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FAULT PATTERN AT THE NORTHERN END OF THE DEATH VALLEY - FURNACE CREEK FAULT ZONE, CALIFORNIA AND NEVADA

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FAULT PATTERN AT THE NORTHERN END OF THE DEATH VALLEY-FURNACE CREEK FAULT ZONE, CALIFORNIA AND NEVADA

An Application of ERTS-1 MSS Imagery

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ABSTRACT

The pattern of faulting associated with the termination of the Death Valley-Furnace Creek Fault Zone in northern Fish Lake Valley, Nevada was studied in ERTS-1 MSS color composite imagery and color IR U-2 photography. Imagery analysis was supported by field reconnaissance and low altitude aerial photography. The northwest-trending right-lateral Death Valley-Furnace Creek Fault Zone changes northward to a complex pattern of discontinuous dip slip and strike slip faults. This fault pattern terminates to the north against an east-northeast trending zone herein called the Montgomery Fault Zone. No evidence for continuation of the Death Valley-Furnace Creek Fault Zone is recognized north of the Montgomery Fault Zone. Penecontemporaneous displacement in the Death Valley-Furnace Creek Fault Zone, the complex transitional zone and the Montgomery Fault Zone suggests that the systems are genetically related.

Mercury mineralization appears to have been localized along faults recognizable in ERTS imagery within the transitional zone and the Montgomery Fault Zone.

INTRODUCTION

The Death Valley-Furnace Creek Fault Zone of eastern California is one of several major right-lateral strike slip fault systems in the southwestern Basin-Range Province. About thirty miles of post-Jurassic displacement and 0.6 miles of post-Pliocene displacement have been estimated (McKee, 1968) on the Death Valley-Furnace Creek

Fault Zone at the south end of Fish Lake Valley (lower right corner of Figure 1). Although detailed studies of portions of the Death Valley-Furnace Creek Fault Zone have been conducted, little attention has been directed to its apparent termination in the northwestern end of Fish Lake Valley, Nevada. For this reason, literature research and field reconnaissance was conducted for the area of Figure 2 to confirm structural interpretation of the ERTS-1 MSS imagery, and to determine possible structural controls of local volcanism and mercury mineralization.

The area of this report (Figure 2) is underlain by Paleozoic sedimentary and volcanic rocks which have been intruded and metamorphosed by Mesozoic granitic rocks of the White Mountains Batholith. Anderson (1933) made a detailed study of an extensive sequence of Oligocene and Miocene andesites, rhyolite flows and tuffs, and Pliocene to Recent basalts which unconformably overlie the Mesozoic and Paleozoic basement. Many of the ignimbrite units within this volcanic sequence may be derived from distant sources such as Silver Peak or the Mono Basin. Other flow units appear to have local sources and restricted areal distribution. For convenience in discussion, this eruptive sequence will be referred to as the Mustang volcanics after the large canyon located near the center of the volcanic terrane (Figure 2).

METHOD

The northern end of Fish Lake Valley was first investigated using color composites of ERTS-1 MSS frame 1126-18010, 26 November 1972, and black and white ERTS MSS frames 1163-18060, 2 January 1973, and 1307-18064, 26 May 1973. Details of the fault pattern were studied in USAF-USGS high altitude U-2 black and white photography and NASA high altitude U-2 color IR photography:

Flight	Frames	Date
USAF-USGS 374L	169-172	6 September 1968
USAF-USGS 744V	003-005	29 November 1968
NASA-PEIS 72-100		15 June 1972

This data was used to guide detailed field reconnaissance supported by color and color infrared photography taken from a low altitude aircraft. Large faults were plotted in the field directly on an ERTS-1 9" x 9" color composite with detail plotted on 15' and 7-1/2' topographic quadrangles.

TRANSITIONAL FAULT PATTERN AT THE NORTH END OF DEATH VALLEY - FURNACE CREEK FAULT ZONE

A progressive change in the pattern of faulting across the study area is shown in the structural map of Figure 2. In the southern portion of the map area, northwest-trending faults of the Death Valley-Furnace Creek Fault Zone predominate. Strands of this zone can be projected northward for short distances into the Mustang volcanics (Figure 2).

Within the volcanic terrane, the fault pattern becomes more complex and two additional fault trends, namely north, and approximately east-west are recognized. The diverse fault system of this region is interpreted to be transitional to the Montgomery Fault Zone.

Anderson (1933) mapped three large northwest-trending normal faults within the Mustang volcanics. Albers and Stewart (1965) recognized three additional northeast trending faults, and Crowder et al (1972) show a large northeast-trending fault and several north-trending faults. In addition, range-front faults, some of which cut Recent alluvium along the eastern side of the White Mountains, have been cited by Anderson (1933), Bryson (1941) and Albers and Stewart (1965). Many of these faults are apparent in the ERTS-1 imagery. Scarps cutting alluvium are not as evident in the Mustang volcanic area as they are farther south, supporting Anderson's (1933) conclusion that Quaternary movement may decrease in magnitude northward.

Vertical displacement across the transitional fault pattern in the Mustang volcanics is estimated to be on the order of 2000 feet, east side down, based on correlation of similar volcanic units near the crest of the White Mountains and in Sand Spring Canyon. Strike slip movement on a north-south fault in Sand Spring Canyon is suggested by a pervasive set of subhorizontal slickensides. Minor strike slip movement is probable on other ERTS-recognized faults to the east and south. The small magnitude of strike slip displacement apparent in the transitional zone contrasts with the large displacements recognized farther south along the Death Valley-Furnace Creek Fault Zone. An analogous northward decrease in strike slip on the nearby, subparallel Owens Valley fault system is suggested by the negligible strike-slip noted by Gilbert (1968) near its northern end.

Many of the larger northwest and north-south faults in the Mustang volcanics have strong topographic expression and produce conspicuous anomalies in the ERTS-1 imagery (Figure 1). A north-south fault in Sand Spring Canyon demonstrates rough synchroneity of at least some of the faulting and volcanism, because the fault offsets a layered sequence of pumice breccias and is itself draped by overlying rhyolite flows. In general, the east-trending faults appear to crosscut and postdate movement on the faults trending north and northwest.

Fault control of mercury mineralization in the area is mentioned by Lincoln (1923) and by Bailey et al (1941) and was confirmed by the author. The two largest mercury mines in the area, the Wild Rose and the B and B, are located on ERTS anomalies identified in the field as fault zones along which Tertiary pumice breccias have been fractured, silicified, and mineralized. The pumice breccias and their altered equivalents appear as white anomalies in the ERTS-1 imagery.

MONTGOMERY FAULT ZONE

The complex pattern of faulting in the Mustang volcanics appears to be terminated on the north by faults of the east-northeast trending Montgomery Fault Zone. Several

earlier workers in the region have disagreed as to the pattern and position of faults [see for instance Anderson (1933), Gilbert (1941), Ross (1961) and Crowder et al (1972)]. In the present study, three main faults are recognized in the Montgomery Fault Zone. These faults are arranged in a general right stepping en echelon pattern which is evident in ERTS-1 MSS and color infrared U-2 imagery and has been confirmed by field work (Figure 2). The westernmost of the three faults, located northwest of Montgomery, Nevada, is shown in part by Crowder et al (1972), Ross (1961) and Gilbert (1941). Based on offset of lithologic units, this fault has apparent dip slip displacement, north side down, and borders the depression occupied by Truman Meadows north of Queen Valley (Figure 2). The middle fault, suggested by Anderson (1933) and mapped in part by Crowder et al (1972), extends from Mount Montgomery on the west to a diatomite mine southeast of Basalt, Nevada (Figure 2). The sense of vertical displacement on this middle strand appears to change along strike.

The third, and easternmost fault has a component of dip slip, north side down, and forms the northern boundary of an extensive sequence of basalt underlying the Volcanic Hills (Figure 2). This fault and a number of parallel subsidiary faults to the south are shown in Figure 2.

Gilbert (1968) describes faults along the north side of Queen Valley on which slickensides plunge eastward at low angles. Because these faults dip steeply southward and are found on a steep south facing escarpment, Gilbert postulates that they have had left lateral movement. The faults described by Gilbert are part of the east-northeast trending Montgomery Fault Zone described here.

L-shaped faults in alluvium concave to the southeast have been recognized in Fish Lake Valley south of the study area (Albers and Stewart, 1965) and at the southern margin of Queen Valley (Figure 2). The Queen Valley faults and other L-shaped faults near Adobe Valley (Figure 1) are considered to be pull apart structures (Gilbert, 1968, 1973) formed southeast of the intersection of the left lateral northeast-trending Mono-Excelsior Zone and right-lateral north-trending faults in Owens Valley. A similar explanation for the L-shaped faults in alluvium in Fish Lake Valley appears to be consistent with their sense of displacement eastside down, and their position southeast of the intersection formed by the right-lateral Death Valley-Furnace Creek Fault Zone and a left-lateral Montgomery Fault Zone.

The sequence of Quaternary basalt south of the easternmost strand of the Montgomery Fault Zone is petrographically similar to basalt found north of the fault zone near Montgomery Pass. These basalt flows may be equivalents which have been offset left-laterally. As cited by Gilbert (1968), recognition of strike slip displacement in the low dipping volcanic rocks of the area is difficult; however, several indirect lines of evidence suggest strike slip movement on the Montgomery Fault Zone. The general right stepping en echelon arrangement of the three main strands, the straight trench-like character of the faults, the apparent reversal in sense of vertical displacement, and parallelism of the fault zone with the left-lateral Mono-Excelsior Zone 35 miles

to the north are all permissive for strike slip displacement. It is, therefore, likely that left-lateral strike slip movement has taken place along the Montgomery Fault Zone, although the total displacement is probably small.

Two lines of evidence suggest approximately synchronous movement in the transitional zone and the Montgomery Fault Zone. First, the western and middle faults forming the Montgomery Fault Zone bend or splay into northerly trending normal faults. The western fault bends northward at its eastward termination and the middle fault splays southward into a normal fault of the transition zone near Basalt, Nevada (Figure 2). Also, both of the fault systems cut Quaternary olivine basalts in the study area.

The complex pattern of faulting in the Mustang volcanics at the northern end of the Death Valley-Furnace Creek Fault Zone does not appear to extend north of the Montgomery Fault Zone within the study area. Several north trending faults within the complex transitional zone terminate against strands of the Montgomery Fault Zone south of Basalt, Nevada [Figure 2; Albers and Stewart, 1965; Crowder et al, 1972]. This termination does not imply that the Montgomery Fault Zone is the younger of the two. Rather, the close temporal relationship and the tendency for one system to bend into the other suggests that they are cogenetic.

CONCLUSIONS

ERTS-1 MSS imagery has proven to be a valuable tool in studying the anomalous structural pattern associated with the northern termination of the Death Valley-Furnace Creek Fault Zone. Field reconnaissance conducted to support interpretation of the ERTS-1 MSS and subsidiary imagery has confirmed a complex transitional pattern of faulting between the Death Valley-Furnace Creek Fault Zone and the Montgomery Fault Zone of probable left-lateral displacement. Movement in the transitional zone and the interconnected Montgomery Fault Zone appears to have been roughly synchronous, suggesting a cogenetic origin. Although faulting and volcanism are spatially and temporally associated, clear structural control of local volcanism has not yet been demonstrated.

Several faults within the transitional zone and the Montgomery Fault Zone which have expression in the ERTS-1 imagery appear to have localized mercury mineralization.

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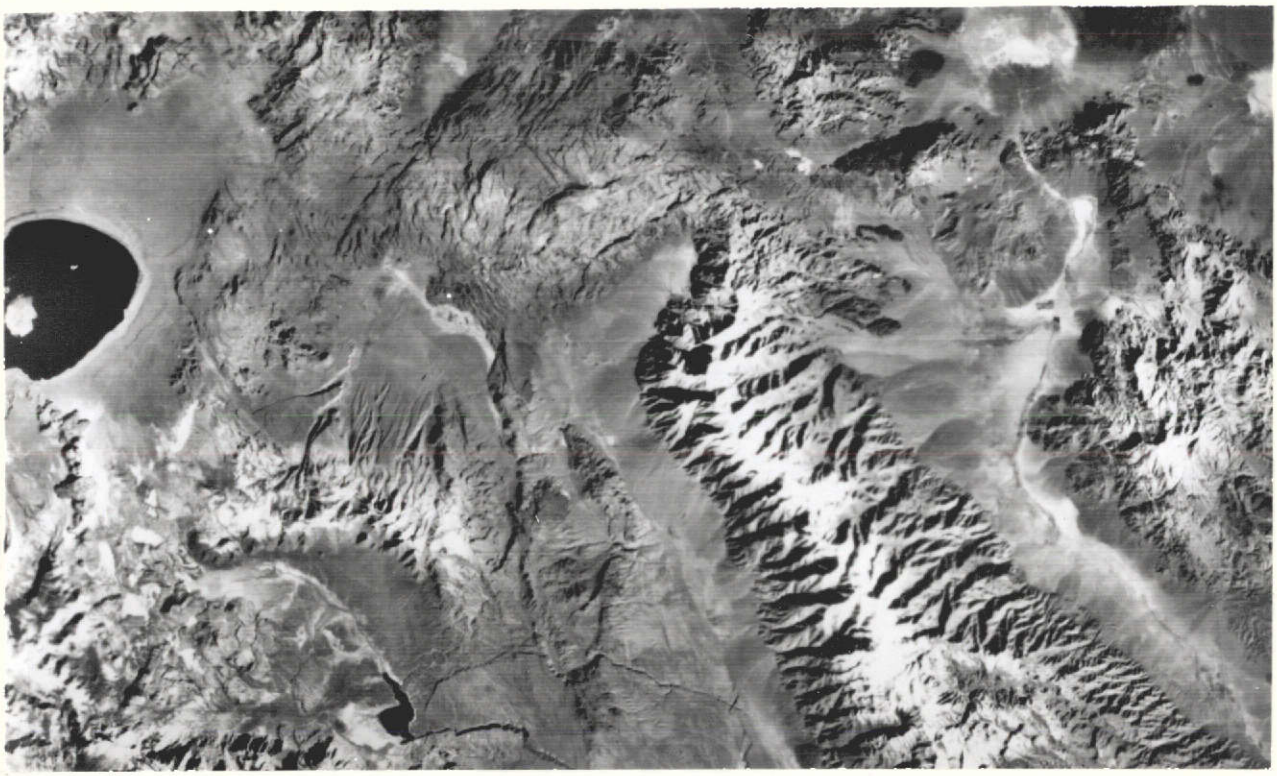

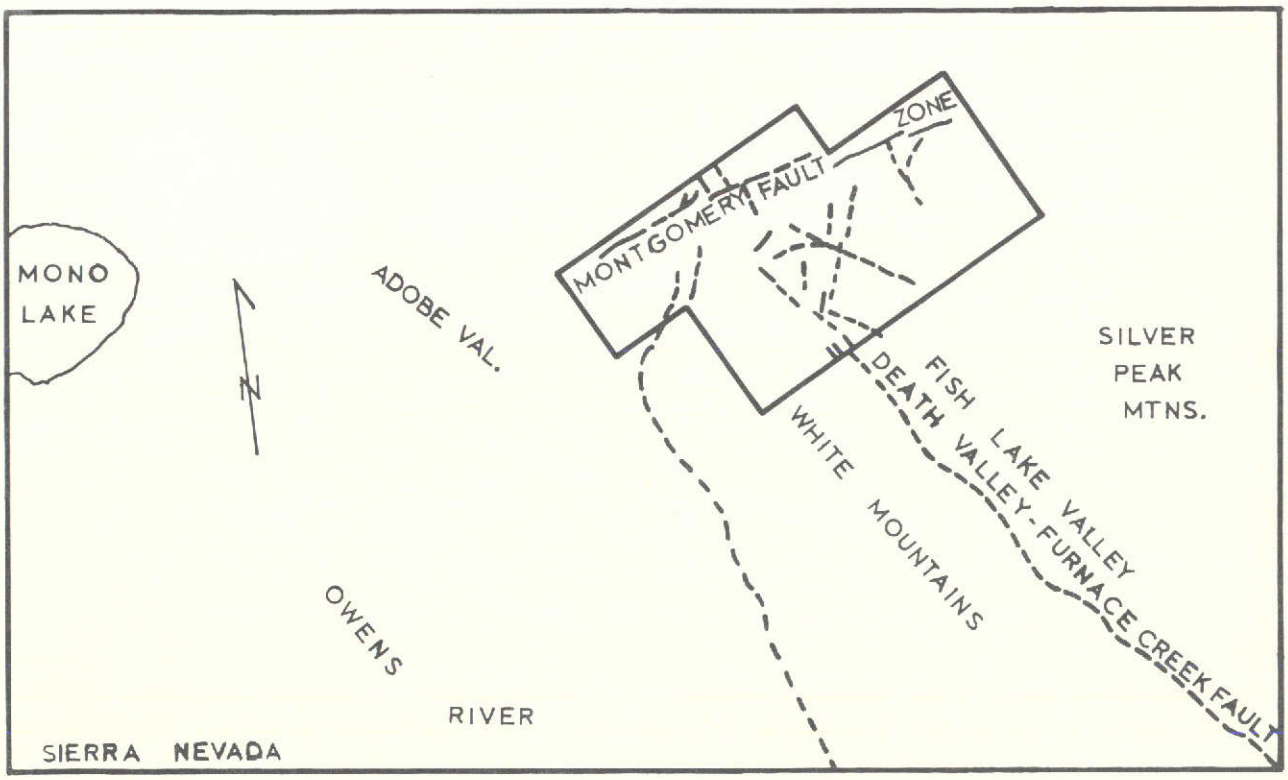

Figure 1 - Enlarged portion of ERTS-1 MSS Frame 1163-18063, Band 7, 2 January 1973, and corresponding index map. The study area shown in Figure 2 is outlined and some of the important structural and geographic features are indicated.

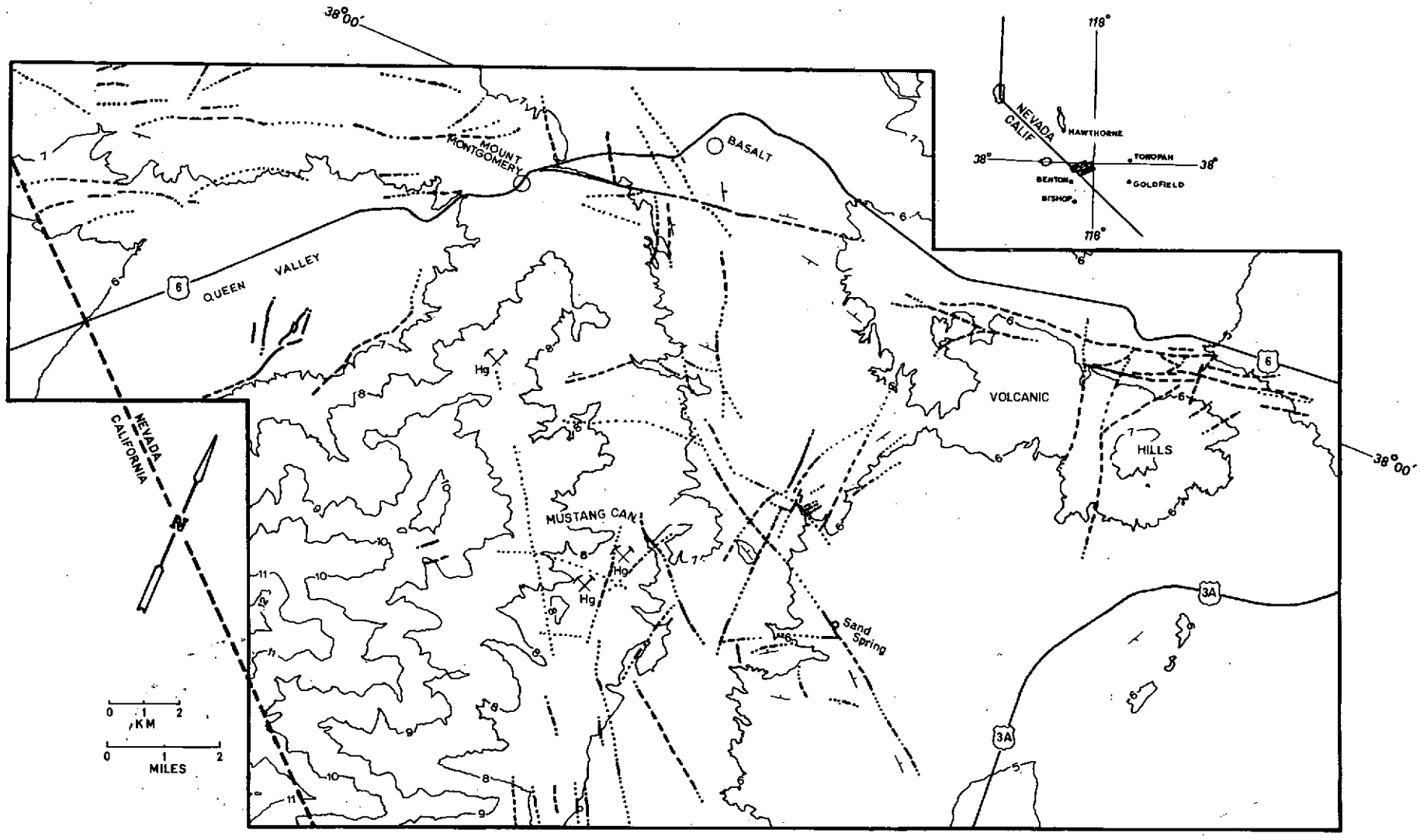

Figure 2 - Structural map of the study area. Faults solid where definite, dashed where approximate and dotted where inferred. Contour interval in thousands of feet. Base maps used are the Benton and Davis Mountain 15' and the Jacks Spring, Basalt, Miller Mountain, and Columbus 7-1/2' topographic quadrangles. Index map is in upper right hand corner.