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TO ACCOMPANY MAP GQ–1710

GEOLOGIC MAP OF THE LA PLATA CANYON QUADRANGLE, CHURCHILL COUNTY, NEVADA

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INTRODUCTION

The La Plata Canyon quadrangle covers about 148 km^2 in the southern Stillwater Range, Churchill County, Nev. (fig. 1, see map sheet). Rocks and deposits exposed in the quadrangle range from Triassic to Holocene in age. The oldest rocks are Triassic and Jurassic metasedimentary and metavolcanic rocks that form three discrete tectonic blocks. The pre-Tertiary rocks were multiply deformed prior to emplacement of a Late Cretaceous granitic pluton and Cretaceous or Tertiary felsites. Pre-Tertiary rocks are unconformably overlain by Oligocene and early Miocene volcanic rocks. Extensional faulting in the early Miocene rotated these rocks as much as 70°; subsequent Miocene volcanic and sedimentary rocks were deposited across a pronounced angular unconformity. Basin-range faulting has continued into Holocene time as indicated by normal faults that cut Quaternary alluvium and by historic (1954) earthquakes.

The geology of the La Plata Canyon quadrangle was mapped in 1987-1993 as part of the Reno Conterminous United States Mineral Assessment Program (CUSMAP) project. Cenozoic geology was mostly mapped by John, and pre-Cenozoic geology was mapped by Silberling. Previous geologic studies of the area include reconnaissance geologic maps by Page (1965) and Willden and Speed (1974), a thesis on Mesozoic rocks in La Plata Canyon by Butler (1979), and brief descriptions of mineral deposits in the La Plata (Mountain Wells) district by Vanderburg (1940), Schrader (1947), Willden and Speed (1974), Quade and Tingley (1987), and Sidder (1987). The geology of the adjacent Table Mountain quadrangle (fig. 1) is shown by John (1992), and John and McKee (1991) and John (1993) discuss the geology of Tertiary rocks in the southern Stillwater Range.

GEOLOGY OF PRE-TERTIARY STRATIFIED ROCKS

Pre-Tertiary stratified rocks in the La Plata Canyon 7.5-minute quadrangle belong to three lithologically and structurally different tectonic blocks. One block consists entirely of phyllite (Mzp) and is predominantly composed of stratigraphically disrupted lower Mesozoic(?) phyllite containing rare interbeds of marble or impure volcaniclastic sandstone. These rocks have affinity with some of those included in the Sand Springs "lithotectonic assemblage" of Oldow (1984) in the Sand Springs Range about 15 km south of the La Plata Canyon quadrangle, as pointed out in the "Description of Map Units". Separated from the phyllite unit (Mzp) by the pre-Tertiary La Plata Fault is another tectonic block formed of Lower Jurassic(?) and Upper Triassic limestones (JTRcl and TRcl) and nonvolcanic siliciclastic argillite (TRca) in a partly coherent stratigraphic succession. These rocks are representative of the Clan Alpine sequence (Speed, 1978), typified by correlative rocks in the Clan Alpine Mountains about 50 km northeast of the map area. However, turbiditic and debris-flow limestones, that in age, lithic character, and association with pelitic rocks are remarkably similar to those of unit TRcl, occur in the Sand Springs "assemblage", as recognized by J.S. Oldow (personal commun., 1992) in the Gillis Range, about 40 km south-southwest of the La Plata Canyon area. Thus, either sections having the lithic character and age of the Clan Alpine sequence are part of different major lithotectonic assemblages, or the partly volcanogenic Sand Springs assemblage is a structural composite of different assemblages. The third major tectonic block in the La Plata Canyon quadrangle is composed of lightly metamorphosed, stratigraphically coherent, volcanic, volcaniclastic, orthoquartzitic, and pelitic rocks, informally designated here the Mountain Well sequence (Jmv, Jms, and Jmd). This sequence is faulted against the Clan Alpine sequence on a variety of cross-cutting faults, most or all of which are of Cenozoic age. The lithologically distinctive Mountain Well sequence is known only in the southern Stillwater Range and is provisionally dated as Middle and (or) Lower Jurassic, the general age of other volcanic-rock and quartzite associations elsewhere in western Nevada.

Uncertainties in the ages of the rocks forming these three tectonic blocks in the La Plata Canyon area allow the possibility that they are structurally juxtaposed parts of a single stratigraphic succession. However, although they share some of the same polyphase deformation, they have partly different metamorphic and structural histories, suggesting that they were brought together by large horizontal displacements. The Clan Alpine sequence in the map area has undergone at least three successive deformations involving folding and faulting. For the most part, rocks of this sequence have little penetrative deformation except in proximity to the La Plata Fault. Three-dimensional megafossils in the Clan Alpine sequence are little distorted only several tens of meters away from this fault, but in closer proximity to the fault, strain in rocks of the Clan Alpine sequence increases dramatically, resulting in the appearance of stretching lineations, ductile minor folds whose hinges are rotated into the lineation direction, and mylonitic fabrics. Crossing the La Plata Fault, the phyllite unit (Mzp) has a generally higher regional metamorphic grade and possibly a more complex structural history than does the Clan Alpine sequence; it evidently underwent pronounced metamorphic deformation in concert with the earliest deformation in the Clan Alpine sequence associated with movement on the La Plata Fault. Because the Clan Alpine sequence generally overlies the phyllite unit on the La Plata Fault, this structure was first described by Page (1965) as a thrust. However, the original orientation and nature of the La Plata Fault prior to subsequent Mesozoic folding and Cenozoic tilting is uncertain.

The youngest well developed compressive structures of the pre-Tertiary strata are northwest-trending, southwest-verging, outcrop and map-scale folds of the Clan Alpine sequence rocks (fig. 2*A*), the La Plata Fault, and the phyllite unit (Mzp) (fig. 2*B*). These are notably brittle structures, in places associated with northwest-striking faults; they represent a final major compressional deformation, designated D3.

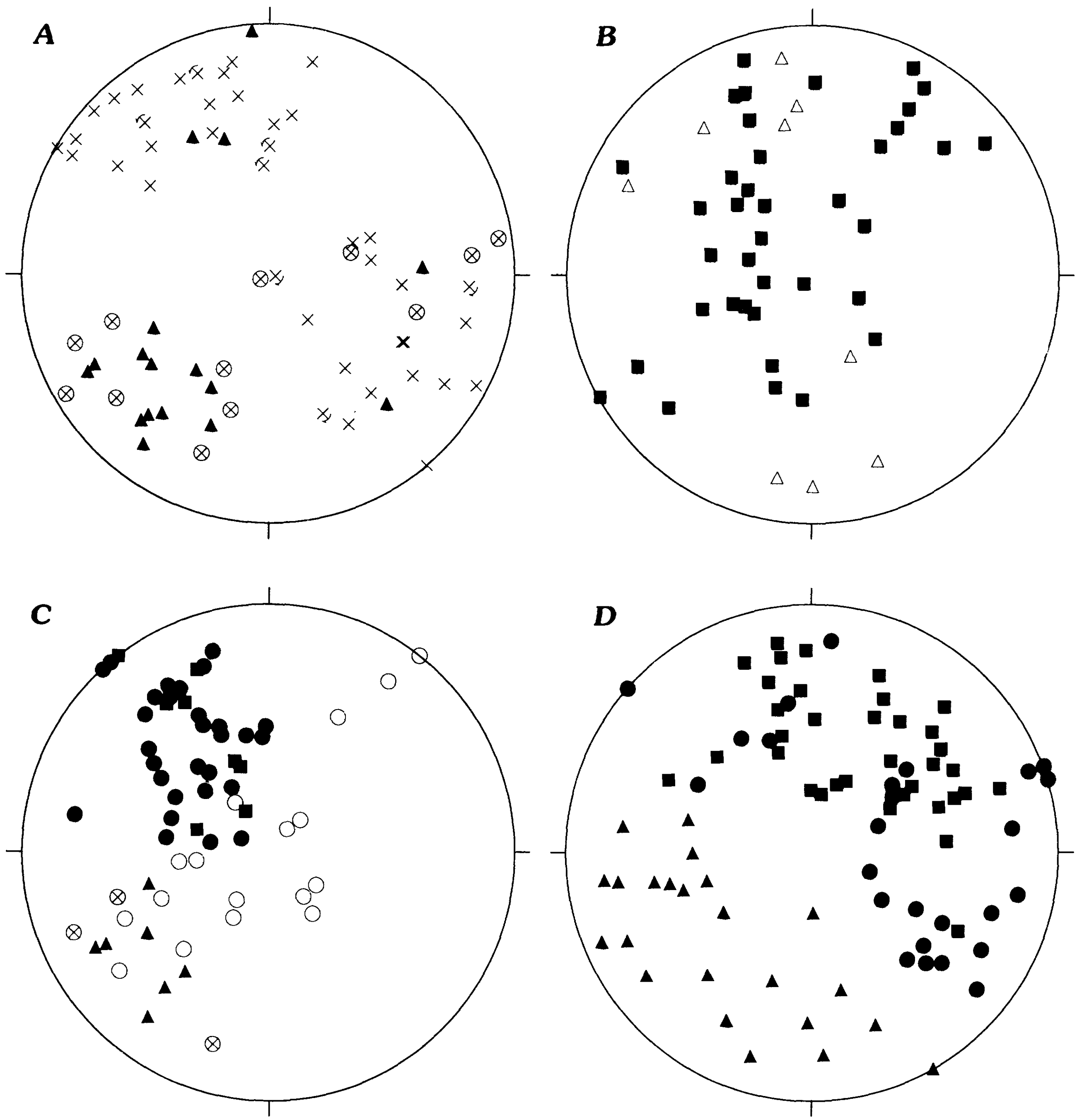
Folds of an earlier deformation, designated D2, affect both the Mountain Well and Clan Alpine sequences, as well as the La Plata Fault and the phyllite unit (Mzp), and are notably more ductile than D3 folds. In the Clan Alpine sequence, D2 is expressed by mesoscopic, tightly appressed to isoclinal folds, regional bedding-parallel foliation, and bedding-foliation lineation. As the Clan Alpine sequence is either upright or overturned over large parts of the outcrop area, D2 may have produced kilometer-scale overturned folds. Axial planes of D2 folds are not plotted on figure 2 but dip shallowly to steeply southeast, as does bedding and foliation of Clan Alpine sequence strata where not directly involved with smaller scale D3 folds (fig. 2*C*).

In the Mountain Well sequence, foliation and foliation-bedding lineation is pervasive except in the most massive dacitic rocks of unit Jmd. Although widely scattered on the stereographic plot (fig. 2*D*), this generally southwest-plunging lineation is similar in direction to that in the Clan Alpine sequence, which along with similarly trending minor-fold axes, are ascribed to D2 deformation (fig. 2*A*, *C*). Bedding in different outcrops of the Mountain Well sequence is both upright and overturned and is generally at a small angle to foliation, suggesting at least local isoclinal folding of these rocks, but no mesoscopic folds were observed. The scatter of apparently D2 fabric elements in rocks of the Mountain Well sequence (fig. 2*D*) suggests later rotation around a shallow northeast-trending fold axis, but this could be attributed to variable Cenozoic tilt instead of a phase of folding not recognized in the other pre-Tertiary stratified rocks.

The oldest and most penetrative deformation, designated D1, is expressed in the rocks on either side of the La Plata Fault whose original displacement is evidently an effect of this deformation. The mylonitic strain gradient in the Clan Alpine sequence, mentioned above as increasing towards this fault, is an effect of D1 deformation as are metamorphic fabrics in unit Mzp. Where not too disrupted by outcrop-scale brittle D3 folds and by reactivation of the fault surface, the D1 mylonitic foliation and conspicuous stretching lineation in the Clan Alpine sequence near the fault are parallel to the metamorphic foliation and andalusite growth lineation in unit Mzp, respectively, on the other side of this fault. Since figures 2*A* and 2*B* were drawn, nine additional measurements of D1 lineation were made in unit Mzp and eight in unit Ћcl of the Clan Alpine sequence. Lineations in both units cluster on a stereographic plot and plunge shallowly to moderately either north-northwest or south-southeast. D1 folds are not adequately characterized, and separation of D1 from D2 foliation is not understood.

The original shear sense on the La Plata Fault is shown in mylonitic, impure limestone of the Clan Alpine sequence by thin sections and hand specimens collected from within a few meters of the fault about 0.5 km west-southwest from elevation point 6,340 on the divide west of La Plata Canyon. Along this part of the fault zone, where it is not too disrupted by brittle D3 structures, the shear zone dips gently to moderately northwest, and the plunge of associated lineations is gently to the north or north-northwest, like that of the three lineations included on figure 2*A* that plot apart from the other lineations and ductile fold axes plotted on this figure. Asymmetry in the shear fabric, such as pressure shadows associated with porphyroclasts, indicates a top to the the north sense of shear. However, without better characterizing D2 folding, subsequent reorientation to the opposite sense of shear remains a possibility.

Pre-Tertiary structures have been significantly reoriented by major Cenozoic structures. In the La Plata Canyon quadrangle, the attitude of compaction foliation in the older Tertiary tuff units, such as the tuff of Elevenmile Canyon, varies widely but is fairly consistent within each of the four Cenozoic domains (fig. 3) represented by figure 4*A*-*D*. The mean tilts of these domains are generally down to the east by amounts ranging from about 25° to 60° around mean strikes ranging from N. 25° W. to N. 43° E. Several observations indicate that the pre-Tertiary rocks have undergone Cenozoic rotation along with the earlier Tertiary caldera-fill tuffs. First, a large rotation is necessary to restore the moderate to subvertical orientation of the inferred depositional contact between pre-Tertiary rocks and highly tilted older Tertiary volcanic rocks (tuff of Elevenmile Canyon) on the drainage divide between La Plata and Elevenmile Canyons. Second, the present reverse-fault geometry of the Tertiary caldera-boundary fault, as exposed locally in Elevenmile Canyon, suggests appreciable Cenozoic tilt. If this fault and the pre-Tertiary rocks on its southwest side were tilted coincident with the tuff of Elevenmile Canyon, then rotation of the tuff to horizontal around its general strike in nearby outcrops restores the fault to a more plausible, subvertical to normal fault configuration. Finally, the most compelling additional evidence that pre-Tertiary strata were involved in Cenozoic tilting is provided by paleomagnetic directions indicating that the La Plata Canyon pluton, which clearly intrudes both phyllite (Mzp) and the Clan Alpine sequence, has experienced pronounced eastward tilting (Mark R.



EXPLANATION

- ● Pole to bedding
- ○ Pole to bedding in map-scale D3 brittle fold or fault-related fold within Clan Alpine sequence
- ■ Pole to foliation
- ⊗ Axis of ductile D1 fold in Clan Alpine sequence
- Axis of D3 brittle fold in Clan Alpine sequence, arrows show sense of rotation as viewed down plunge
- ▲ Stretching lineation
- △ Mineral-growth or grain-stretch lineation in early Mesozoic(?) phyllite (Mzp)

Figure 2.—Lower hemisphere, equal-area projection, structural-fabric diagrams. *A*, Clan Alpine sequence in lower part and west of La Plata Canyon. Lineations plunging north-northwest represent D1; those plunging southwest represent D2. *B*, Early Mesozoic(?) phyllite in lower plate of La Plata Fault. *C*, Clan Alpine sequence in upper part and east of La Plata Canyon. *D*, Mountain Well sequence.

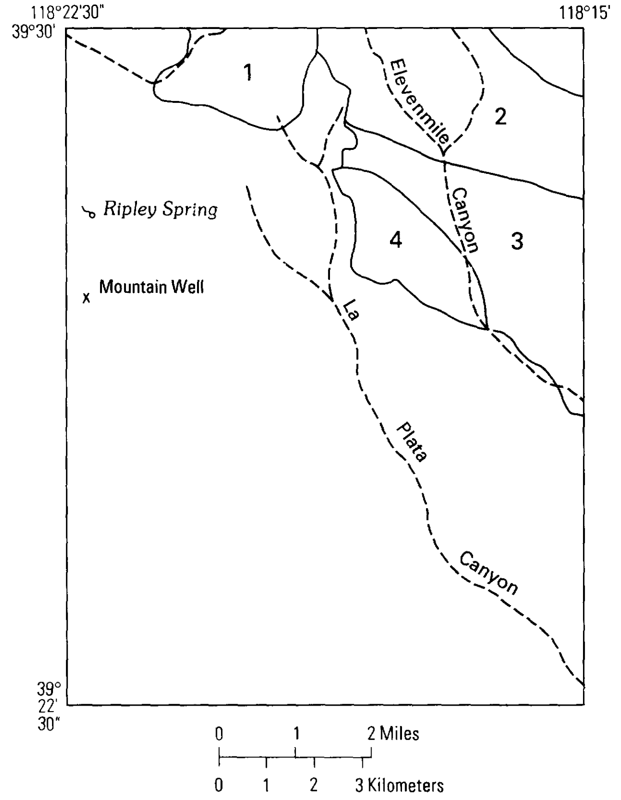


Figure 3.—Outline of La Plata Canyon quadrangle showing structural blocks in the tuff of Elevenmile Canyon. Blocks are defined on the basis of changes in orientation of compaction foliation and are separated by a major mapped fault (block 1 from block 2), by an inferred major fault (block 3 from block 4), or by a rhyolite dike swarm that is inferred to intrude major fault zone (block 2 from block 3).

Hudson, U.S. Geological Survey, written commun., 1989). Unfortunately, the scatter in these paleomagnetic directions presently prevents precise statistical determination of the amount and direction of tilt.

A large correction for generally down-to-the-east Cenozoic tilt is thus required before the geometry of pre-Tertiary structural features of the La Plata area can be compared with that of other outcrop areas in western Nevada, but the choice of an average amount and axis of tilt for restoration of pre-Tertiary directions is poorly constrained. The geometry of tilt differs among the various Cenozoic domains, and different blocks within the pre-Tertiary outcrop area are bounded by large Cenozoic faults and may have had geometries of Tertiary tilt still different from those of the Cenozoic rocks.

If Cenozoic tilt to the east about a generally north-trending axis was only moderate in amount, the three successive pre-Tertiary deformations in rocks of the La Plata Canyon quadrangle could correspond to the three major phases of deformation recognized regionally by Oldow (1984) in western Nevada. Of these, Oldow's "D2" and "D3" faults and folds are characteristic of "Luning-Fencemaker" deformation and would originally have had traces trending respectively northeast and northwest; his "D1" deformation is seen only in the Sand Springs "lithotectonic assemblage" and in the more western and structurally higher Mesozoic allochthons of western Nevada. If, on the other hand, Cenozoic tilt is more than about 60° to the east, the axial surfaces of folds designated D3 in the La Plata area would restore upon correction for tilt to a northeast strike like those of Oldow's regional "D2" folds; structures designated D1 and D2 in the La Plata area would then presumably represent a polyphase "D1" generation in Oldow's scheme. In either case, recognition of the regional "D1" generation of deformation in the La Plata area is reason to include at least unit Mzp in the Sand Springs "lithotectonic assemblage" of Oldow (1984).

LA PLATA CANYON PLUTON AND TERTIARY OR CRETACEOUS FELSITES

Pre-Tertiary stratified rocks are intruded by the La Plata Canyon pluton (Klp) and felsite (TKf) bodies between Elevenmile Canyon and the vicinity of Ripley Spring. The La Plata Canyon pluton is a composite intrusion consisting of relatively leucocratic, fine- to medium-grained, biotite granite and quartz monzonite and numerous irregular bodies of aplite, alaskite, and pegmatite. Two major bodies of this pluton are present; the small northern body forms part of the floor of a Tertiary caldera (Elevenmile Canyon caldera) that lies on the ridge separating Elevenmile and La Plata Canyons. The La Plata Canyon pluton intrudes rocks of the Clan Alpine sequence and the phyllite unit and crosscuts folds in these rocks and the folded trace of the La Plata Fault (see section *A-A'*). The pluton has not been directly dated, but coarse-grained muscovite from a selvage on a fluorite vein in pre-Tertiary wallrocks near the south margin of the pluton yielded a K-Ar age of 84 Ma which suggests that the pluton is Late Cretaceous in age (Garside and others, 1981).

Several bodies of altered, sparsely porphyritic felsite intrude rocks of the Clan Alpine and Mountain Well sequences between La Plata Canyon and Ripley Spring. In La Plata Canyon, contacts between felsite dikes and leucocratic parts of the La Plata Canyon pluton are gradational and arbitrarily drawn. The felsite unit is structureless and lacks tectonically flattened conglomerates that are present in similar appearing rocks in the Mountain Well sequence (unit Jmd). Most contacts with Tertiary rocks are faults, although the older andesite (unit Toa) may unconformably overlie the felsite unit about 3 km east of Ripley Spring. Many contacts of the felsite with older Tertiary rocks are fault contacts, in contrast to similar appearing silicic intrusions of late Tertiary age (unit Tsi) that commonly intrude these faults. The felsite unit has not been directly dated but is inferred to be Cretaceous or early Tertiary in age on the basis of gradational contacts with the La Plata Canyon pluton, intrusive relations with the Mountain Well sequence, and fault and (or) unconformable contacts with Tertiary rocks.

GEOLOGY OF CENOZOIC ROCKS

Cenozoic rocks in the La Plata Canyon quadrangle consist of thick sequences of upper Oligocene to lower Miocene silicic to intermediate composition ash-flow tuffs and intermediate lavas that are unconformably overlain by lower to middle Miocene, fine-grained to very coarse grained, continental sedimentary rocks. Both groups of older rocks are unconformably overlain by middle Miocene intermediate to mafic lavas. The Oligocene and early Miocene rocks are intruded by numerous dikes, domes, and plugs of silicic to intermediate composition. Thick deposits of consolidated and unconsolidated alluvium and talus of late Tertiary(?) and Quaternary age blanket large parts of the quadrangle, particularly in the south half.

The oldest Tertiary rocks exposed in the quadrangle are propylitized andesite and basalt(?) lava that crops out southeast of Ripley Spring. Although these rocks are undated and everywhere in fault contact with pre-Tertiary rocks, they probably are middle to late Oligocene in age based on ages of dated rocks in adjacent ranges (Willden and Speed, 1974; Stewart and McKee, 1977; Best and others, 1989).

Faulted against the older lavas is the tuff of Elevenmile Canyon (Tec). This ash-flow tuff is the most widespread Tertiary volcanic unit in the La Plata Canyon quadrangle and covers much of the north half of the quadrangle. The tuff of Elevenmile Canyon is a thick (greater than 3? km), mostly intracaldera, densely welded, crystal-rich rhyolitic to dacitic tuff that is believed to have been erupted from a source in or near Elevenmile Canyon. The south wall of the caldera is preserved in the southeastern part of Elevenmile Canyon, where the tuff of Elevenmile Canyon is faulted against Mesozoic(?) metamorphic rocks, and part of the floor of the caldera also may be preserved along the north-trending ridge that separates Elevenmile and La Plata Canyons. Numerous lenses of megabreccia are enclosed within the tuff near Elevenmile Canyon. The megabreccia includes blocks of the older Tertiary andesitic lavas as well as Mesozoic(?) rocks that are meters to tens of meters in diameter. Many of the blocks are internally shattered and cemented with silicified rock flour. Most of the tuff of Elevenmile Canyon is hydrothermally altered, but biotite from a sample collected in the Table Mountain quadrangle yielded a K-Ar age of 24.5±0.9 Ma (E.H. McKee, written commun., 1989).

The tuff of Poco Canyon (Tpc) is faulted against the tuff of Elevenmile Canyon in the northeast corner of the quadrangle. The tuff is a crystal-rich rhyolite and high-silica rhyolite ash-flow tuff that probably fills a structurally dismembered caldera located near the center of the Table Mountain quadrangle, about 10 km north of the La Plata Canyon quadrangle (John, 1992, 1993). Two cooling units of the tuff of Poco Canyon are present locally; tuff exposed in the La Plata Canyon quadrangle is believed to be part of the lower cooling unit. In the La Plata Canyon quadrangle, the tuff is pervasively hydrothermally altered, but K-Ar ages of 24 to 23 Ma were obtained on biotite and sanidine from samples of the upper cooling unit collected in the Table Mountain quadrangle (E.H. McKee, written commun. 1987). Chemical and modal data, regional distribution, and similar K-Ar ages suggest that the tuff of Poco Canyon may be equivalent to the New Pass Tuff and the tuff of Chimney Spring, which are widespread units in west-central Nevada and eastern California (Deino, 1985; Best and others, 1989; John, 1993).

The ash-flow tuffs and older andesites are unconformably overlain and faulted against a unit of water-laid(?) silicic tuff, tuffaceous sedimentary rocks, and silicic lavas (Tst). In the La Plata Canyon quadrangle, this unit is found primarily in the upper plates of low-angle normal faults of unknown displacement near the south limit of exposures of the tuff of Elevenmile Canyon. The origin of this unit is uncertain but its distribution and general association with the tuff of Elevenmile Canyon suggests that it represents caldera fill deposited into the Elevenmile Canyon caldera.

Numerous silicic domes and dikes intrude, and minor tuffs and epiclastic sedimentary rocks, overlie the pre-Tertiary rocks and older Tertiary volcanic rocks. At least four major textural varieties of intrusive rocks are present: (1) coarsely porphyritic hornblende-biotite-quartz-K-feldspar-plagioclase porphyry, (2) aphyric to sparsely porphyritic, fine-grained quartz-feldspar rhyolite, (3) fine-grained biotite rhyolite, and (4) sparsely porphyritic, medium-grained plagioclase-K-feldspar rhyolite. Many dikes are composite and contain more than one textural variety. Most of the larger bodies in the southern Stillwater Range are variety 4 and are shown as a separate unit on the map (rhyolite, unit Tr).

The ash-flow tuffs, older andesitic lavas, and rhyolite intrusions are unconformably overlain by early and (or) middle Miocene fluvial and lacustrine sedimentary rocks (Ts). The sedimentary rocks consist of pebble conglomerate, sandstone, siltstone, shale, and minor freshwater limestone. Near Mountain Well coarse landslide or debris-flow deposits (Tlb) laterally interfinger with the basal(?) part of the sedimentary rocks. The landslide deposits contain unsorted blocks as much as tens of meters across of the older andesite, the tuff of Elevenmile Canyon, and silicic intrusive rocks units but lack blocks of pre-Tertiary and younger Tertiary volcanic rocks; the clast association indicates that the landslide deposits formed during initial faulting and uplift of the southern Stillwater Range prior to deep erosion of the older Tertiary volcanic rocks and eruption of the younger Tertiary units. The upper part of the sedimentary rocks unit locally contains thin layers of intermediate to mafic tuff and basalt scoria.

The sedimentary deposits are overlain, locally with minor angular discordance, by middle Miocene intermediate and mafic lava flows, flow breccias, and lahars. The oldest lavas are 15-Ma hornblende and pyroxene andesite and dacite lavas that crop out east, west, and south of Mountain Well. A small plug that probably was a feeder for some of these lavas crops out about 3 km south of Mountain Well. The andesitic lavas interfinger laterally southward, westward, and northward with basaltic lava flows whose age is about 13-14.5 Ma. Several small basalt plugs and dikes crop out between Mountain Well and Ripley Spring.

Widespread gravel deposits of late Tertiary and (or) early Quaternary age (QToa) blanket much of the south half of the quadrangle. These gravels contain abundant clasts of pre-Tertiary rocks, andesite, and basalt, in contrast to the older Miocene debris deposits in which clasts of pre-Tertiary rocks are scarce. Tertiary(?) and Quaternary surficial deposits, including younger alluvium (Qya), talus (Qt), and eolian(?) sand (QTs), locally cover all older deposits.

The structural history of Cenozoic rocks in the southern Stillwater Range is complicated by superposition of two or more periods of extensional faulting and tilting and by the lack of marker units in the intracaldera tuff of Elevenmile Canyon, which inhibits recognition of faults. At least two major periods of tilting and extensional faulting are evident in the older Tertiary rocks: earliest Miocene and late Miocene to Holocene. Late Oligocene to early Miocene ash-flow tuffs and lavas are moderately to steeply tilted around northwest- to northeast-trending axes. In the La Plata Canyon quadrangle and the southern part of the Table Mountain quadrangle, nearly all of the older Tertiary volcanic rocks dip to the east, whereas Tertiary rocks farther north in the northern part of the Table Mountain quadrangle and in the southern part of the Cox Canyon quadrangle dip steeply west. The change in direction of dip in the Table Mountain quadrangle takes place in an area that contains numerous silicic intrusions, which were probably emplaced into a major east-west-trending structural zone. Four structural blocks separated by major faults or inferred faults have been recognized in the tuff of Elevenmile Canyon in the La Plata Canyon quadrangle (fig. 3). The amount of tilt based on average orientation of compaction foliation is fairly consistent within each of these blocks but varies significantly between blocks (fig. 4). Three of the blocks have an average compaction foliation orientation that strikes N. 30–45° E. but have dips varying from 25° to 60° SE. (figs. 4*A*, *B*, *C*). A fourth block that includes the floor of the Elevenmile Canyon caldera has an average orientation of N. 25° W. 42° NE. (fig. 4*D*). Elsewhere in the southern Stillwater Range, as much as 50–90° of tilting took place during early Miocene faulting, as shown by angular unconformities between ash-flow tuffs and overlying Miocene sedimentary rocks and lava flows. Field relations between silicic intrusions and ash-flow tuffs, paleomagnetic data (Hudson and others, 1993), and K-Ar dating indicate that tilting and formation of low-angle normal faults took place shortly after eruption of the tuffs of Elevenmile Canyon and Poco Canyon, during and just prior to emplacement of numerous silicic intrusions. Tilting involved both pre-Tertiary and Tertiary rocks as indicated by tilting of the margins of several calderas (John and McKee, 1991; John, 1993) and paleomagnetic data (see discussion in section "Geology of pre-Tertiary stratified rocks") and probably resulted from large-scale crustal extension similar to early Miocene extension described in the Yerington mining district, Nevada, about 90 km southwest of the La Plata Canyon quadrangle (Proffett, 1977; Proffett and Dilles, 1984). At least part of the tilting took place during movement along shallow west-dipping, curviplanar faults in the tuff of Elevenmile Canyon; these faults may be similar to shallow-dipping, spoon-shaped faults described by Proffett (1977) in the Yerington mining district. Undoubtedly, the great apparent thickness of the homogeneous tuff of Elevenmile Canyon is in part due to repetition by unrecognized faults (see section *A-A'*).

A brief, possibly transient, change in the stress field may be indicated by the swarm of west-northwest-trending silicic dikes that intrude the tuff of Elevenmile Canyon in Elevenmile Canyon and continue eastward across Dixie Valley to the Louderback Mountains, about 15 km east of the La Plata Canyon quadrangle (fig. 1, see map sheet). The dikes cut low-angle normal faults that separate the tuff of Elevenmile Canyon from unit Tst, and the dikes are locally unconformably overlain by Miocene sedimentary rocks. A biotite age of 18.3±0.5 Ma was obtained for one of these dikes (E.H. McKee, oral commun., 1991). The dikes probably indicate north-northeast--south-southwest extension. In contrast, early Miocene and Holocene extension directions are oriented approximately east-west to west-northwest--east-southeast. The dikes may have emplaced during an "instantaneous" change in the state of stress as opposed to a change in the long-term state of stress indicated by fault orientations and direction of tilting (see, Best, 1988, p. 256).

A second major period of extensional faulting and tilting is related to modern Basin and Range extension and continues to the present day. The younger andesites and basalts (units Tya, Tha, and Tb) are gently tilted to the west by north- to north-northeast-trending normal faults. There is Holocene movement on a few faults in the quadrangle, and scarps from the 1954 Dixie Valley earthquake are present about 3 km east of the La Plata Canyon quadrangle.

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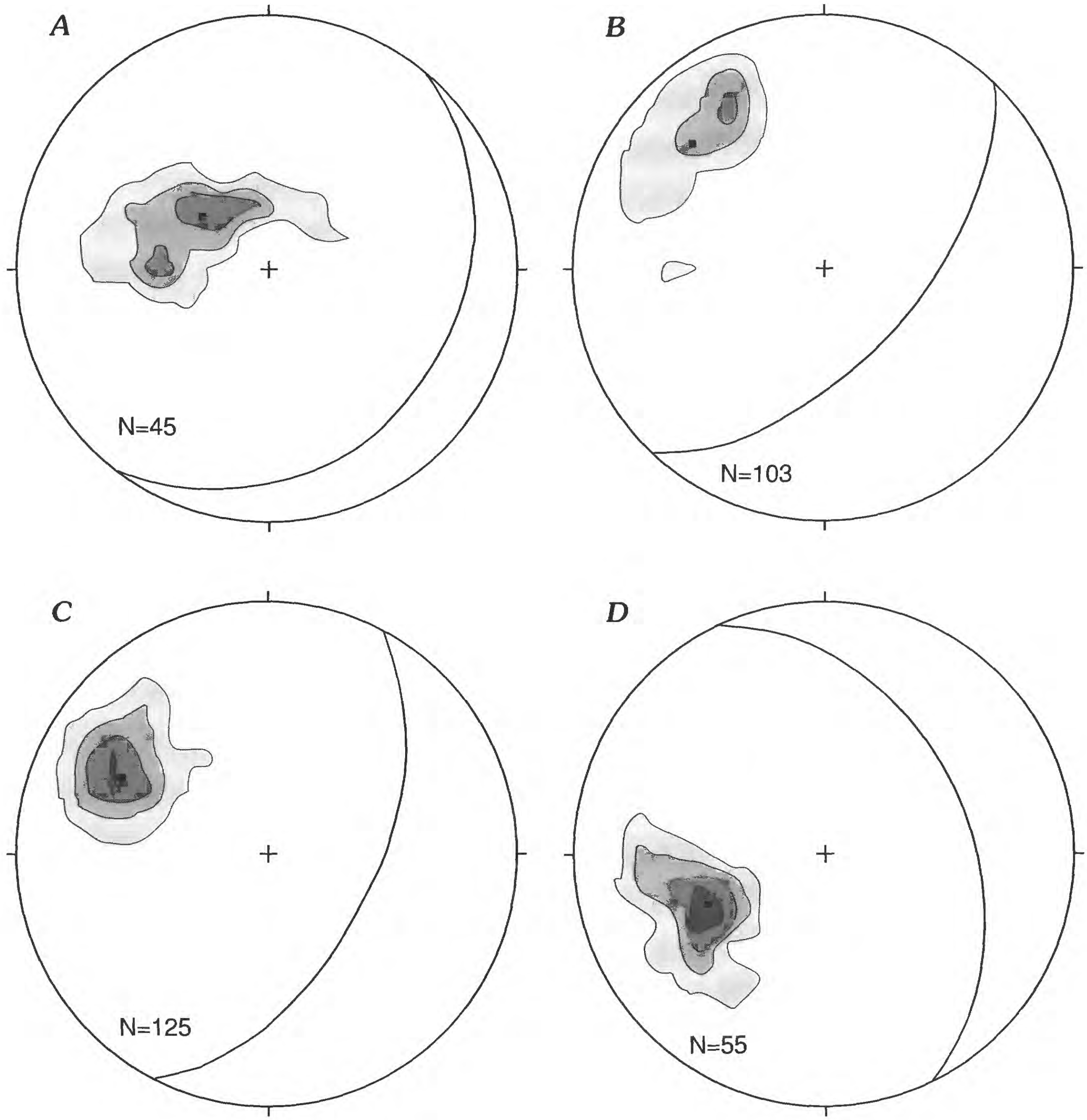

Figure 4.—Contoured, lower hemisphere, equal-area projection diagrams of poles to compaction foliation in the tuff of Elevenmile Canyon. Location of blocks shown in figure 3. Square, mean pole; N, number of measurements. A, Block 1, northwest block. Contours at 4 (lightest), 8, and 12 (darkest) percent per 1 percent area. Strike and dip of average foliation N. 38° E.; 25° SE. B, Block 2, northeast block in Elevenmile Canyon. Contours at 4 (lightest), 8, and 12 (darkest) percent per 1 percent area. Strike and dip of average foliation N. 43° E.; 60° SE. C, Block 3, main block of exposures south of west-northwest-trending rhyolite dike swarm in Elevenmile Canyon. Contours at 4 (lightest), 8, 12, and 16 (darkest) percent per 1 percent area. Strike and dip of average foliation N. 27° E.; 55° SE. D, Block 4, south-central block including floor of the Elevenmile Canyon caldera. Contours at 4 (lightest), 8, 12, and 16 (darkest) percent per 1 percent area. Strike and dip of average foliation N. 25° W.; 42° NE.

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