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LINCOLN COUNTY, NEVADA

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PAHRANAGAT SHEAR SYSTEM,  
LINCOLN COUNTY, NEVADA

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ABSTRACT

A structural model which relates strike-slip deformation to Basin Range extensional tectonics was formulated on the basis of analysis and interpretation of ERTS-1 MSS imagery over southern Lincoln County, Nevada. Study of published geologic data and field reconnaissance of key areas has been conducted to support the ERTS-1 data interpretation. The structural model suggests that a left-lateral strike-slip fault zone, called the Pahrnagat Shear System, formed as a transform fault separating two areas of east-west structural extension.

Introduction:

This investigation was conducted in order to evaluate an anomalous structural pattern observed in ERTS-1 MSS imagery over a portion of the southern Basin Range Province of Lincoln County, Nevada.

A portion of ERTS-1 MSS frame 1106-17492 over the area of study is shown in Figure 1, and a corresponding structural map in Figure 2. The anomalous north-east strike of the Pahrnagat Shear System and its apparently abrupt termination within the north trending valleys focused attention on the genetic origin and tectonic significance of the local fault pattern.

Based on analysis of the ERTS-1 data, a structural model was formulated which suggests that left-lateral strike-slip displacement on the Pahrnagat Shear System has resulted from differential east-west extension on Basin Range normal faults. A schematic diagram of this structural model is illustrated in Figure 4. Detailed study of the available published geologic data, and field reconnaissance of key areas was conducted in order to evaluate this hypothesis.

This study was supported by the National Aeronautics and Space Administration and Cyprus Mines Corporation as part of an investigation on applications of ERTS-1 MSS imagery to study of Basin Range tectonics and related resource exploration.

### Pahranagat Shear System:

The Pahranagat Shear System was first mapped by Tschanz and Pampeyan (1961) in a regional geologic survey of Lincoln County. The geologic map and its interpretation was considered in greater detail in their County Report (Tschanz and Pampeyan, 1970). This report described three northeast-striking faults which are collectively termed the Pahranagat Shear System. Tschanz and Pampeyan (1970, p. 84, 109) believed the system to have undergone approximately 9 to 16 km of left-lateral strike-slip displacement based on the offset of a distinctive ignimbrite unit. This ignimbrite has been correlated with the Hiko Tuff of middle Miocene age (Noble and McKee, 1972).

Based on possible correlations of lithology and structural features in the Spotted and Pahranagat Ranges, Tschanz and Pampeyan (1970) postulated the existence of an antecedent, right-lateral shear zone of Laramide age along the same trend as the Pahranagat Shear System. However, evidence for this earlier fault system is ambiguous and inconclusive. Although Tschanz and Pampeyan (1970) discussed possible genetic origins for the hypothetical Laramide fault zone, none was considered for the post-Miocene Pahranagat Shear System.

In a discussion of the regional importance of strike-slip faulting in the Basin Range Province, Shawe (1965) cited the Pahranagat area as an example. Shawe interpreted the geologic map of Tschanz and Pampeyan (1961) in support of a temporal and spatial association of late Tertiary and Recent normal and strike-slip faulting. On a regional scale, Shawe concluded that Basin Range structure may have formed en echelon with, and in response to a deep-seated, conjugate system of strike-slip deformation. However, such a causal relationship between strike-slip and normal faulting was not documented in the Pahranagat area.

### Tectonic Model:

The structural model for the Pahranagat Shear System proposed here is based largely on the detailed mapping of Tschanz and Pampeyan (1970). However, in key areas this mapping has been amended and supplemented by field reconnaissance guided by analysis of enhanced ERTS-1 MSS data.

A simplified structural diagram is shown in Figure 4 which illustrates a left-lateral strike-slip fault zone formed by differential crustal extension within two structural grabens. This model is believed to be mechanically similar to the tectonics of the Pahranagat Shear System. In contrast to the regional interpretation of Shawe (1965), we propose that the Pahranagat Shear System developed as a response to differential east-west crustal extension. Most of this extension is represented by the complex normal faulting which forms the structural basin of Delamar Valley northeast of the shear system, and a corresponding area of normal faulting adjacent to Desert Valley southwest of the shear system (see Figure 2).

Like the mechanical analogue in plate tectonics, the Pahranaġat Shear System may have formed as a transform fault, joining two areas of simultaneous crustal spreading (Wilson, 1965; Dennis, 1967). Similar concepts of intracontinental transform faulting have recently been applied to other areas of the Basin Range Province in explanation of displacement on the Garlock Fault (Davis and Burchfiel, 1973) and the Las Vegas Shear Zone (Fleck, 1970; Bechtold and others, 1973).

#### Supporting Evidence:

Geologic field evidence and published data corroborate the geometric and temporal requirements of this genetic model. Guided by ERTS-1 imagery, field work along both sides of Delamar Valley has located several large and previously unrecognized north-striking normal faults, which form parts of a complex structural basin in that area. As shown in Figures 1 and 2, north-striking faults on both sides of the Pahranaġat Shear System appear to terminate at the zone without being displaced along it. Likewise, strands of the shear system typically end by turning abruptly in strike to merge with north-striking range-front faults. This geometric relationship between dip-slip and strike-slip faulting requires synchronous movement and suggests that displacement on both sets has occurred in response to a common cause.

In the field, strike-slip movement is indicated by abundant subhorizontal slickensides found along east and northeast-striking strands of the Pahranaġat Shear System in the vicinity of Maynard Lake in the South Pahroc Range. The estimate by Tschanz and Pampeyan (1970, p. 84, 109) of 9 to 16 km of left-lateral displacement on the Pahranaġat Shear System was based on the apparent separation across the fault system of an eastward dipping unit of volcanic ignimbrites. This apparent separation could be caused in part by vertical displacement. For this reason, our estimates of strike-slip movement are based on the displacement of a generally north-south linear trend defined by the angular unconformity between west-dipping sedimentary units of Devonian through Ordovician age, and the overlying east-dipping Miocene volcanic cover (Tschanz and Pampeyan, 1970, geologic map, T9S-R62E, T9S-R61E, T8S-R61E). Although the Paleozoic basement is highly deformed and the regional continuity of structural trends is uncertain, this data suggests post-volcanic strike-slip displacement of approximately 9 to 14 km.

Within the scale limitations of the mapped geology, interpretive structural sections were constructed across the structural basins northeast and southwest of the Pahranaġat Shear System. These are shown in Figure 3. For simplicity, these structure sections were constructed assuming an average dip of 45 degrees on the range front faults. As discussed below, this generalization of fault plane dip is based on published data as well as field observations.

Gilluly (1928) estimated 40°-80° dips for typical Basin Range normal faults. Stewart (1971, p. 1035) and other recent workers (Hamilton and Myers, 1966; Thompson, 1966) have used a value of approximately 60° as an average for the Basin Range Province.

However, the dips of normal faults in the Pahranaगत area appear to be unusually shallow. Along one well-exposed scarp north of Delamar Lake, the dip of the fault is estimated to be less than 45°. Geologic mapping (Longwell, 1945) in the Desert Range south of the Pahranaगत Shear System, indicated 15-20° dips on most normal faults. In addition, Longwell's mapping indicated that these faults are concave upward, and hence flatten at depth. Thus, the assumption of an average 45° dip on the range front faults in the Pahranaगत area is reasonable, and perhaps conservative.

Analysis of the interpretive structural sections shown in Figure 3 suggests net crustal extension on both normal fault systems of approximately 8-11 km. This figure represents crustal extension of less than 25% in these areas, which is moderate compared with many regional estimates for the Basin Range Province (Davis and Burchfiel, 1973, p. 1416). The amount of extension within the structural basins north-east and southwest of the Pahranaगत Shear System is large enough to account for most of the postulated 9-14 km of post-Miocene strike-slip displacement on the shear system.

#### Conclusion:

Analysis of the ERTS-1 imagery, and field reconnaissance in key areas in the Pahranaगत region indicate that eastern portions of the shear system terminate against the north-striking normal faults of the Delamar Range front. Major eastward continuations of the Pahranaगत Shear System as suggested by Shawe (1965) and Tschanz and Pampeyan (1970) are unlikely. For this reason, at least in the Pahranaगत area, a regional strike-slip stress system does not seem to be a probable driving force for generation of Basin Range structure. Rather, the strike-slip deformation seems to be a normal consequence of differential rates or amounts of regional crustal extension.

Several recently active faults are evident in the Pahranaगत area. These include a frontal fault along the east side of Delamar Valley which cuts alluvium for more than 15 km. (Tschanz and Pampeyan, 1970) and similar faults along both sides of the Sheep Range (Longwell, 1930; Tschanz and Pampeyan, 1970, p. 85). The strong topographic expression of both normal and strike-slip faults in the Pahranaगत area suggests that both Basin Range extension and the Pahranaगत Shear System may be presently active.

The ERTS-1 MSS imagery has proven to be a valuable tool for efficiently studying regional patterns of Tertiary faulting, and for guiding geologic field reconnaissance to evaluate and confirm interpretations.

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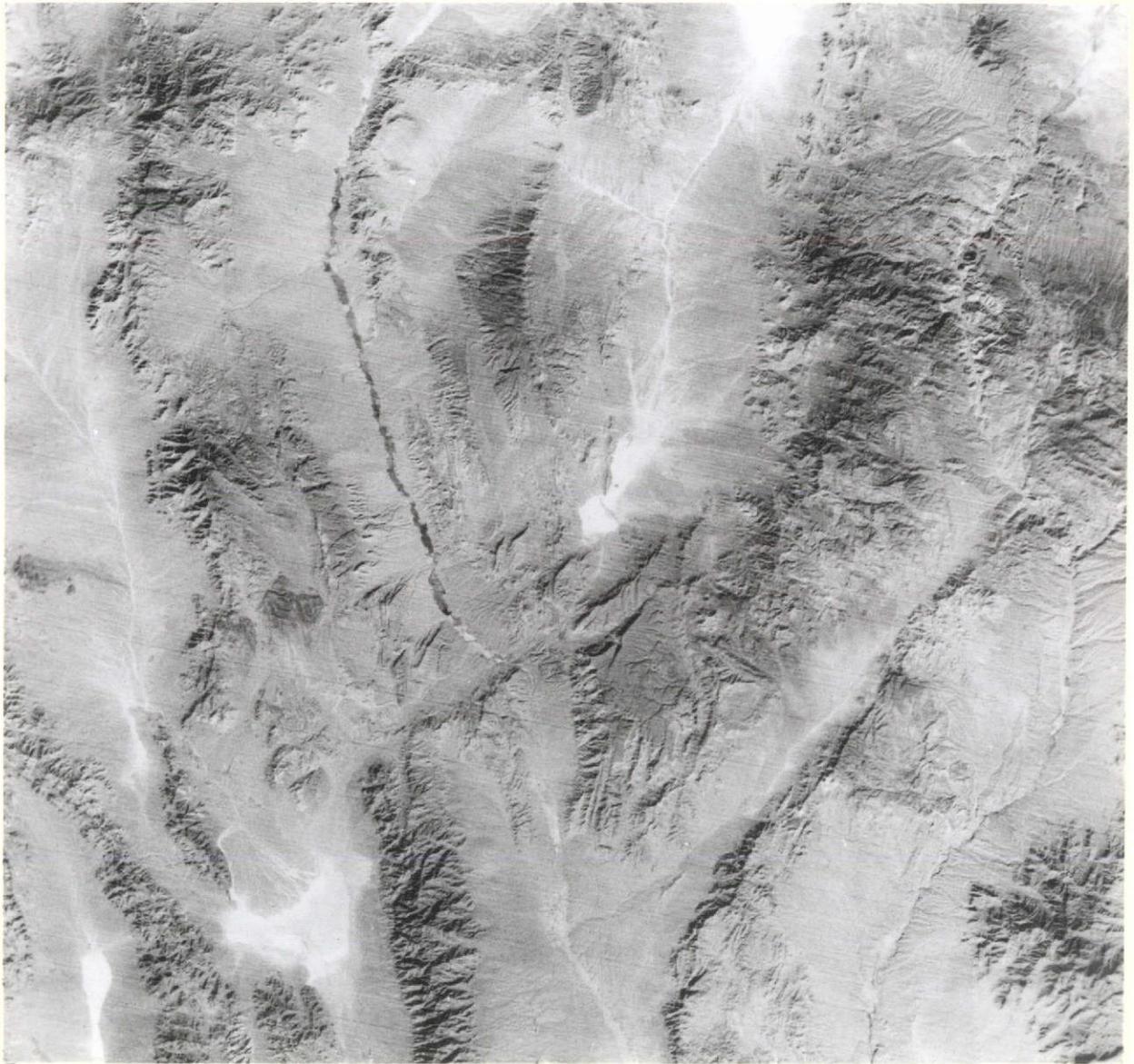


Figure 1: Enlarged portion of ERTS-1 MSS frame 1106-17492 Band 5, over the Pahranagat Shear System of Lincoln County, Nevada. A corresponding structural map is shown at the same scale in Figure 2.

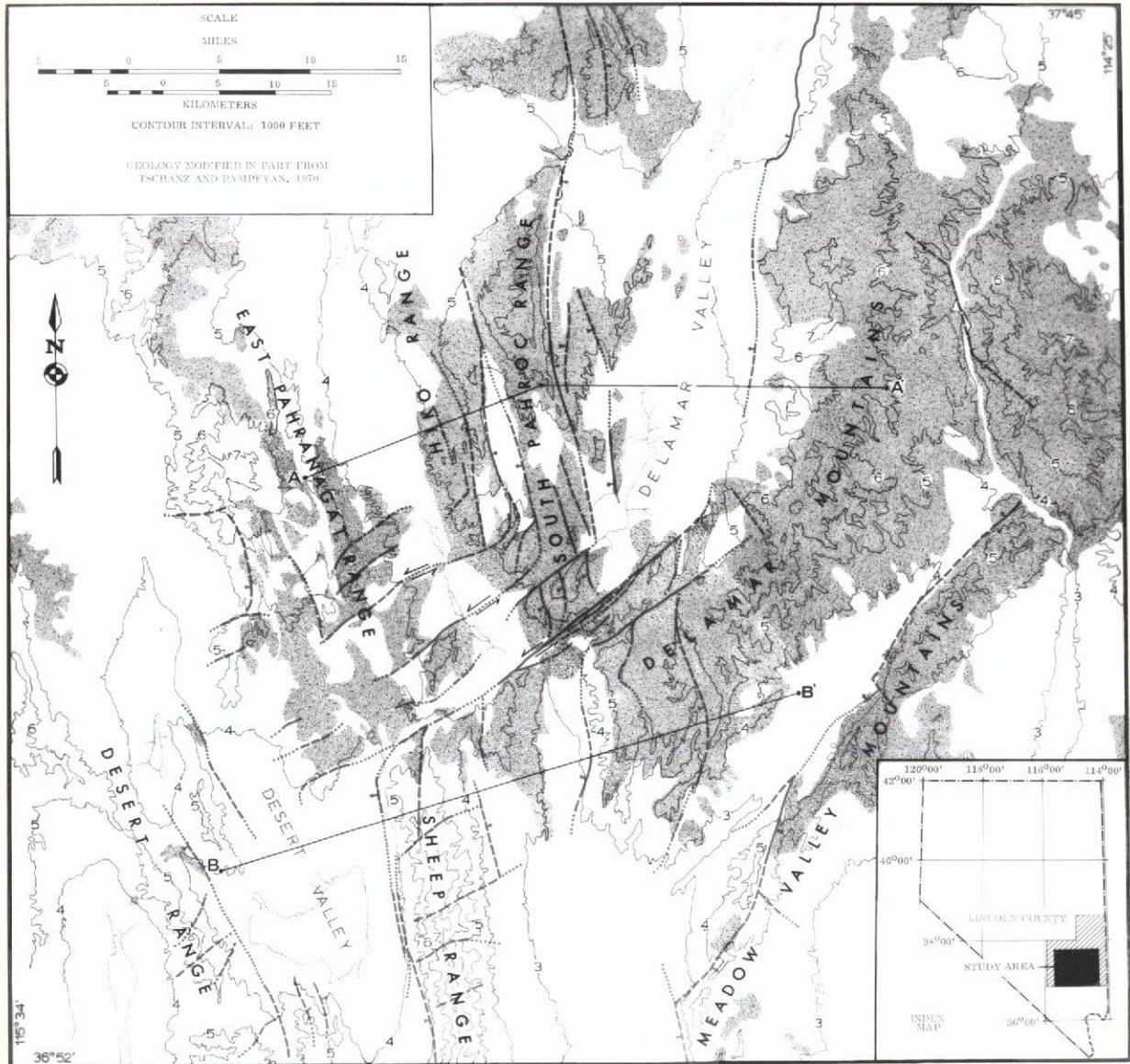


Figure 2: Structural map of the Pahrangat Shear System and surrounding terrain illustrated in Figure 1. Shaded areas represent Tertiary volcanic rocks. Faults are solid where well exposed, and dashed or dotted where approximately located or inferred. Interpretive structural sections along A-A' and B-B' are shown in Figure 3.

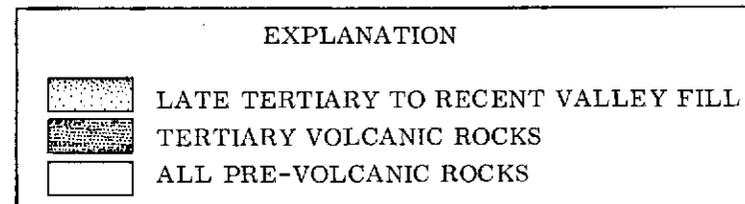
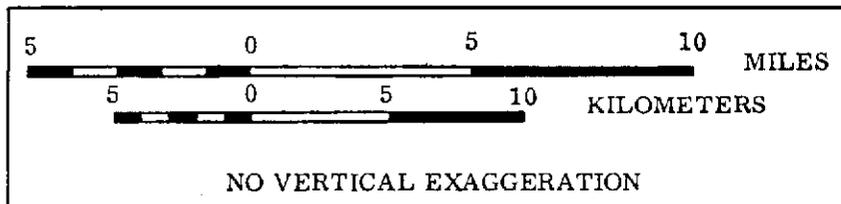
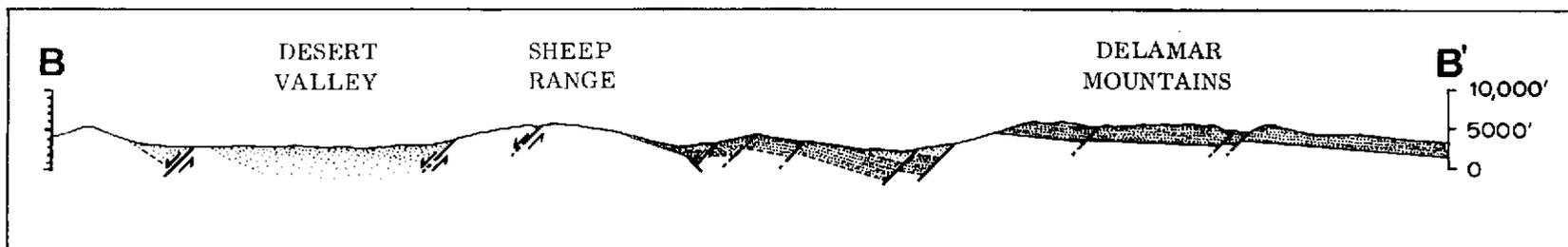
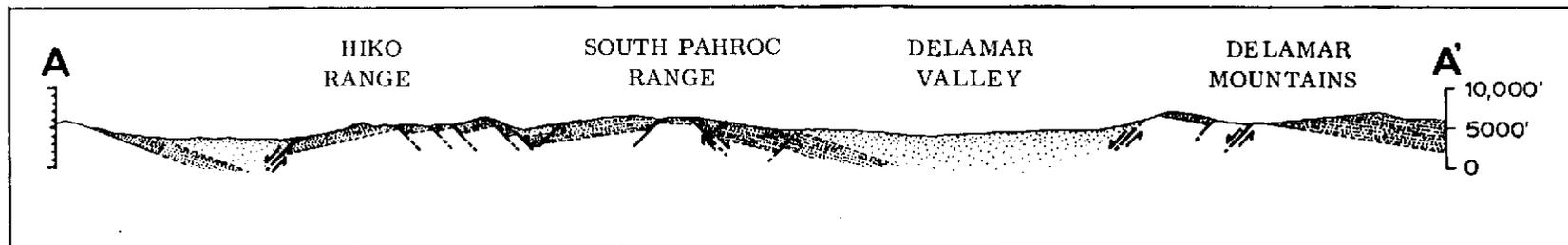


Figure 3: Interpretive structural sections A-A' and B-B' at locations shown in Figure 2. The complex normal faulting in the areas traversed by these sections is believed to have resulted in crustal extension of from 8 to 11 km. See text for discussion.

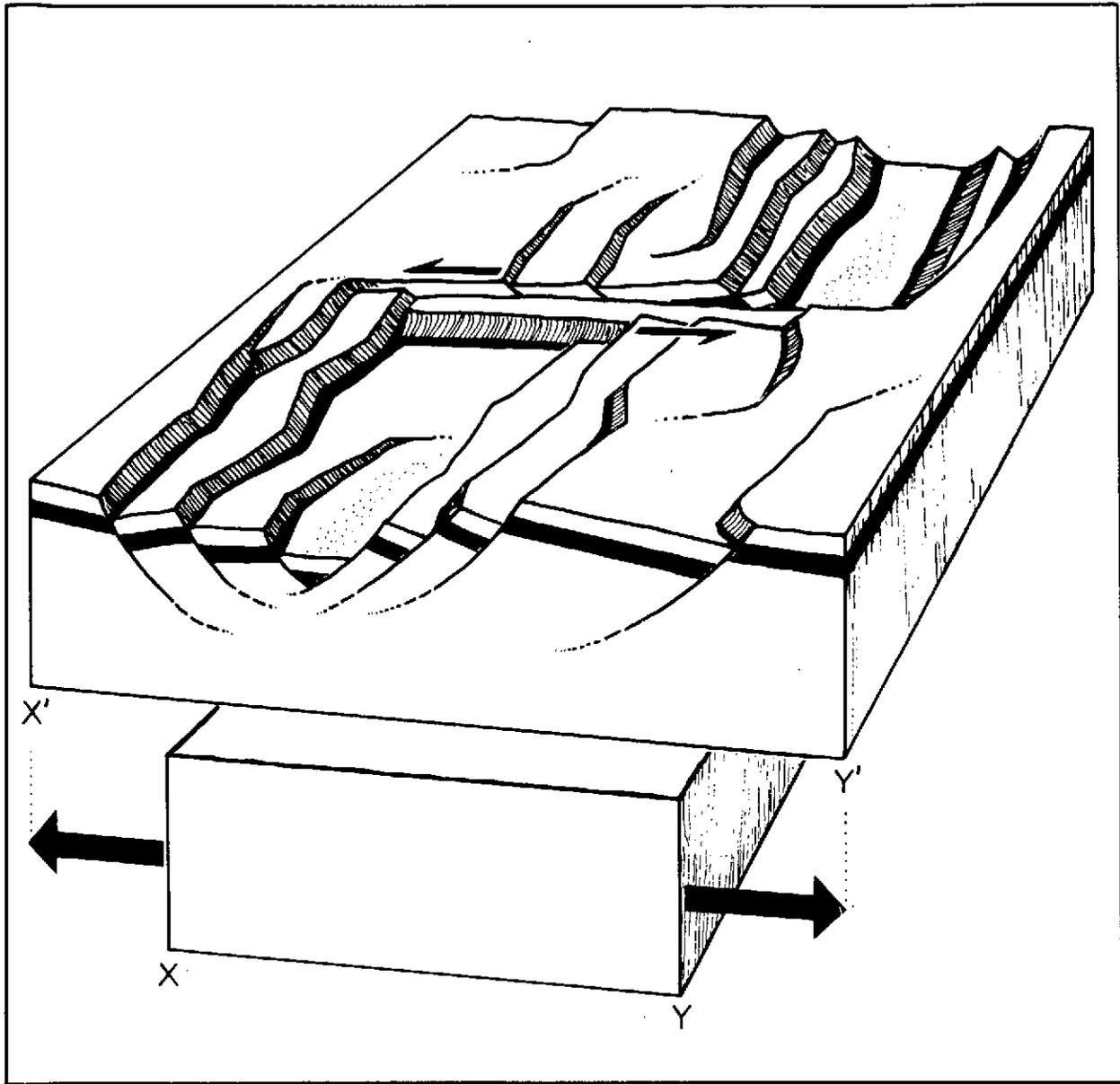


Figure 4: Diagrammatic model illustrating a left-lateral strike-slip fault zone formed by differential crustal extension within the two graben basins. The amount of extension is indicated by the increase in width of block X-Y to X'-Y'. This model is believed to be mechanically similar to the tectonics of the Pahrangat Shear System.