40.15 STOP 5.

Guild Mine Member of the Mickey Pass Tuff in detachment fault contact over pre-Tertiary rocks. The Singatse Tuff, forming the ridge crest, is in detachment fault contact over the Guild Mine Member. To the east in this canyon wall, the Guild Mine Member wedges out.

Climb hill on the north side of the wash to whitish outcrop along the pre-Tertiary-Tertiary contact. Return to vehicles.

40.45 STOP 6.
(Time permitting). Just around bend in Wildhorse Canyon at reentrant in canyon wall (gully to the east). Climb to exposures at head of gully to view the detachment fault at the base of the Singatse Tuff.

Return to vehicles and retrace route back down Wildhorse Canyon to railroad line.

45.5 At railroad crossing. Follow road on west side of tracks to the south.

60.2 Railroad crossing at Thorne (former railroad depot site). Turn right (west) on blacktop road. Pass through ordnance facility.

64.0 Junction of Bonanza Rd. (chain-link fenced compound on the right). Turn left, cross railroad tracks, and proceed to Hawthorne.

65.45 Major intersection just past cemetery on right (west) side of road. Proceed straight ahead through intersection and straight ahead at next stop sign onto F Street. Proceed about 3 blocks to the El Capitan Lodge (Best Western Motel) and Casino.

66.0 END OF SECOND DAY ROAD LOG.

THE GABBS VALLEY RANGE--A WELL-EXPOSED SEGMENT OF THE WALKER LANE IN WEST-CENTRAL NEVADA

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ABSTRACT

Four northwest-striking, en echelon right-slip faults are exposed in and adjacent to the Gabbs Valley Range in west-central Nevada. These faults, together with northwest-striking faults exposed in the Gillis Range and Walker Valley to the west, lie within the Walker Lane structural zone and have a combined displacement of 48-60 km. The four faults in and adjacent to the Gabbs Valley Range probably have a minimum of 4 km. displacement each, and the two easternmost faults may have displacements as great as 10-15 km. each. In addition to the four northwest-striking right-slip faults, several northeast-striking conjugate left-slip faults are present. The most important of these conjugate wrench-system faults lies just east of the Monte Christo Range and is the only fault in the region that shows extensive associated drag folding. This fault drags beds of cobble conglomerate from northeast strikes in exposures several kilometers east of the fault zone to northwest and west strikes adjacent to the fault zone. This major fault probably has at least 10-15 km. of left-slip displacement.

Listric normal faults are abundant in several localities along the Gabbs Valley Range. These strike northwest--parallel to the range-bounding right-slip faults--and are principally down to the west. Tertiary volcanic rocks appear to be detached from the underlying Mesozoic basement rocks in most localities. The detachment faulting, wrench faulting, and listric-normal faulting were synchronal and recurrent. Strike-slip faulting along northwest trends commenced about 25 m.y. ago and has persisted into recent times.

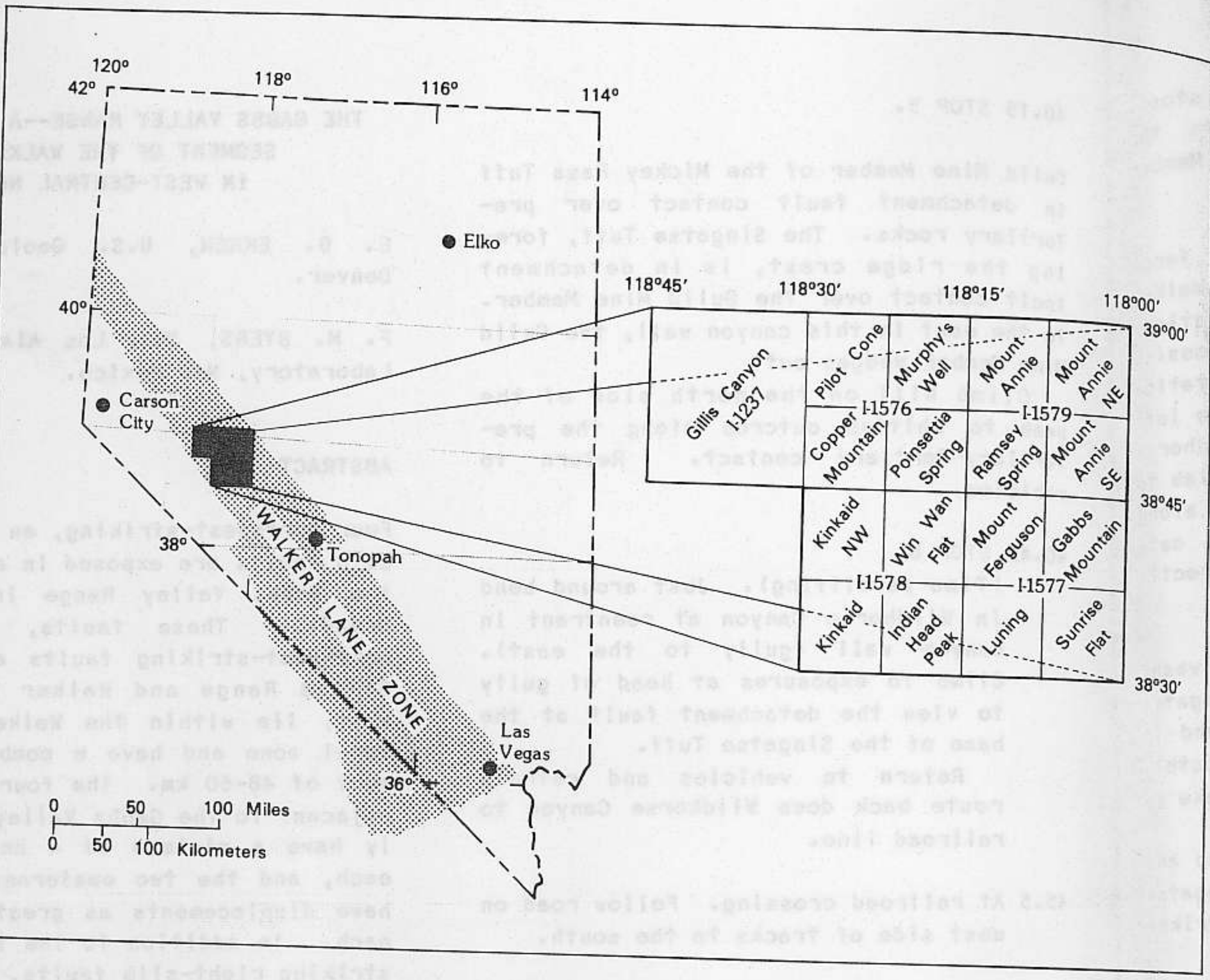


FIGURE 1: Index map of Nevada showing Walker Lane structural zone and location of quadrangles referred to in this report and in Hardyman (this volume). Width of Walker Lane zone based on data from W.J. Carr (written communs., 1983-84), and Ekren and others (1976).

INTRODUCTION

The Gabbs Valley Range and vicinity in west-central Nevada is very intriguing geologically because the area straddles the Cenozoic Walker Lane structural zone (Fig. 1) and, in addition, lies within the Mesozoic Luning embayment of Ferguson and Muller (1949) and Muller and Ferguson (1939). The area lies north of the Pancake Range lineament (Fig. 2) which marks a change in the tectonic fabric of the Walker Lane. North of the lineament strike-slip faults are conspicuous and lie within a relatively narrow zone; south of the lineament they are not easily discerned and the lane is characterized by a broad region of distributed shear (Ekren and others, 1976).

The principal sedimentary rocks within the embayment consist of shallow marine carbonates and clastics and deep marine turbidites of Triassic and Jurassic age (Muller and Ferguson, 1939; Ekren and Byers, in press a, b, c, d). Sedimentary rocks of Paleozoic age are absent over an extremely broad area, apparently having been eroded from the area prior to the encroachment of the Mesozoic sea and development of the Luning embayment.

Sedimentary rocks of Triassic and Jurassic age were extensively folded and thrust faulted during the Jurassic Period (Ferguson and Muller, 1949) and subsequently were intruded by numerous large masses of Mesozoic batholithic rocks that

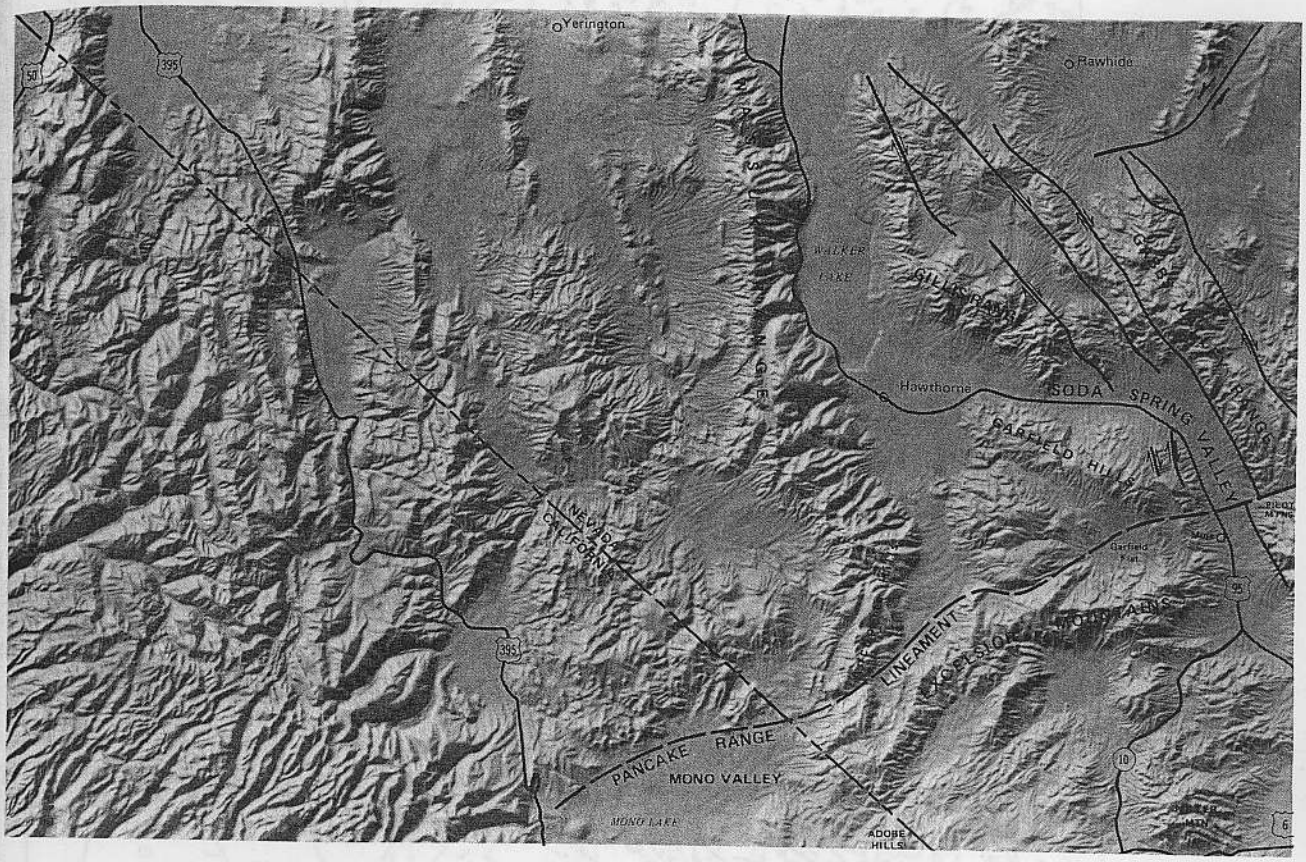


FIGURE 2: Relief map of part of eastern California and western Nevada showing major strike-slip faults and geographic features referred to in this report and in Hardyman (this volume). Photo from Ekren and others (1976).

range in composition from diorite to granite. The batholithic rocks are spatially and temporally part of the Sierra Nevada.

Mesozoic basement rocks had been deeply eroded and the paleotopography was subdued when the first Tertiary volcanic eruptions occurred. These eruptions started about 29 m.y. ago and ended about 6 m.y. ago. Stratigraphy of these volcanic rocks is described in detail in Ekren and others (1980), and the stratigraphy and petro graphy of the Mesozoic rocks are described in Muller and Ferguson (1939), Ekren and Byers (in press a, b, c, d), and Hardyman (1978, 1980).

The objective of this paper is to describe the principal Walker Lane structures in the Gabbs Valley Range. Excellent exposures of the rocks in this rugged range reveal certain faults that seem to be an integral part of strike-slip fault systems wherever strike-slip faulting can be documented in the Basin and Range province in Nevada. These strike-slip and related faults include detachment faults and listric normal faults.

RIGHT-SLIP FAULTS

INDIAN HEAD FAULT

The westernmost right-slip fault in the Gabbs Valley Range and immediate vicinity is the Indian Head fault (Fig. 3), named for an erosional monolith of basalt (see I-1578). Right-slip displacement along

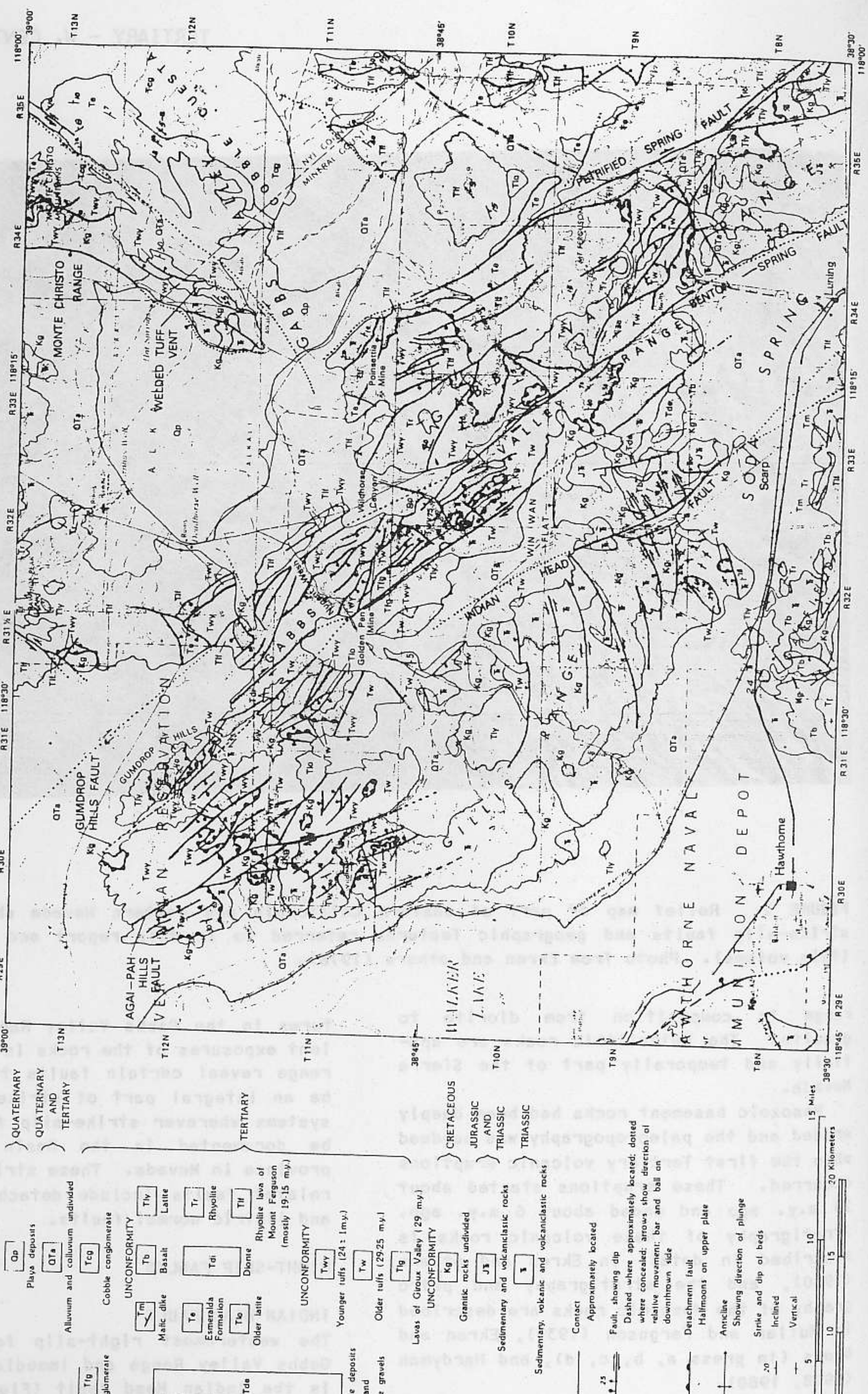


FIGURE 3: Generalized geologic map of Gabbs Valley and Gillis Ranges.

FIGURE 5: Generalized geologic map of Gabbs Valley and Gillis Ranges.

this fault amounts to slightly more than 4 km., based on the offset of a steeply dipping marker bed in the Luning Formation of Triassic age in the vicinity of T. 9 N., R. 33 E. (see I-1578). Southeast of this area, the fault separates bedrock of Mesozoic age from alluvium of Quaternary and Tertiary age, but only in one locality, near a small outlier of Cretaceous granitic rock, does the fault show as a well defined lineament on aerial photographs (Fig. 4). The extensive erosion of the scarp along the well-defined lineament suggests that the latest movement along this fault was probably Pleistocene in age. The time of earliest movement along the Indian Head fault is not easily deciphered. The abundance of landslipped debris beneath a 5.8-m.y.-old black latite (see I-1578) seen in exposures east of the fault suggests extensive displacement prior to the latite intrusive and extrusive activity.

GUMDROP HILLS FAULT

This fault is almost continuously exposed from the northwest corner of T. 8 N., R. 34 E. in Soda Spring Valley to Nugent Wash in the southeast 1/4 of T. 11 N., R. 31 1/2 E. The fault continues northwest from Nugent Wash for another 24 km. and is a major fault through the northeast part of the northern Gillis Range. Here (Fig. 3) a Mesozoic granite is offset about 6.4 km. along the fault (Hardyman, 1978, 1980). In the vicinity of Soda Spring Valley, the fault displacement is not precisely known; however, on the north flank of the valley, 10 km. north of Luning, steeply dipping sedimentary rocks of Triassic age intersecting the fault at a high angle on the east side (in the northwest corner of T. 8 N., R. 34 E.) appear to have correlative rocks (also steeply dipping) on the west side of the fault about 9 km. to the northwest; hence, the actual displacement is inferred to be close to this apparent offset. Most of the displacement predates a 5.8 m.y. old (Ekren and others, 1980) black latite intruded and extruded along the fault (Fig. 5) in T. 12 N., R. 32 E.

The Gumdrop Hills fault is of special interest because it separates an area to the northeast that contains blocks dramatically affected by listric normal faults from an area to the southwest where such faults have not been positively identified.

BENTON SPRING FAULT

This fault is named for Benton Spring, located about 1.6 km. north of the township line between T. 8 N. and T. 9 N., R. 34 E. The fault was first recognized as a right-slip "flaw" by Ferguson and Muller (1949, p. 14) who inferred about 4 mi. (6.4 km.) of horizontal movement. Nielsen (1965) postulated a displacement of at least 6.4 km. and possibly as much as 16 km. We believe that the Cretaceous granitic pluton, with its steep south contct with country rock exposed east of Highway 23 (Fig. 3) has been displaced 4 to 6 mi. (6.4-9.6 km.) from its original position opposite the granite that straddles the range line between Rs. 33 and 34 E., T. 9 N. The Tertiary welded tuffs, detached at their bases on both sides of the Benton Spring fault, nevertheless show a right-slip displacement of about 8 km. This suggests that the movement along this right-slip fault is entirely Tertiary in age as deduced earlier by Ferguson and Muller (1949, p. 14). Similarities of displacements also suggest that the detachment-fault displacements are minimal.

All the right-slip faults, including the Petrified Spring fault (see later pages), have breccia and gouge zones that vary in thickness from a few meters to several tens of meters; the widest of these zones is associated with the Benton Spring fault. In places along this fault, the Mesozoic granitic rocks are mechanically ground down to the consistency of coarse sand for a distance of 100 m. or more away from the fault (Fig. 6). The mineral constituents in the "sand" are fresh. In contrast, the Tertiary volcanic rocks adjacent to the fault are extensively altered and locally impregnated with pyrite and gypsum of presumed hydrothermal origin. A combination of gouge and argillically altered volcanic rock in zones as wide as 30 m. is present along the fault between the sanded granite and relatively intact welded tuff or other volcanic rock. The fault controls the site of Benton

FIGURE 4: Fault scarp in older fanglomerate along the Indian Head fault (see Fig. 3 for scale). Deep erosion of scarp indicates a Pleistocene age.

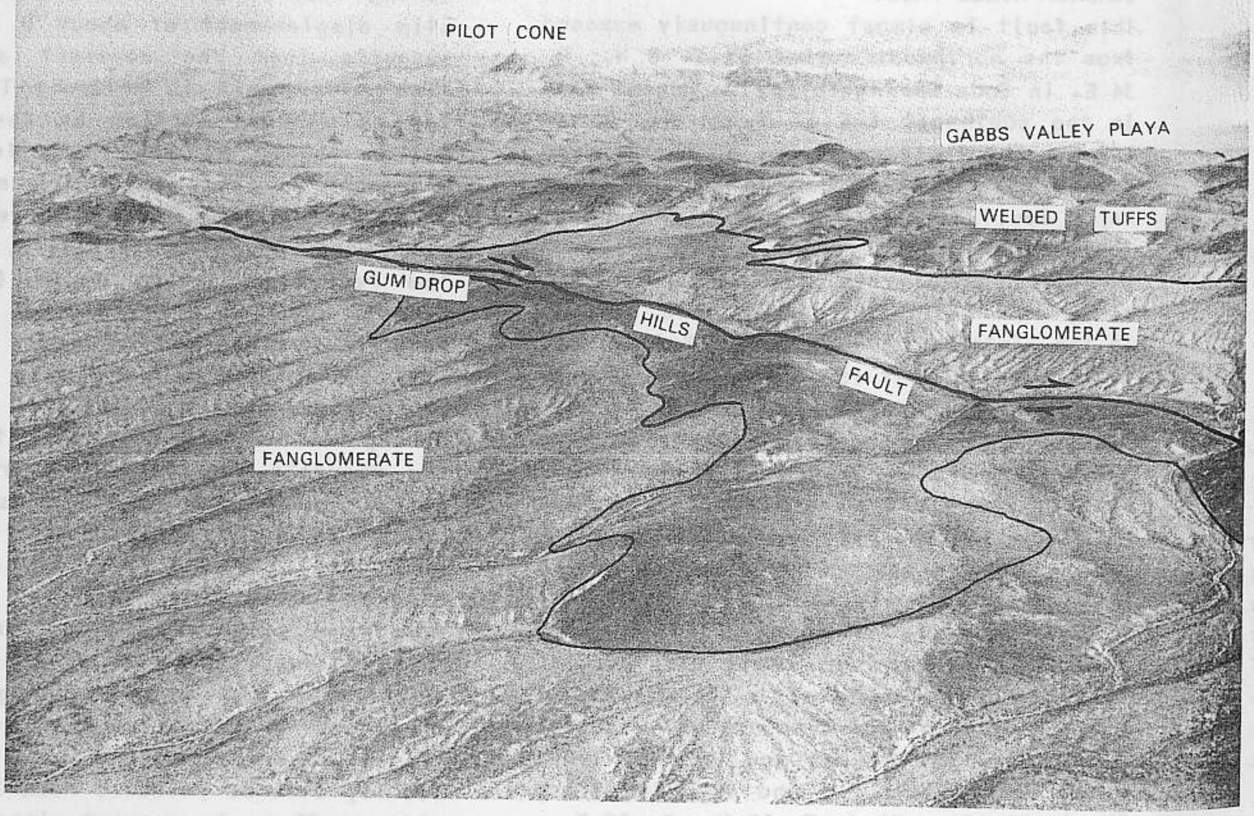
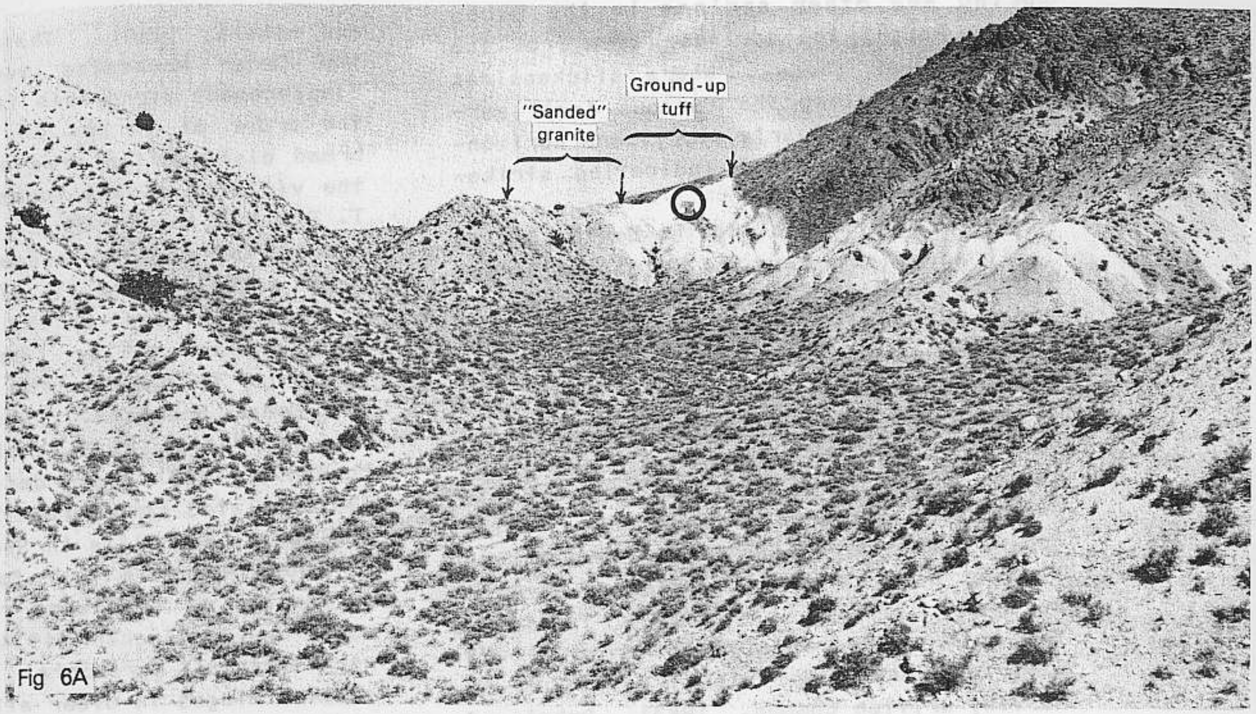


FIGURE 5: View northward of black latite (5.8 m.y.) intruded and extruded along the Gumdrop Hills fault south of Nugent Wash.



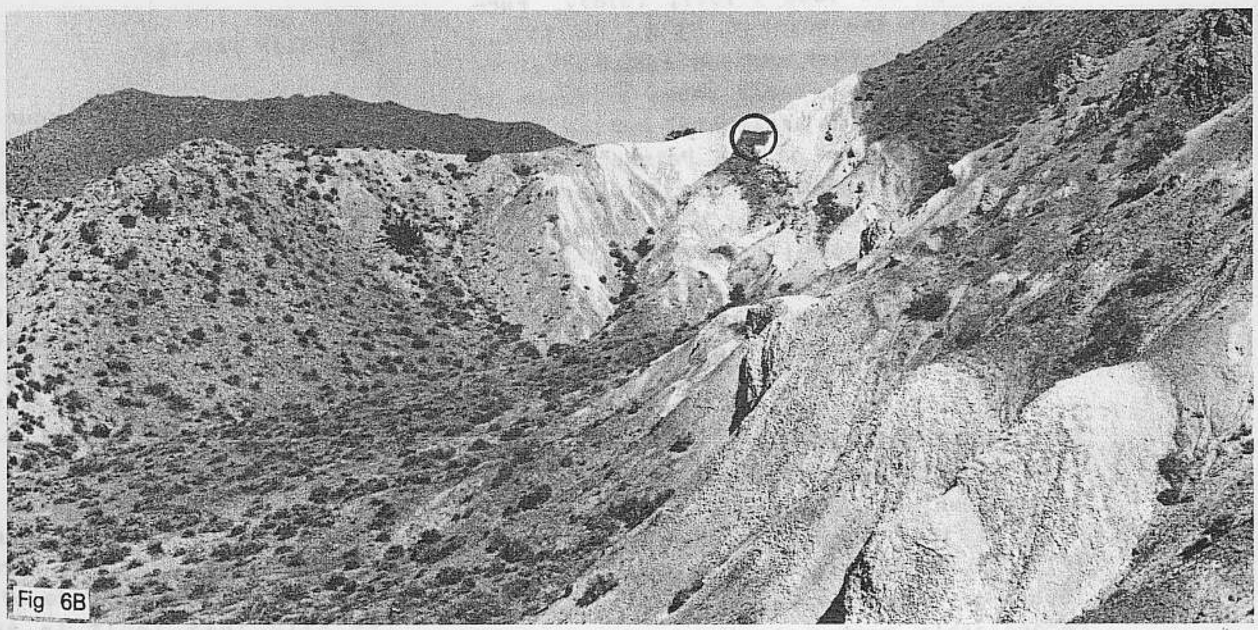


FIGURE 6: Views looking northward at "sanded" gouge zone along the Benton Spring fault: A, distant view with arrows showing width of ground-up "sanded" granite on west side of fault; white zone is ground-up hydrothermally altered welded tuff; Singatse Tuff of the Benton Spring Group forms bluff on east side of fault; B, close-up view of same outcrop. On both views, dark rectangular patch within circle on white ground-up tuff zone is a 12 X 15 foot tarpaulin for scale.

Spring and other springs in the Gabbs Valley Range; the springs issue from the clayey fault gouge. Where slickensides are visible along the various fault surfaces, they are nearly everywhere horizontal or subhorizontal, indicating strike-slip movement.

Age of faulting along the Benton Spring fault and also along the Petrified Spring fault (see later paragraphs) can be deduced by several lines of evidence. The tuff of Redrock Canyon (Ekren and others, 1980; and I-1577) rests on a variety of land-slipped debris, including granite boulders several meters in diameter. These debris zones are confined to outcrops in the area between the Benton Spring and Petrified Spring faults and seem to be most easily explained as products of intense strike-slip faulting. The tuff of Redrock Canyon is almost 24 m.y. old (Ekren and others, 1980; R. F. Marvin, written commun., 1983). Debris of landslide origin is present also at numerous localities beneath the lavas of Mount Ferguson, which are principally about 22 to 15 m.y. old (see I-1577, 1578). Furthermore, in the NE1/4 T. 10 N., R. 33 E., a major fault that strikes subparallel to the Benton Spring fault shows evidence of both vertical and horizontal motion prior to the deposition of the Poinsettia Tuff Member of the Hu-pwi Rhyodacite, which has been dated at 22 to 24 m.y. (Ekren and others, 1980; and I-1577,78). The tuff was deposited against a preexisting fault scarp and was subsequently faulted prior to the deposition of the lavas of Mount Ferguson.

PETRIFIED SPRING FAULT

This fault is named after Petrified Spring, which is located about 1.6 km. west of the nearest splay of the fault (Fig. 3). The fault juxtaposes various lavas of Mount Ferguson that have no recognizable marker horizons; therefore, the amount of displacement along the fault cannot be accurately determined. Recent mapping by R. F. Hardyman (oral commun., 1983) in the Cedar Mountain area east of the fault, however, reveals the presence there of the tuff of Copper Mountain and tuffs of the Benton Spring Group (Ekren and others, 1980). These occurrences in the Cedar Mountains suggest, 1) large displacement along this fault--probably on the order of 16 km. or, 2) a remarkably broad distribution area of the tuffs. In the vicinity of the township line between T. 8 and 9 N., R. 35 E., the fault forms scarps and shutter ridges where it cuts older alluvium (Fig. 3, QTa).

The Petrified Spring fault projects into Stewart Valley (Ekren and others, 1976, p. 7) between the Pilot Mountains and Cedar Mountain. Recent mapping in Stewart Valley by M. Molinari, (written commun., 1983) has defined right-slip fault-related structures there in Cenozoic sediments; and rifts in Stewart Valley and on Cedar Mountain that formed during the earthquake of 1932 were regarded by Gianella and Callaghan (1934) as indicating right-lateral horizontal movement. The shutter ridges in older alluvium, together with the earthquake data of 1932, indicate the likelihood of continuing earthquake activity along this system of right-slip faults.

LEFT-SLIP FAULTS

Left-slip faults occur sporadically throughout the map area. The most spectacular of these cuts through Gabbs Valley along the east flank of the Monte Cristo Range (Fig. 3). The fault is poorly exposed compared with the right-slip faults described earlier, but its location can be accurately delineated because of the occurrence of regional drag. The east-dipping Cobble Cuesta lying just east of the fault (Fig. 3 and I-1579) has been dragged from a regional N. 40° E. strike to N. 30° W., and finally to a westerly strike adjacent to the fault zone. The left-slip fault, itself, strikes about N. 30-40° E. The magnitude of drag associated with this fault in the relatively young cobble conglomerate suggest that the total amount of left-slip displacement is large. The Monte Cristo Range on the west side of this major fault may have moved southwestward 16 km. or more relative to Gabbs Valley.

The rocks in Gabbs Valley are indeed relatively young compared to the welded tuffs. The conglomerate that caps Cobble Cuesta is probably Pliocene in age (see I-1579), and the basal part of the underlying Esmeralda Formation in this area has been dated at about 15 m.y. old. This area also is the site of recent fault scarps that formed during an earthquake in 1954. The scarps are not located along the main left-slip fault, but instead they occur along an adjacent north-trending fault showing right-lateral oblique slip (see I-1579).

Individual left-slip faults that seem to have less than 1 km. of displacement are numerous on both sides of the Indian Head right-slip fault which separates the southern Gillis Range from the Gabbs Valley Range (Fig. 3; I-1578). The left-slip faults on both sides of the right-slip fault strike due east to about N. 60° E.--diverging considerably from the N. 30-40° E. strike of the major left-slip fault in Gabbs Valley described above. The left-slip faults in the southern Gillis Range area and southwest flank of the Gabbs Valley Range (Fig. 3), appear to terminate against the Indian Head fault. At least those on the east side of the Indian Head zone terminate against the major fault, whereas those on the west side of the zone either terminate or become indistinct adjacent to the fault. The major right-slip fault and the minor left-slip faults probably formed simultaneously and are part of a single system of conjugate wrench faults.

DETACHMENT FAULTS

The nearly flat detachment faults mentioned previously are an important part of the tectonic fabric of the central Walker Lane as well as farther south in the Lane (see discussion of the Mellan Hills southeast of Tonopah in Ekren and others, 1971, p. 74). Both here and southeast of Tonopah, the "flat" faults appear to be synchronal with strike-slip faulting and also with the development of numerous repetitious listric normal faults.

The best evidence for detachment faulting in the Gabbs Valley Range is the pronounced angular discordance at the contact between Tertiary welded tuffs and the Mesozoic basement rocks. For example, in the range north of Soda Spring Valley, between Rs. 33 and 34 E., the tuffs of the Benton Spring Group (Fig. 3, Tw) dip as steeply as 60° into the nearly flat contact with the underlying Cretaceous granite. The fault zone is concealed throughout this area except in a few prospect pits; however, the occurrence of densely welded tuff dipping 60° only 3 or 4 m. above massive granite or other varieties of Mesozoic rock indicates a structural contact rather than a depositional one. The amount of displacement is probably relatively small--perhaps not more than a few tens or hundreds of meters--even though clay gouge as thick as 1 m. was seen in some of the prospect pits in T. 10 N., Rs. 32 and 33 E.

Detachment faults higher in the Tertiary section, for example at the base of the lavas of Mount Ferguson (Fig. 3, Tlf), are locally spectacular where there are thick zones of gouge and breccia; but elsewhere, flat-fault movements are difficult to prove due to a lack of breccia or gouge. The best exposed and documented detachment faults in this region are in the northern Gillis Range (see Hardyman, this volume).

NORMAL FAULTS

Normal faults are abundant throughout the Gabbs Valley Range and vicinity where two distinct types have been noted: (1) repetitious listric faults that flatten with depth and (2) high-angle normal faults that show no flattening at the current erosional level and presumably penetrate deep into the Mesozoic crust.

LISTRIC FAULTS

Repetitious listric faults are conspicuous features of the Gabbs Valley Range between lat. 38°40' and 38°52' N. (Fig. 3). They are best developed and widely exposed in the Gabbs Valley Range south of Nugent Wash in T. 11 N. and R. 32 E. (between the Benton Spring and Petrified Spring faults). It should be emphasized that only a few of the major faults, exhibiting displacements of at least several tens of meters are shown on Fig. 3 and on maps I-1576 to 1579.

South of Nugent Wash, these faults together with myriad minor parallel faults, when viewed from a distance, resemble bedding planes of thin-bedded strata. In fact, a geologist without a working knowledge of textures in welded tuffs might well consider the closely spaced faults as bedding surfaces. The minor faults have the same attitudes as the major faults with large displacements, but displace the strata only a few centimeters. Both the major and minor listric faults dip 40° to 60° westward in the Nugent Wash and Wildhorse Canyon areas, and they strike parallel to the bounding strike-slip faults (Fig. 3). They are consistently down to the west between Nugent Wash and the Golden Pen Mine in the SW1/4 T. 11 N., R. 32 E., but south of the mine, along the limbs of an anticline, they are down to the east on the west flank and down to the west on the east flank. Still farther south between Wildhorse Canyon and Win Wan Flat (Fig. 7), the faults dip westward as gently as 25° and the beds commonly dip eastward as much as 70° but locally are vertical. Where vertical attitudes prevail, the underlying fault planes probably are nearly flat because with this type of faulting, the beds consistently maintain a near 90° attitude relative to the fault plane (Anderson, 1971, 1973; Proffett, 1977; Angelier and Coletta, 1983). In this area, the Mesozoic rocks exposed in windows beneath the Tertiary strata do not appear to be repetitiously faulted. This fact, together with the steep attitudes of the bedding in the Tertiary rocks (see cross section, Fig. 7), suggest that the listric faults either merge tangentially with the detachment fault or intersect the detachment fault at low acute angles, such as inferred in the cross section (Fig. 7).

The tuffs that are repeated by listric faults in this part of the Gabbs Valley Range, between the Gumdrop Hills and Benton Spring faults, compose the oldest part of the Tertiary volcanic section--principally the Benton Spring Group (29 to 26 m.y.). The rocks affected by listric faults farther east in the Gabbs Valley Range, between the Benton Spring and Petrified Spring faults (Fig. 3), are about 22 to 24 m.y. old and form the younger tuff sequence-principally the Poinsettia Tuff Member of the Hu-pwi Rhyodacite. The two tuff sequences in these separated areas appear to have an equal density of listric faults, even though we have shown only a few of the largest listric faults in Figs. 3 and 7. Comparable to the older tuffs south of Nugent Wash, the tuffs of the Poinsettia are repeated by listric faults (just south of the Poinsettia Mine) where the faults superficially resemble bedding. The eroded faulted sequence resembles giant ocean waves when viewed from the air. Sufficient relief in the Poinsettia area clearly reveals the flattening downward nature of the faults. In some of the deepest canyons, the faults are seen to be nearly flat, and the overlying tuffs of the Poinsettia dip vertically into the fault.

Although the two tuff sequences, ranging in age from probably 29 m.y. to 22 m.y., show equal density of listric faults between the Gumdrop Hills and Benton Spring and between the Benton Spring and Petrified Spring faults, the next overlying volcanic sequence (lavas of Mount Ferguson) appears to be less faulted. We may be deceived, however, because few marker zones are recognizable in the sombre lava pile, and some significant faults undoubtedly were overlooked. Nevertheless, the lavas, which range in age from less than 22 to 15 m.y., dip more gently than the underlying welded tuffs; and inasmuch as the dips of the tuffs are in large part listric-fault dependent and commonly are 60° or more, it probably follows that the lavas with dips as gentle as 5°-10° are relatively unfaulted. The inference that the listric-faulting episode may have largely predated the lavas is supported by many observations that indicate a marked angular unconformity at the base of the lava pile. In some places the lavas rest on wedges or thick lenses of debris or breccia of the Poinsettia Tuff Member and older volcanic rocks. Most of these lenses are intercalated between the lavas and the Poinsettia Tuff Member. These two relations indicate that

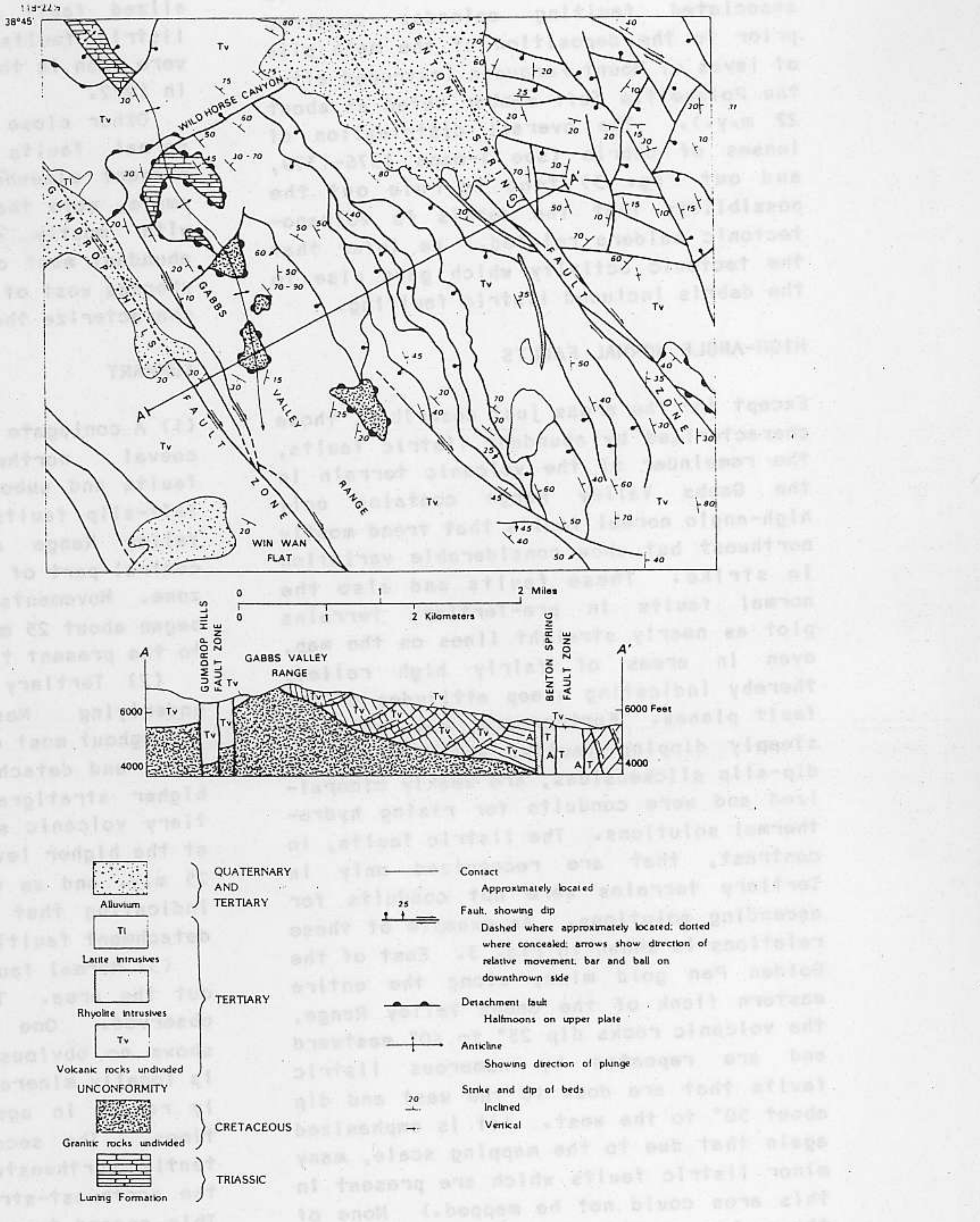


FIGURE 7: Segment of Gabbs Valley Range south of Wildhorse Canyon between Gumdrop Hills fault zone on right. This part of the range is strongly affected by listric normal faults. Normal faults east of the Benton Spring zone are not of the listric type, but in the upper right corner of the map above the right-slip fault, listric faults again dominate. Most of the volcanic rocks in cross-section are massive welded tuffs. Form lines are used to show attitudes. T and A indicate "toward" and "away from" observer in cross-section.

significant tilting of beds related to associated faulting episodes occurred prior to the deposition of the main pile of lavas of Mount Ferguson (extruded after the Poinsettia Tuff member dated at about 22 m.y.). The overall distribution of lenses of debris (see I-maps 1376-1379, and out Fig. 3) tend to rule out the possibility that the debris is volcano-tectonic caldera related. We infer that the tectonic activity which gave rise to the debris included listric faulting.

HIGH-ANGLE NORMAL FAULTS

Except for the areas just described, those characterized by abundant listric faults, the remainder of the volcanic terrain in the Gabbs Valley Range contains only high-angle normal faults that trend mostly northwest but show considerable variation in strike. These faults and also the normal faults in pre-Tertiary terrains plot as nearly straight lines on the map, even in areas of fairly high relief, thereby indicating steep attitudes of the fault planes. Furthermore, some of these steeply dipping faults, which have only dip-slip slickensides, are weakly mineralized and were conduits for rising hydrothermal solutions. The listric faults, in contrast, that are recognized only in Tertiary terrains were not conduits for ascending solutions. An example of these relations is shown in Fig. 3. East of the Golden Pen gold mine, along the entire eastern flank of the Gabbs Valley Range, the volcanic rocks dip 25° to 40° eastward and are repeated by numerous listric faults that are down to the west and dip about 50° to the west. (It is emphasized again that due to the mapping scale, many minor listric faults which are present in this area could not be mapped.) None of the major or minor listric faults are mineralized. At the Golden Pen gold mine, however, a high-angle normal fault was mapped that is down to the east. This fault, which dips 75° to 80° eastward and shows only dip-slip slickensides, is weakly mineralized. The west-dipping listric faults must either abut this east-dipping normal fault at a high angle, probably at a shallow depth, or the mineralized fault cuts directly through the listric faults. No fault intersections were seen in the mine during a brief visit in 1972.

Other close associations of high-angle normal faults and listric faults are present elsewhere. On Fig. 3, for example, note that high-angle normal faults with mostly straight-line traces are abundant east of the Benton Spring fault, whereas west of this fault, listric faults characterize the range.

SUMMARY

(1) A conjugate fault system consisting of coeval northwest-trending right-slip faults and subordinate northeast-trending left-slip faults is present in the Gabbs Valley Range and vicinity within the central part of the Walker Lane structural zone. Movements along these wrench faults began about 25 m.y. ago and have continued to the present time.

(2) Tertiary rocks are detached from underlying Mesozoic basement rocks throughout most of this part of the Walker Lane, and detachment faults also occur at higher stratigraphic levels in the Tertiary volcanic section. Detachment faults at the higher level affect rocks as old as 25 m.y. and as young as 15 m.y., thereby indicating that strike-slip faulting and detachment faulting overlapped in time.

(3) Normal faults are abundant throughout the area. Two major types have been observed. One type with diverse trend shows no obvious flattening downward and is locally mineralized. This type probably ranges in age from 25 m.y. to recent times. The second type strikes consistently northwestward and is parallel to the northwest-striking right-slip faults. This second type comprises listric faults that flatten downward and are inferred to intersect the detachment faults at a low angle. These shallow-rooted listric faults do not appear to have served as major conduits for rising mineralizing solutions; they probably all bottom at the base of the Tertiary section.

(4) Most listric faulting may have occurred during a time span of about 5 to 10 m.y. This period largely followed the

deposition of the Poinsettia Tuff Member of the Hu-pwi Rhyodacite that has been dated at 22-24 m.y., and preceded the extrusions of the main, younger part of the lavas of Mount Ferguson (19 m.y. to about 15 m.y. ago).

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