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Analysis of Lineaments in the Great Basin: Relationship to Geothermal Resources

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ABSTRACT

Linear features, mainly streams, ridge crests and escarpments, mapped on Lansat Multispectral Scanner (MSS) images of the Great Basin were analyzed along with diverse geological, geophysical, and geochemical data in order to delineate potentially fractured zones that might be favorable for subjacent magmatic intrusion. In Nevada, analysis of linear features $\geq$ 50 km length indicated the presence of nine lineaments trending dominantly northeast, northwest, and east-northeast. Analysis of fault density, aeromagnetic gravity, and heat-flow data indicate that seven of these lineaments are the morphological expressions of four structural zones that are 100 to 200 km wide.

In southern Nevada, three structural zones were delineated: the northwest-trending Walker Lane zone, east-northeast-trending Southern Nevada zone, and northeast-oriented Pahranaget zone. The Walker Lane structural zone contains the well-documented Walker Lane right-lateral strike-slip faults, and extends southeastward to include the Las Vegas shear zone. Northwest-trending mapped faults are concentrated within the Walker Lane zone but are relatively sparse elsewhere in Nevada. East-northeast-trending faults are abundant locally within the Southern Nevada structural zone, and field evidence indicates that left-lateral strike-slip, as well as dip-slip, displacement is characteristic. Aeromagnetic anomalies and lineaments in MSS images of Utah suggest extension of this structural zone eastward to the Wasatch front. The Pahranaget structural zone, which is marked by northeast-oriented left-lateral strike-slip faults, transects the Southern Nevada structural zone near the Utah-Nevada border and continues for approximately 175 km into Utah. A zone of high heat flow parallels part of this structural zone.

Northern Nevada is dominated by the northeast-oriented Humboldt structural zone. This zone is 150-200 km wide and characterized by numerous northeast- and north-northeast-trending faults—many of which are Pliocene or younger, disruptions in the trends of aeromagnetic and Bouguer gravity anomalies, the Battle Mountain heat-flow high, numerous hydrothermal convection systems with temperatures>150°C, and broad arching during the last 10,000 years. Left-lateral strike-slip, as well as dip-slip, displacement has been documented along faults within this zone. The zone continues northeastward along the southeastern border of the Snake River Plains, across the Yellowstone caldera and into central Montana. It is interrupted in north-central Nevada by the north-northwest oriented Northern Nevada rift.

The northeast-trending linear features marking the Humboldt and Pahranaget structural zones are interpreted as left-lateral strike-slip fractures formed during the last 10 m.y. when the minimum principal stress direction was oriented west-northwest, as it is at present. These fractures provided the conduits for magmatic intrusions which are responsible for the anomalously high heat flow within parts of these zones. The left-lateral strike-slip faults that characterize the Pahranaget zone probably formed under these regional stress conditions.

The north-northwest-trending right-lateral strike-slip fractures anticipated during the west-northwest-oriented extension of the Great Basin have not been noted along any of the structural zones. We believe that northwest- rather than north-northwest-oriented right-lateral strike-slip faults formed in the Walker Lane structural zone owing to the presence of northwest-oriented faults that formed prior to 10 m.y. ago in response to west-southwest-directed extension. Although only a few high heat-flow anomalies are scattered along the northwestern part of the Walker Lane structural zone, late Cenozoic volcanic rocks and mineralized areas are abundant within the central and northeastern parts.

In the Southern Nevada structural zone, the generally east-orientation of the left-lateral strike-slip faults do not correspond to any of the primary shear directions resulting from the post- and pre-10 m.y. old-extension directions. However, the orientation and sense of displacement of these faults are consistent with those expected for second-order features in a west-northwest-directed extensional field.

The Walker Lane, Pahranaget, and Southern Nevada structural zones occur at the margins of the Great Basin and, therefore, probably reflect zones of compensation between this extensional province and adjacent areas having less extension during the past 10 m.y. The Humboldt structural zone separates the highly extended region to the south from the area to the north, where extension has been active during the past 10 m.y. but the magnitude has been less.