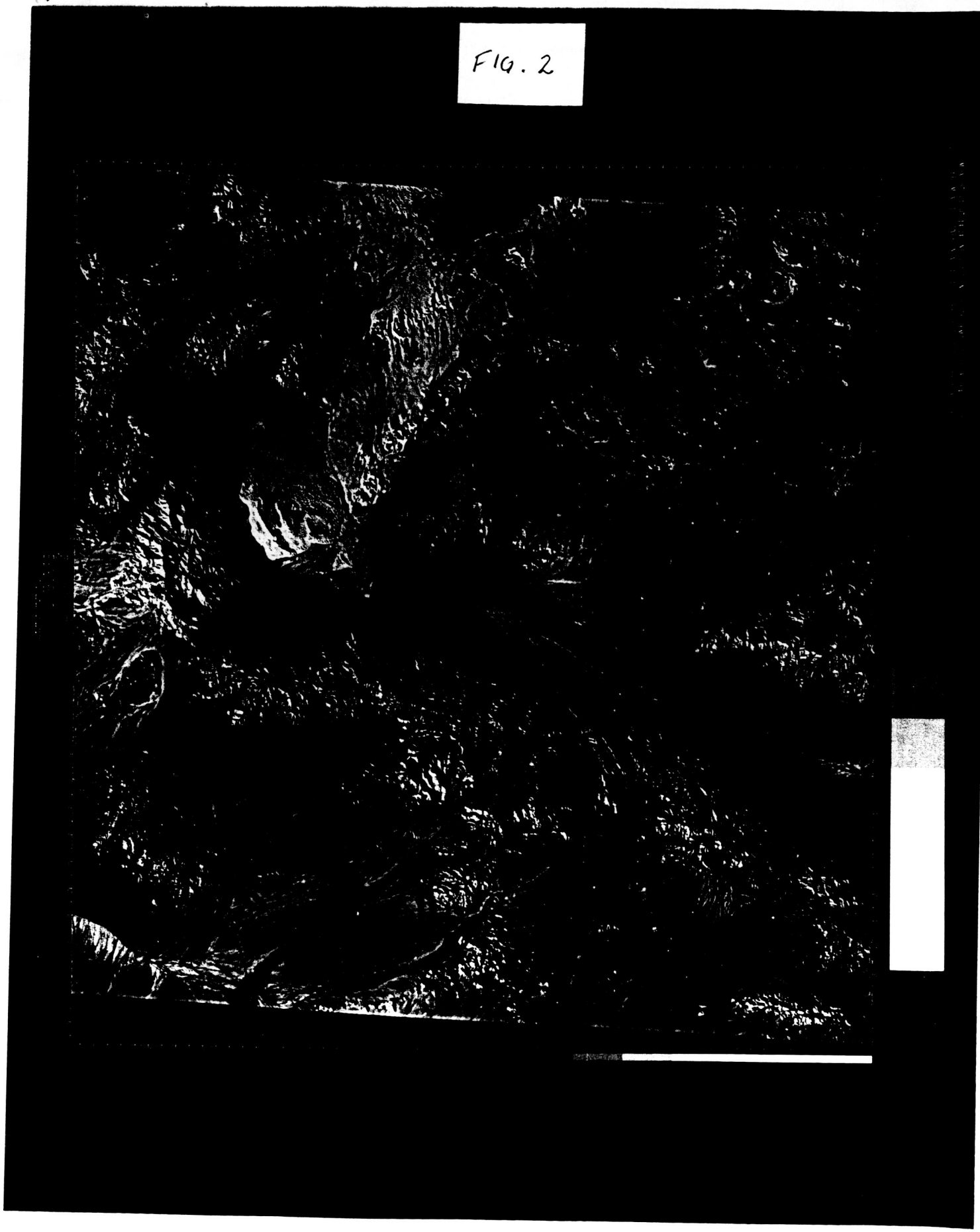
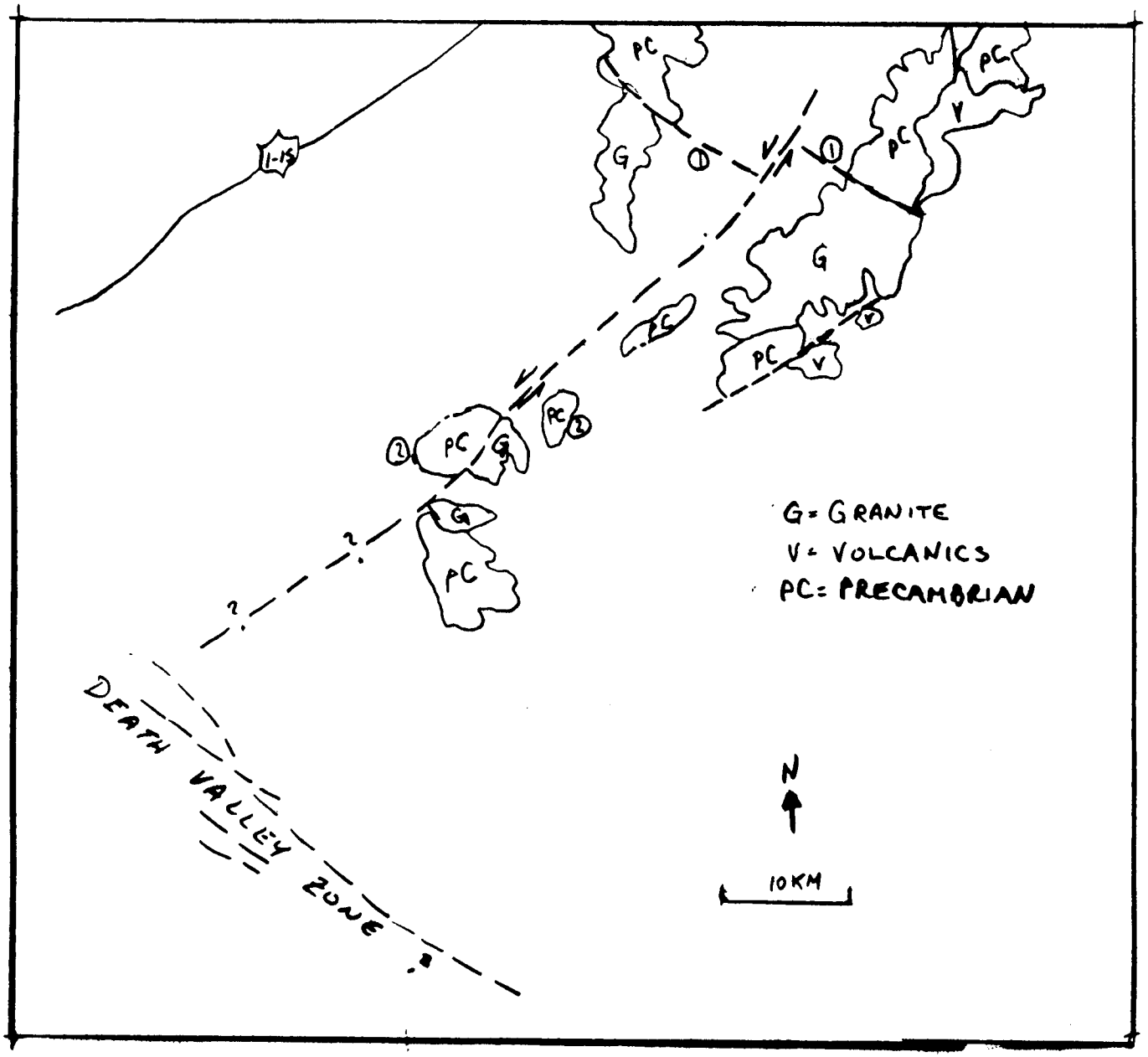
LOCATION MAP
0 50 100 KM

FIG. 2




I-15
PC
G
V
PC
V
PC
G
V
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V
PC
PC
G
G
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?
?
DEATH VALLEY ZONE
G = GRANITE
V = VOLCANICS
PC = PRECAMBRIAN
N
10 KM

FIG. 3

4) Comparison and analysis of processed TM and TIMS data for the Avawatz Mtns. area has allowed us to better calibrate the image derived characteristics of Quaternary and Tertiary fans based on textural and lithologic differences. At least four different ages of fans are differentiable, versus only three on published maps. This information will provide further constraints on vertical tectonics on the reverse faults on the east side of the Avawatz. This work will be extended to other areas further southeast by extrapolating the techniques and relative age determinations.

5) Left-lateral displacement of alluvial fans from their sources was discovered on TIMS data for three areas along the central part of the Garlock fault near the Owlshead Mtns. Field verification, and attempts to find datable materials will put constraints on the tectonic history of the Garlock fault.

6) An abstract was submitted for a poster session or oral presentation at the American Association of Petroleum Geologists meeting in Idaho in September to present the results of this project. A copy of the abstract is attached.

Type abstract (250 words or less), using this form for first page and blank paper for the 2nd page, with the IBM Selectric in Letter Gothic, Courier, or Prestige Elite for computer scanning. Please double-space with only one space after periods. Manuscripts printed by word processors should *not* be justified. **Any editorial marks must be made in red.** Indicate speaker with an asterisk if not first author.

Submitted For: ☐ Oral ☐ Poster ☒ Either

Topic Area: Local and regional geology/ Remote sensing

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Title: KINEMATICS AT THE DEATH VALLEY_GARLOCK FAULT ZONE JUNCTION

The Garlock and Death Valley fault zones in southeast California a two active strike-slip faults that come together on the east side of the Avawatz Mtns. The kinematics of this intersection, and the possible continuation of either fault zones, is being investigated using a combination of detailed field mapping, and processing and interpretation of remotely sensed image data from satellite and aircraft platforms. Regional and local relationships are derivable from the Thematic Mapper data (30 m resolution), including discrimination and relative age dating of alluvial fans, bedrock mapping, and fault mappng. Aircraft data provide higher spatial resolution data over more limited areas. Hypotheses that are being considered are: 1) the Garlock fault extends east of the intersection; 2) the Garlock fault terminates at the intersection and the Death Valley fault continues southeastward; 3) the Garlock fault has been offset right laterally by the Death Valley fault which continues to the southeast. Preliminary work indicates that the first hypothesis is invalid. From kinematic considerations, image analysis, and field work the third hypothesis is favored. The projected continuation of the Death Valley zone defines the boundary between the Mojave crustal block and the Basin and Range block.

Mail abstract to:
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Deadline: March 1, 1987