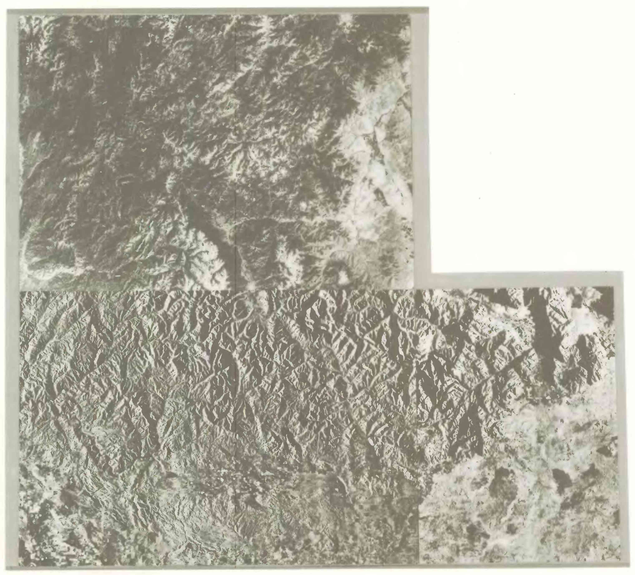
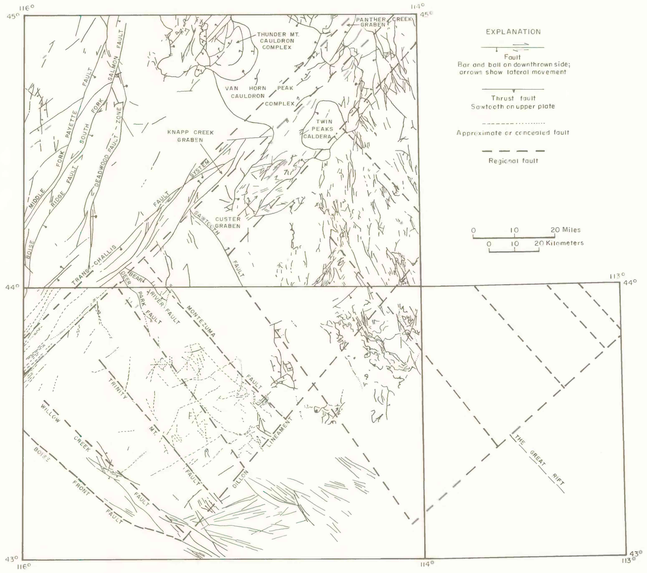
DEPARTMENT OF THE INTERIOR
U.S.GEOLOGICAL SURVEY

OPEN-FILE REPORT 88-640

EXPLANATION

- LINEAMENT
- TONAL PATTERN
- ESCARPMENT
- VOLCANIC VENT





EXPLANATION

Fault
Bar and ball on downthrown side; arrows show lateral movement

Thrust fault
Sawtooth on upper plate

Approximate or concealed fault

Regional fault

PRELIMINARY LINEAMENT MAP OF THE HAILEY, IDAHO AND WEST HALF IDAHO FALLS, IDAHO 1° x 2° QUADS WITH INSET OF REGIONAL IMAGE MOSAIC AND GEOLOGIC STRUCTURES

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Introduction

A preliminary lineament map from the interpretation of side-looking airborne radar (SLAR) and Landsat Thematic Mapper (TM) images of the Hailey, Idaho, and west half of the Idaho Falls, Idaho, 1°x2° quadrangles was produced to support the Conterminous United States Mineral Assessment Program (CUSMAP). The purpose of the preliminary lineament map is to aid reconnaissance and detailed field geologic mapping and also help address the relationship of geologic structures to mineralization. A regional compilation of known geologic structures and companion image mosaic is provided for tectonic framework analysis.

SLAR

An X-band (3.1 cm λ) digital high resolution, synthetic aperture STAR-1 radar system of INTERA Technologies, Inc., was flown over the Hailey and Idaho Falls, Idaho 1°x2° quadrangles in September, 1986. The Hailey data were acquired in north 5°west flight lines with an east look direction and approximately 12° depression angle. Eleven 46 km wide image strips flown on 20 km line spacings were acquired from an operating altitude of 27,000 feet above sea level (asl). The Idaho Falls data were acquired in north-south flight lines looking west with an average depression angle of 10° from a flight altitude of 25,000 feet asl. These image strips were compiled as a mosaic to fit the USGS Universal Transverse Mercator (UTM) projection 1:250,000-scale base map. All USGS SLAR data are available from the EROS Data Center, Sioux Falls, S. Dak.

SLAR is an active sensor which uses electromagnetic signals at microwave frequencies to illuminate and thus form images of the terrain. The amount of reflected energy is dependent on the physical properties of the terrain surface, primarily topography, but also surface roughness, moisture content, and vegetation cover. The representation of topography in SLAR images is largely a function of slope aspect and surface roughness. Topographic slopes facing the direction of SLAR energy provide a greater radar diffuse scatter and thus a strong return which appears as a light tone on the image. Rough surfaces diffusely scatter radar energy and results in a moderate to strong return. Topography sloping away from radar energy provides reduced backscatter of energy and results in a shadow zone, which appears as a dark tone on the image. Flat topography, water bodies, and flat-lying cultural features such as highways, cause a specular reflection of radar energy away from the receiver and thus appear as a dark tone on the image.

High topographic relief of the Idaho Batholith and adjoining thrust and block faulted mountains create extreme layover (top of objects displaced relative to their base) and foreshortening distortions on the SLAR images. These geometric distortions and abundant shadow zones limit the use of these data in the high terrain. Topographic features which parallel the SLAR look direction (approximately eastwest) are subdued and this effect may be a source of bias in recognition of lineaments.

Thematic Mapper

Landsat TM data acquired 6/30/84 (50121-17542, path 41, row 30, quad 2) and 8/29/85 (50540-17941, path 40, row 30, quads 1 and 2) were computer processed on a VAX 11-780 to produce color infrared composite (CIC) images. TM bands 2 (0.52-0.60 um), 3 (0.63-0.69 um), and 4 (0.76-0.90 um) were contrast-stretched and color-coded blue, green, and red, respectively, to produce the 30 m resolution CIC images. Approximately sixty per cent side lap of the two temporal scenes acquired from an altitude of 705 km provide stereoscopic coverage of approximately 60 km² of the terrane.

Tonal and textural differences in the image due to vegetation, soil, and rock, and topographic alignments and discontinuities are mapped as lineaments. Topographic features which parallel the sun azimuth during scene acquisition (approximately northeast), and the scan-line direction (approximately westnorthwest) may be a source of bias in recognition of lineaments.

Lineament Map

Lineaments have been defined as "mapable, simple or composite linear feature(s) of a surface, whose parts are aligned in a rectilinear or slightly curvilinear relationship and which differ distinctly from the patterns of adjacent features and presumably reflect a subsurface phenomenon" (O'Leary and others, 1976).

Independent lineament analyses were conducted on SLAR, TM, and stereoscopic-TM images, respectively. The separate interpretation overlays were manually registered to produce a composite lineament map. Thus, the composite lineament map provides data from the best available sources.

Mostly short linear segments were mapped and are believed to be fracture-controled topographic discontinuities. In addition, volcanic vents (cones, calderas) and tonal patterns suggestive of lithologic contacts were delineated. Regions with no mapped lineaments are the agricultural fields and featureless basalt flows of the Snake River Plains. In addition, fewer lineaments were mapped in the areas of high relief because of excessive SLAR shadow zones and(or) the absence of TM image coverage. Photoreduction of the 1:250,000-scale lineament map spatially merges the discrete, short linear segments to suggest several regional lineaments. Therefore, short, discontinuous linear segments may be extended along strike.

Regional Image and Geologic Structure Map

After the lineament interpretation was completed, a regional compilation of geologic structures was compiled from Maide and others (1963), Fisher and others (1983), Bennett and Knowles (1985), Killagaard and Lewis (1985), Bennett (1986) and Worl and others (in preparation). The purpose of the image mosaic and geologic structure map (inset) is to demonstrate that regional and local geologic structures are recognized on images of this region. The regional tectonic framework may help correlate and(or) determine the significance of these lineaments.

Discussion

Two significant geologic trends are recognized on the images. Northeast- and northwest-trending lineaments are seen at both local and regional scale. The northeast-trending lineaments in the western half of the study area are believed to be related to the structural trend of the Trans-Challis fault system (Killagaard and Lewis, 1985; Bennett, 1986). Plutonic intrusions, dike swarms, and mineralization are associated with this ancestral fault system (Thor Killagaard, 1988, pers. comm.). Northwest-trending lineaments are believed to be related to extensional faults of Paleogene and Neogene Basin and Range tectonics. The younger, northwest-trending faults often offset the older, northeast-trending faults. Both trends of faults have probably experienced periods of reactivation; thus, areas at the intersection of these trends may be potential zones of mineralization. Regionally, the northeast- and northwest-trending lineaments form a series of horsts (Paleozoic sedimentary rocks) and grabens (Cenozoic volcanic rocks). The block boundaries generally correlate with the regional faults of Bennett (1986). The arcuate belt of lineaments in the Snake River Plains are probably normal faults related to regional downwarp. Contrasting tonal patterns recognized in the black shale rocks of Paleozoic age may be indicative of low angle thrust faults, lithologic contacts, and(or) hydrothermal alteration.

References

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