Age of Basin and Range Normal Faults in Nevada Test Site and Nellis Air Force Range, Nevada

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ABSTRACT

Two normal fault systems are present in Nevada Test Site and Nellis Air Force Range. The earlier system consists of two sets that strike northeast and northwest, and the later system, a single set, strikes north. In the southern Kawich and Belted Ranges the Belted Range Tuff, dated at 13 to 14 m.y. and faulted only by the north-trending faults, laps onto older volcanic rocks that are broken by both fault systems. The older faults probably started to form during or shortly after the extrusion of the oldest welded tuff dated at 26.5 m.y. (age dates by R. W. Kistler, written commun., 1964), as is evidenced by essentially the same fault densities and displacements in pre-Tertiary rocks as in Tertiary rocks.

The north-trending faults first began to appear after the deposition of the Fraction Breccia, dated at 17.8 m.y., and the present mountain ranges were well defined prior to extrusion of the Thirsty Canyon Tuff dated at 7 m.y.

In the southern part of the Bombing and Gunnery Range near the Las Vegas Valley shear zone, north-trending faults that are inferred to be the same age as those to the north change strike gradually from north to northeast as the valley is approached from the north. This rotation, interpreted as being caused by drag during later right-lateral movement rather than a change in the stress field, suggests that much of the displacement along the shear zone has taken place within the last 17 m.y.

Recent geologic mapping in the northern part of the Nevada Test Site and in the ranges to the north has disclosed two normal fault systems of Tertiary age (Fig. 1). The earlier system consists of two sets of faults that strike northeast and northwest. The later system, a single set, strikes essentially north.

In the Kawich and Belted ranges (Fig. 1) volcanic rocks older than about 17 m.y.[1] are broken mainly by faults of the older system, which have displacements ranging up to several thousand feet. Because these faults appear to be no more numerous in pre-Tertiary rocks than in Tertiary rocks, it is inferred that they began to form after the oldest Tertiary rocks were deposited. This does not preclude the existence of normal faults in Paleozoic strata prior to deposition of the oldest volcanic rocks, but apparently such faults were not closely spaced. There is strong evidence that the faulting which produced the northeast- and northwest-trending fractures persisted for a considerable period of time. For example, in places, lavas dated at about 18 m.y. were erupted from vents localized by northeast- and northwest-trending faults,

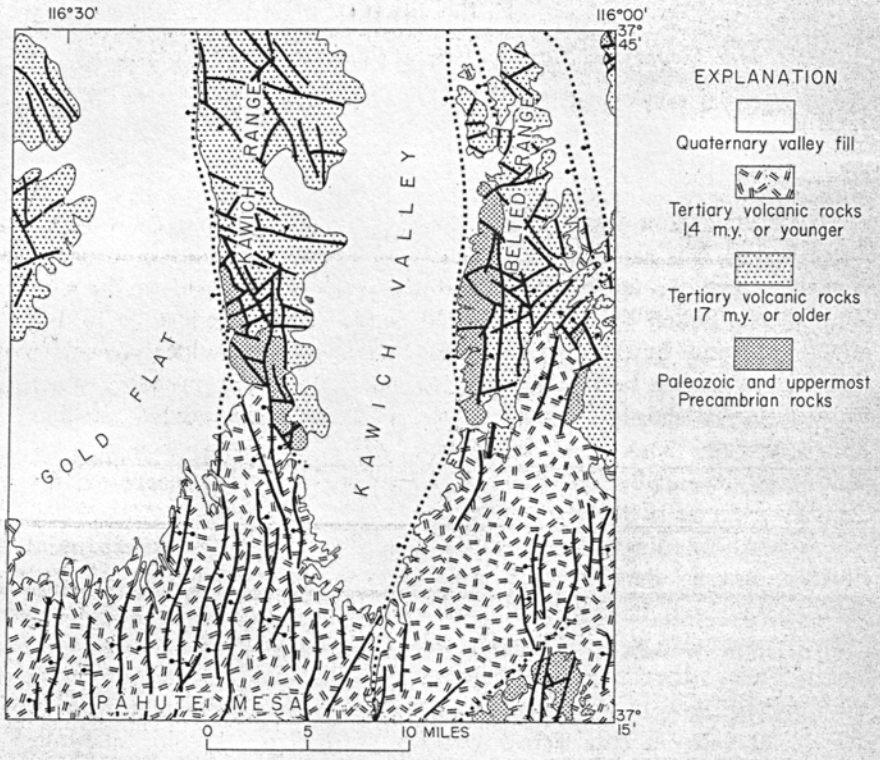

Figure 1. Geologic map of the Belted and Kawich Ranges and part of Pahute Mesa, Nevada. Contacts are dashed where approximately located. Faults are dotted where concealed; bar and ball indicates downthrown side.

[1]All age determinations listed herein are by Ronald Kistler and H. H. Mehnert, U.S. Geological Survey. Also see Kistler's article (this volume) for potassium-argon ages of volcanic rocks in Nye and Esmeralda Counties, Nevada.

and then the lavas themselves were broken by younger faults having the same trends.

After the deposition of the Fraction Tuff (dated about 17 m.y.) and before the deposition of the Belted Range Tuff (dated about 14 m.y.) the north-trending faults began to form. These faults truncate the older faults along the range fronts and give rise to the present pattern of north-trending basins and ranges. The approximate age of these faults can be demonstrated on the

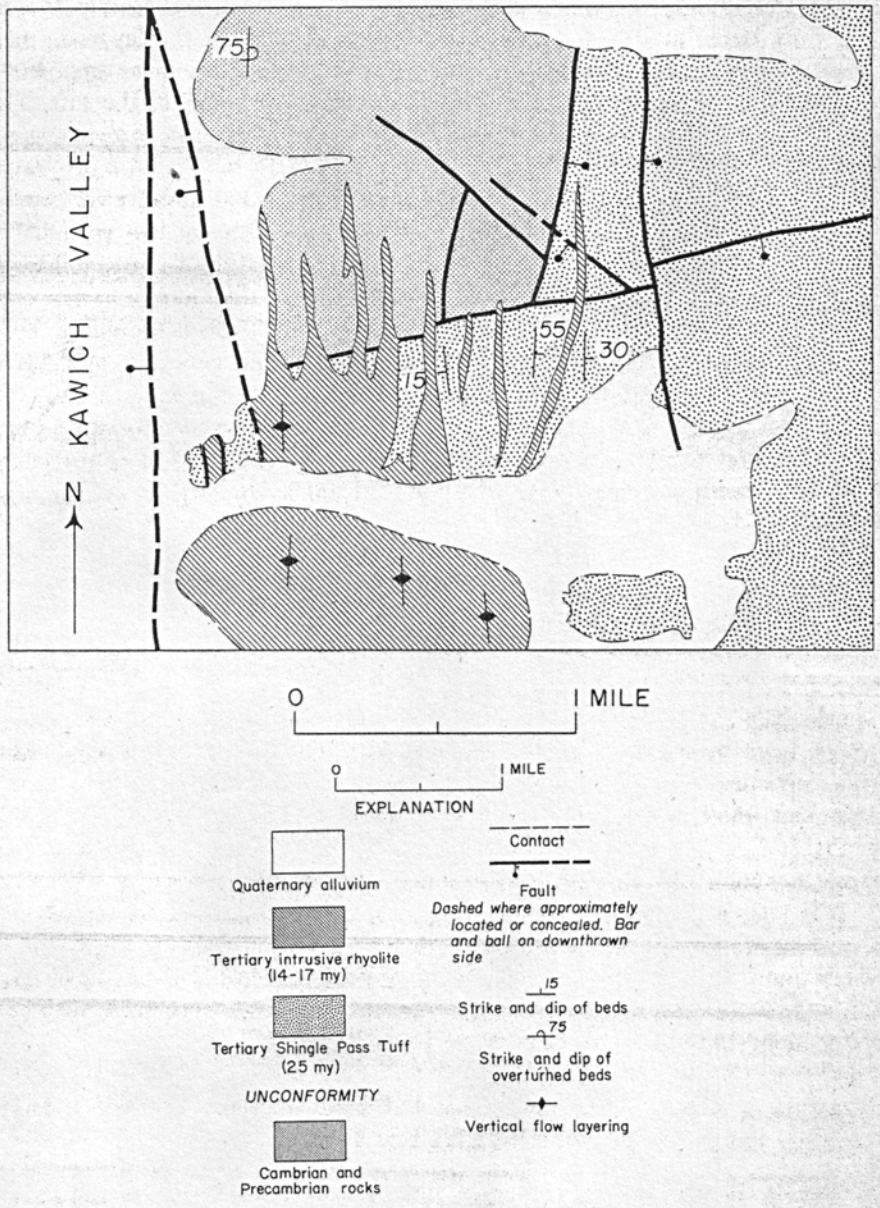

Figure 2. Geologic map of part of west flank of Belted Range.

western flank of the Belted Range (Fig. 2), where rhyolite overlying the Fraction Tuff and underlying the Belted Range Tuff has been intruded along several north-trending faults and fractures that crosscut the older faults. These north-trending fractures appear to have been contemporaneous with the faults that bound the Belted Range on the west.

Although the north-trending faults started to form between 17 and 14 m.y. ago, there is good evidence that at least some of the basins and ranges were still in their infancy as late as 11 m.y. ago. For example, the Timber Mountain Tuff, dated at about 11 m.y., is no thicker in the Yucca Flat basin than on the flanks of the adjacent mountains. This situation would be impossible if the basin had been well developed prior to the eruption of the tuff. The same relation prevails in the area west of the Nevada Test Site, where several hundred feet of Timber Mountain Tuff is preserved on the very top of Grapevine Peak, a conspicuous landmark that now towers 4000 ft above the Amargosa Desert to the east. Although the tuff is thicker in the low ground between Pahute Mesa and Beatty, Nevada, to the east and the Grapevine Mountains to the west, it is apparent that the Basin-Range topography in that area was still very subdued during the eruptions of the Timber Mountain Tuff.

By the time the Thirsty Canyon Tuff was deposited (about 7 m.y. ago), however, the topographic grain of the area was much as it is now. This tuff lapped up against some of the ranges and in places flowed into valleys that mark the sites of present-day streams. The Thirsty Canyon Tuff is broken by numerous north-trending faults, which are related to the large structures controlling the basins and ranges. However, vertical displacements on the faults are, in general, small, averaging less than 100 ft; at least one fault occurs, however, with a vertical displacement of about 1000 ft.

Ranges formed of pre-Tertiary rocks are as youthful as the ranges composed of Tertiary volcanic strata. In the southern part of the Nevada Test Site, for example, several ranges contain blocks of lacustrine limestone and interbedded ash-fall tuff, dated at 29 m.y., from the Horse Spring Formation, which have been preserved by downfaulting. The Horse Spring apparently was deposited in a large, virtually continuous basin, and, judging from this date and another described by Paul Damon (1965, written commun.), is probably late Oligocene to middle Miocene in age. These ranges, therefore, could not have formed before the middle of the Miocene.

It is interesting to note that the ranges in the southern part of the Nevada Test Site are bent to northeast strikes in the vicinity of the Las Vegas Valley shear zone. Inasmuch as the ranges themselves are probably not older than 17 m.y., it is reasonable to conclude that much of the observable displacement along the shear zone has taken place since then.

REFERENCES CITED

Kistler, R. W., 1968, Potassium-argon ages of volcanic rocks in Nye and Esmeralda Counties, Nevada: Geol. Soc. America Mem. 110, p. 251–262.