Text to accompany NBMG Field Studies Map 5

GEOLOGIC MAP OF THE JOB PEAK QUADRANGLE, NEVADA

by

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The Job Peak Quadrangle covers about 150 km^2 in the southern Stillwater Range, Churchill County, Nevada (fig. 1). Rocks and deposits exposed in the quadrangle are Oligocene to Holocene in age, although Mesozoic metamorphic rocks crop out about 6 km to the south in the Pirouette Mountain Quadrangle and Mesozoic plutonic rocks crop out about 6 km to the southwest in the La Plata Canyon Quadrangle (fig. 1; John and Silberling, 1993). The oldest rocks exposed in the area are Oligocene to earliest Miocene volcanic and plutonic rocks. These rocks underlie and fill parts of three small calderas (fig. 2). As a result of extensional faulting in the early Miocene, these rocks were tilted as much as 90° and subsequently were overlain unconformably by volcanic and sedimentary rocks of middle Miocene age that are exposed mostly west and south of the Job Peak Quadrangle (John, 1993). Basin and Range faulting has continued into Holocene time as indicated by historic (1954) earthquakes along the range front and other normal faults that cut unconsolidated alluvium.

The geology of the Job Peak Quadrangle was mapped in 1986-1991 as part of the Reno 1° by 2° project of the Conterminous United States Mineral Assessment Program (CUSMAP) and completed in 1992 under the auspices of the Nevada Bureau of Mines and Geology Geologic Quadrangle Mapping Program. Previous geologic maps of the area include reconnaissance maps by Page (1965) and Willden and Speed (1974). Nelson (1975) described the IXL pluton. Geologic maps of the adjacent Table Mountain and La Plata Canyon Quadrangles have been published by John (1992) and John and Silberling (1993), respectively. John (1993) summarized the late Cenozoic geologic history of the southern Stillwater Range. Numerous studies of Dixie Valley and the Dixie Valley fault were published after the 1954 earthquakes. These studies include Byerly (1956), Slemmons (1956, 1957), Thompson and others (1967), Thompson and Burke (1973), Anderson and others (1983), Okaya and Thompson (1985), Bell and Katzer (1987, 1990), Schaefer (1988), and Parry and others (1991).

ROCK UNITS

Thick sequences of upper Oligocene and lower Miocene ash-flow tuffs of silicic to intermediate composition and lavas of intermediate composition are exposed in the Job Peak Quadrangle. Most of these rocks are related to the Stillwater caldera complex, which consists of three partly overlapping calderas (fig. 2; John, 1993). These rocks are intruded by granite to quartz monzodiorite plutons that are believed to represent the roots of the calderas. The upper Oligocene and lower Miocene rocks are intruded by numerous dikes, domes, and plugs of silicic to intermediate composition and scattered diabase dikes of middle Miocene age. Thick deposits of consolidated and unconsolidated alluvium and talus of Quaternary age blanket the east half of the quadrangle, filling Dixie Valley.

The oldest rocks exposed in the quadrangle are silicic to intermediate composition ash-flow tuffs (older tuff unit, Tot) and rhyolite lavas and shallow intrusive rocks (older rhyolite unit, Tor). Ash-flows tuffs in the older tuff unit represent several ash flows from unknown sources probably outside of southern Stillwater Range. The ash flows are discontinuously exposed below and interbedded with the older rhyolite unit (Tor) which consists of crystal-poor, commonly flow-banded rhyolite and minor welded tuff. The older rhyolite probably formed a large flow-dome complex which underlay the northwest part of the Job Canyon Quadrangle. The older rhyolite and older tuff units are undated because of pervasive deuteric alteration and(or) thermal metamorphism, but they are probably about 36 to 29 Ma in age based on ages of dated rocks in adjacent ranges (Willden and Speed, 1974; Stewart and McKee, 1977; Best and others, 1989) and the 29- to 28-Ma age of the cross-cutting IXL pluton.

The older volcanic rocks are overlain by rocks related to the Job Canyon caldera (fig. 2). In the Job Peak Quadrangle, these rocks consist of dacite and andesite porphyry lava flows and intrusive rocks (Tda) and the tuff of Job Canyon. The dacites and andesites form a large sill and dike complex that intrudes the older rhyolite (Tor) and older tuff (Tot) units. Lithologically similar lava flows overlie the older rhyolite unit and are as much as 800 m thick. This unit is undated because of pervasive propylitic alteration.

The tuff of Job Canyon overlies the older rhyolite and dacite and andesite units. In the Job Peak Quadrangle, two cooling units of this tuff are present. The lower cooling unit consists of densely welded, locally rheomorphically folded, crystal-poor rhyolite tuff that is as much as 1,100 m thick. The upper cooling unit is much more widespread, notably in the adjacent Cox Canyon Quadrangle, and consists of lithic-rich, crystal-poor, densely welded rhyolite tuff

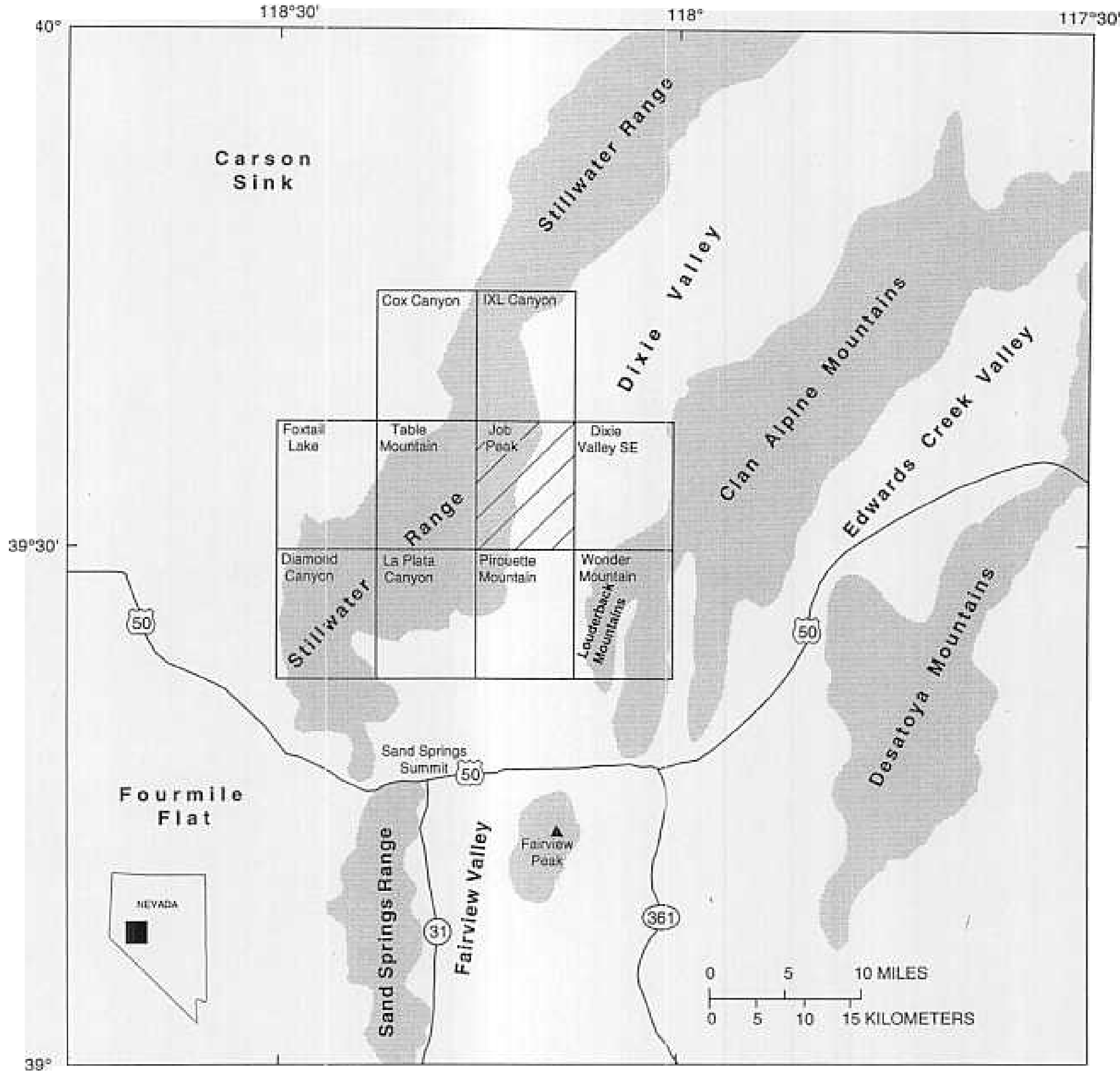

FIGURE 1. Index map of west-central Nevada, showing location of Job Peak Quadrangle (hatched) and other nearby quadrangles and major physiographic and geographic features.

that is about 1,000 m thick in the Job Peak Quadrangle but more than 2,000 m thick in West Job Canyon in the Cox Canyon Quadrangle. The upper cooling unit locally contains coarse blocks of andesite (a) along the crest of the range north of Job Peak.

A unit of andesite and dacite lavas, breccias, and shallow intrusive rocks (Tad) locally overlies and intrudes the tuff of Job Canyon in the northwest corner of the Job Peak Quadrangle. These rocks were emplaced along a complex structural zone that separates the Job Canyon caldera into two structural blocks and was later reactivated to form the northern margin of the Poco Canyon and Elevenmile Canyon calderas (fig. 2; John, 1993; John and Pickthorn, 1993). These rocks may be equivalent to a thick (2+ km) sequence of intermediate lavas that ponded inside the Job Canyon caldera in the Cox Canyon Quadrangle.

The tuff of Job Canyon and the older rhyolite unit are intruded by the IXL pluton along the north edge of the Job Peak Quadrangle. Most of the IXL pluton lies north of the Job Peak Quadrangle in the IXL Canyon Quadrangle. The IXL pluton consists of biotite-hornblende granodiorite and quartz monzodiorite. The texture of pluton ranges from a fine- to medium-grained porphyry along its margins and west side to medium-grained, equigranular rock in its central part and east side. The pluton also becomes more mafic from west to east. The IXL pluton is about 29 to 28 Ma in age (Speed and Armstrong, 1971; E. H. McKee, written commun., 1987). The location (fig. 2), age, and chemical composition (John, 1993) of the IXL pluton suggests that it is genetically related to the tuff of Job Canyon and forms the roots of the Job Canyon caldera.

The tuff of Poco Canyon is faulted against the tuff of Job Canyon and the older rhyolite unit and both underlies and overlies the tuff of Elevenmile Canyon. This tuff is a compound cooling unit of generally densely welded, crystal-rich rhyolite and high-silica rhyolite ash-flow tuff. The tuff fills the structurally dismembered Poco Canyon caldera, which is located near the center of the Table Mountain Quadrangle west of the Job Peak Quadrangle (figs. 1 and 2). The northern margin of the caldera lies near the northwest corner of the Job Peak Quadrangle. In the Job Peak Quadrangle, only the lower cooling unit of the tuff is exposed and is as much as 1,500 m thick. This cooling unit is overlain locally by as much as 200 m of sandstone and sedimentary breccia (Tsb) derived largely from the tuff of Poco Canyon. K-Ar ages of 24.5 and 23.3 Ma were obtained on biotite and sanidine, respectively, from samples of the upper cooling unit collected in Poco Canyon in the Table Mountain Quadrangle (E. H. McKee, written commun. 1987). Chemical and modal data, regional distribution, similar K-Ar ages, and a preliminary single crystal $^{40}Ar/^{39}Ar$ age of 25.0 Ma on sanidine (A. L. Deino, oral commun., 1991) suggest that the tuff of Poco Canyon is a facies 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). These correlations suggest that the Poco Canyon caldera is the source of these units. However, H. F. Bonham, Jr. (oral commun., 1992) suggests that the source of the tuff of Chimney Springs is in the Pah Pah Range, and thus the tuff of Poco Canyon and the tuff of Chimney Springs are not correlative.

The tuff of Elevenmile Canyon fills the Elevenmile Canyon caldera, which is exposed in the Job Peak Quadrangle and in adjacent quadrangles to the west, southwest, and south (Table Mountain, La Plata Canyon, and Pirouette Mountain Quadrangles, figs. 1 and 2); the northwest margin of the caldera is poorly preserved in the northwest corner of the map area. The caldera is recognized by extraordinarily thick sections of welded tuff (as thick as 3 km) and by thick zones of megabreccia along its northern and southern walls. Most of the tuff of Elevenmile Canyon is densely welded, crystal-rich rhyolite to high-silica andesite ash-flow tuff that is fairly heterogeneous and probably consists of many ash-flows; a poorly welded horizon exposed discontinuously between East Lee and Coyote Canyons suggests at least a partial cooling break. Most of this tuff has undergone pervasive propylitic alteration, but a relatively fresh sample collected near the north end of exposures in the Table Mountain Quadrangle yielded a biotite K-Ar age of 24.5 ± 0.9 Ma (E. H. McKee, written commun., 1989).

Near the northwest corner of the Job Peak Quadrangle, the tuff of Elevenmile Canyon is overlain by the megabreccia of Government Trail Canyon, a heterogeneous unit of lithic-rich, crystal-poor ash-flow tuff and megabreccia that is as much as 1,800 m thick. This unit consists of unsorted blocks derived from the tuffs of Job Canyon and Poco Canyon and the older rhyolite unit that are as much as several hundred meters in maximum dimension in a moderately welded ash-flow tuff matrix. The tuff matrix is locally brecciated forming blocks in a matrix of similar-appearing tuff. The origin of this unit is uncertain; it clearly represents ash-flow tuff and breccia deposited during caldera collapse, but it is megascopically unlike caldera fill exposed either above or below it. It may have formed during late-stage collapse of the Elevenmile Canyon caldera, during collapse of a small caldera with no recognized outflow products, or during early collapse of the Poco Canyon caldera. The megabreccia of Government Trail Canyon is depositionally overlain by the upper cooling unit of the tuff of Poco Canyon in the Table Mountain Quadrangle.

The tuff of Lee Canyon depositionally overlies the tuffs of Poco Canyon and Elevenmile Canyon in the Table Mountain Quadrangle, but in the Job Peak Quadrangle, most contacts between the tuff of Lee Canyon and the tuff of Elevenmile Canyon are interpreted to be high-angle or low-angle normal faults. The tuff of Lee Canyon is a homogeneous, crystal- and biotite-

Surficial deposits (Quaternary)
Older gravel deposits (Quaternary and Tertiary)
Intermediate and mafic lavas (Miocene)
Sedimentary rocks (Miocene)

— Post-caldera rocks and deposits

Silicic intrusive rocks (Miocene and Oligocene?)
Younger rhyolite (Miocene or Oligocene)
Intermediate intrusive rocks (Miocene or Oligocene)

— Synextensional rocks

Granite porphyry (Miocene)
Freeman Creek pluton (Miocene)
Tuff of Lee Canyon (Miocene or Oligocene)
Megabreccia of Government Trail Canyon (Miocene or Oligocene)
Sedimentary tuff (Oligocene)
Tuff of Elevenmile Canyon (Oligocene)
Tuff of Poco Canyon (Oligocene)--
  Upper cooling unit
  Lower cooling unit
IXL pluton (Oligocene)
Younger dacite and andesite (Oligocene)
Tuff of Job Canyon (Oligocene)
Older dacite and andesite (Oligocene)

— Caldera-related rocks (=Stillwater caldera complex)

Older rhyolite (Oligocene)
Metamorphic rocks (Mesozoic)

— Pre-caldera rocks

Contact

Fault–dotted where concealed. Bar and ball on downthrown side

Low-angle fault–double ticks on upper plate

87 Strike and dip of compaction foliation

72 Strike and dip of bedding

Caldera margin or floor
  Elevenmile Canyon caldera
  Poco Canyon caldera
  Job Canyon caldera

FIGURE 2 (explanation)

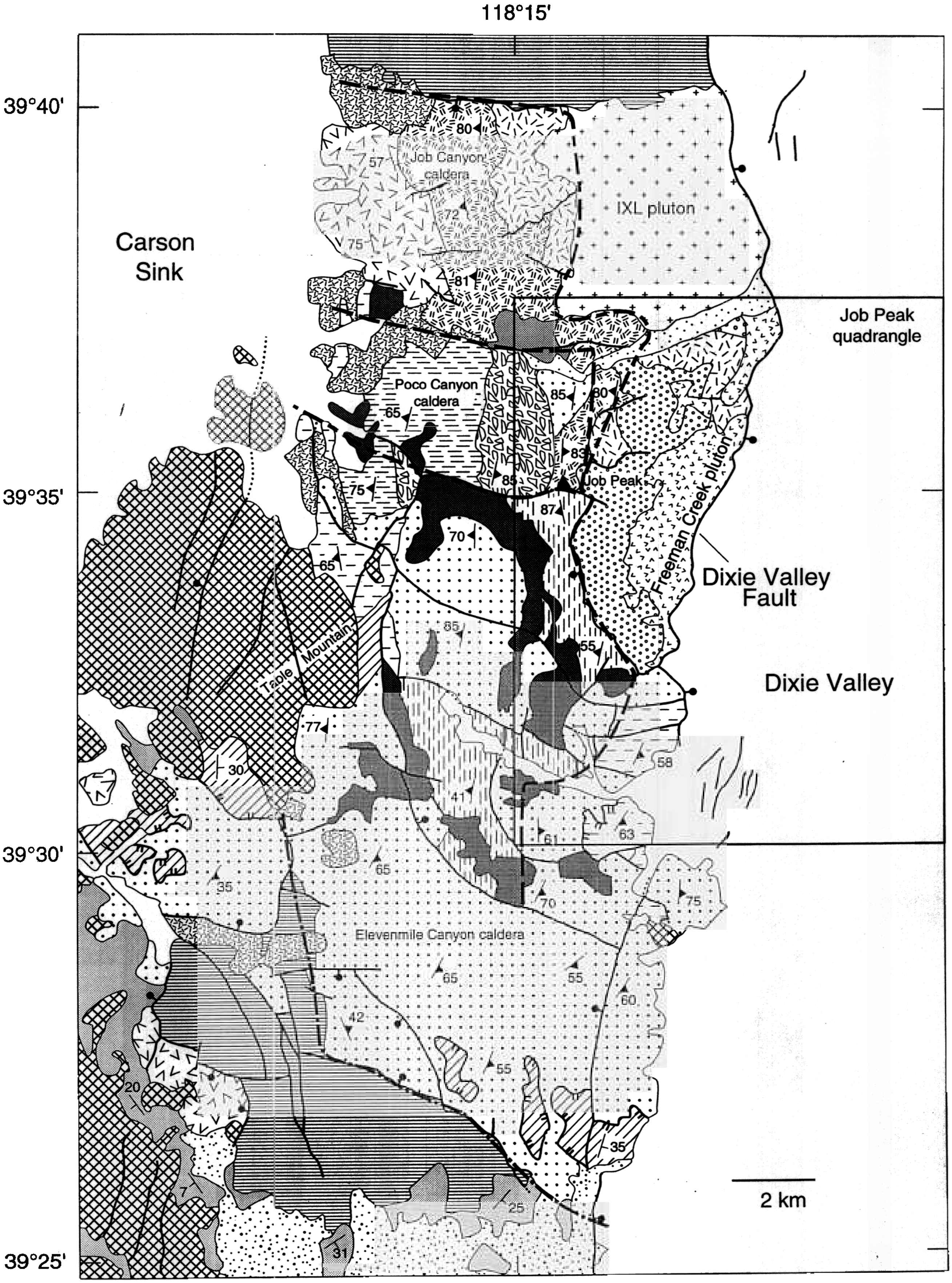

FIGURE 2. Generalized geologic map of the southern Stillwater Range showing approximate outlines of the Job Canyon, Poco Canyon and Elevenmile Canyon calderas and location of the Job Peak Quadrangle.

rich, high-silica dacite ash-flow tuff that megascopically, petrographically, and chemically resembles less altered parts of the tuff of Elevenmile Canyon (John, 1993). It also has a biotite K-Ar age of 24.6 ± 0.8 Ma (E. H. McKee, written commun., 1987) that is analytically indistinguishable from K-Ar ages of the underlying tuffs of Poco Canyon and Elevenmile Canyon. These data suggest that the tuff of Lee Canyon represents a small volume(?), late-stage eruption of the magma that formed the tuff of Elevenmile Canyon.

The Freeman Creek pluton intrudes the older rhyolite, older tuff, and dacite and andesite (units Tor, Tot, and Tda, respectively) and the IXL pluton along much of the east flank of the range in the Job Peak Quadrangle. The pluton is a composite intrusion consisting of at least three textural varieties of medium- to coarse-grained biotite granite and biotite-hornblende granodiorite. The west side of the pluton is commonly finer grained than other parts of the pluton. The age, location, and composition of the Freeman Creek pluton suggest that it is genetically related to the tuff of Poco Canyon and forms the roots of the Poco Canyon caldera (John, 1993).

The Freeman Creek pluton and older rocks are intruded by a composite granite porphyry dike (unit Tgp) in the northwest corner of the Job Peak Quadrangle. The texture of this dike is variable. On its west side, it is a porphyroaphanitic rhyolite containing about 20% fine- to coarse-grained phenocrysts of altered feldspar, bipyramidal quartz and minor chloritized biotite in an altered aphanitic groundmass. On its east side, it is a medium-grained granite porphyry containing about 5% altered biotite. The west-southwest-trending dike was emplaced along the approximate north margin of the Poco Canyon caldera (fig. 2). The dike's location and geochemistry (John, 1993) suggest that it is a ring-fracture dike related to the Poco Canyon caldera.

Numerous silicic domes and dikes intrude the older volcanic and plutonic rocks. At least five major textural varieties of intrusive rocks are present in the southern Stillwater Range: (1) coarsely porphyritic biotite-quartz-K-feldspar-plagioclase porphyry; (2) aphyric to sparsely porphyritic, fine-grained quartz-feldspar rhyolite; (3) fine-grained biotite rhyolite; (4) sparsely porphyritic, medium-grained plagioclase-K-feldspar rhyolite; and (5) (quartz)-biotite-hornblende-plagioclase dacite porphyry. Many dikes are composite and contain more than one textural variety. Most of the larger bodies of these rocks in the Job Peak Quadrangle are variety 4 and are shown as a separate unit (younger rhyolite unit, Tyr) on the map. Potassium-argon dating of six samples of these rocks suggest that they range in age from about 25 to 21 Ma.

The younger rhyolite unit and all older rocks are intruded by a swarm of west-northwest-trending rhyolite dikes that are mostly located south and southeast of the Job Peak Quadrangle (John and Silberling, 1993; John, 1993). A few of these dikes are present in East Lee Canyon and are shown as part of the silicic intrusive rocks unit (Tsi) on the map. Two K-Ar dates on biotite are 19.5 and 18.3 Ma suggesting that these dikes are distinctly younger than other intrusions in the silicic intrusive rocks unit.

Thick sequences of middle Miocene fluvial and lacustrine sedimentary rocks blanket the older Tertiary rocks in the southern Stillwater Range (Page, 1965; John and Silberling, 1993; John, 1993). In the Job Peak Quadrangle, two small outcrops of these rocks (Ts) are located near the mouth of East Lee Canyon.

The small exposures of middle Miocene sedimentary rocks are overlain by coarsely porphyritic andesite and dacite flows and flow breccias (Ta) that are probably temporally and lithologically equivalent to thick sequences of middle Miocene porphyritic intermediate lavas exposed in the La Plata Canyon and Diamond Canyon Quadrangles southwest of the Job Peak Quadrangle (fig. 1; John and Silberling, 1993; John, 1993). In contrast to all older intermediate lavas, these rocks are unaltered and locally glassy.

Fine-grained diabase (Td) and basalt (Tbi) dikes intrude the older igneous rocks and are probably intrusive equivalents of middle Miocene basaltic andesites that are abundant on the west side of the southern Stillwater Range and interfinger and overlie the middle Miocene intermediate lavas (Page, 1965; John, 1993). These dikes are northwest trending, and the most prominent dike, which cuts across the Freeman Creek pluton, is exposed along strike for more than 2 km. These dikes are the youngest igneous rocks in the quadrangle.

Quaternary surficial deposits cover more than half of the quadrangle, filling Dixie Valley. These deposits consist of alluvium and colluvium, alluvial-fan deposits, basin-fill deposits, talus, and small outcrops of beach gravels. Most of the surficial deposits are alluvial-fan deposits shed off the steep east flank of the Stillwater Range. Several ages of alluvial-fan deposits are present, although only remnants of older alluvial fans (probably >200 ka; Bell and Katzer, 1987) are differentiated separately on the map. Beach gravels that are small remnants of a late Pleistocene or earliest Holocene shoreline from a Quaternary lake which filled Dixie Valley are present at an elevation of about 1,094 m along the edge of alluvial-fan deposits. This apparent shoreline is about 8 m higher than the prominent high shoreline (1,086 m) preserved in the IXL Canyon Quadrangle (Bell and Katzer, 1987) and areas further north (Burke, 1967; Thompson and Burke, 1973). Older alluvium consists of prominent gravel terraces as much as 15 m high that are present along the sides of East Lee, Coyote, and Poco Canyons.

STRUCTURAL HISTORY

The structural history of Cenozoic rocks in the southern Stillwater Range is complicated by two or more periods of extensional faulting and the lack of marker units in the intracaldera tuffs. At least two major periods of tilting and extensional faulting are evident in the older Tertiary rocks: earliest Miocene and late Miocene to Holocene. Upper Oligocene and lower Miocene ash-flow tuffs and lavas are moderately to steeply tilted around northwest- to northeast-trending axes. In the southwestern corner of the Job Peak Quadrangle and in the adjacent Pirouette Mountain and La Plata Canyon Quadrangles, nearly all of the older Tertiary volcanic rocks dip to the east, whereas older Tertiary rocks to the north in most of the Job Peak and Table Mountain Quadrangles and in the southern parts of the IXL Canyon and Cox Canyon Quadrangles dip steeply west. In the southern part of the Stillwater Range, as much as 50° to 90° of tilting took place during early Miocene faulting, as shown by angular unconformities between ash-flow tuffs and overlying middle Miocene sedimentary rocks and lava flows. Field relations between silicic intrusions and ash-flow tuffs, paleomagnetic data (Hudson and others, 1993), and K-Ar ages indicate that tilting and low-angle norma faulting took place shortly after eruption of the tuffs of Elevenmile Canyon and Poco Canyon, during and just prior to emplacement of numerous silicic intrusions (John and McKee, 1991; John, 1993). 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 (Hudson and others, 1993), and probably resulted from large-scale crustal extension similar to middle Miocene extension described in the Yerington mining district, Nevada, about 90 km southwest of the Job Peak 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 that are exposed in the Table Mountain Quadrangle (John, 1992); these faults may be similar to shallow-dipping, spoon-shaped faults described by Proffett (1977) in the Yerington district. In the Job Peak Quadrangle, the north-striking, east-dipping, down-to-the-west fault between the older rhyolite unit and the tuff of Poco Canyon north of Coyote Canyon with apparent reverse movement may have formed as a west-dipping normal fault that has been tilted approximately 50° west by rotation on younger faults (see section B-B'). Hudson and others (1993) also noted that early Miocene extension and tilting in the southern Stillwater Range were apparently accompanied by about 40° of counterclockwise vertical axis rotation.

A brief, possibly transient, change in the stress field may be indicated by the swarm of west-northwest-trending silicic dikes that intrude the tuffs of Elevenmile Canyon and Poco Canyon and the younger rhyolite unit mostly south of the map area in Elevenmile Canyon and extend eastward across Dixie Valley to the Louderback Mountains, about 2 km south of the Job Peak Quadrangle (fig. 1). The dikes cut low-angle normal faults that formed during early Miocene extension (John and Silberling, 1993; John, 1993). Biotite K-Ar ages of 19.5 ± 0.6 and 18.3 ± 0.5 Ma were obtained for two of these dikes (E. H. McKee, oral commun., 1991-92). The dikes may indicate north-northeast–south-southwest extension. In contrast, early Miocene and Holocene extension directions are oriented approximately east-west to west-northwest–east-southeast. Emplacement of the dikes may have been coincident with development of a small sedimentary basin that extended from the southern Stillwater Range to Sand Springs Summit (fig. 1), as suggested by preliminary study of transport directions in the middle Miocene sedimentary rocks (J. H. Stewart, oral commun., 1991) and by the age of west-northwest-striking normal faulting, hydrothermal alteration, and mineralization in the Sand Springs mining district at Sand Springs Summit (about 20 to 19 Ma; Willden and Speed, 1974; Garside and others, 1981).

A second major period of extensional faulting and tilting is related to modern Basin and Range extension which continues to the present day. This faulting has uplifted the Stillwater Range several kilometers relative to Dixie Valley. Modern extension has occurred along north-northeast-striking high-angle (50-70°) dip-slip faults, such as the Dixie Valley fault, with little or no oblique slip as shown by scarps from the 1954 earthquake (e.g., Bell and Katzer, 1987) and the lack of lateral offset of the early Miocene west-northwest-trending rhyolite dike swarm across Dixie Valley (D. A. John, unpub. data, 1992). In adjacent quadrangles to the west and southwest, middle Miocene (approx. 14.5 to 13 Ma; John, 1993) basaltic andesite lava flows are gently tilted (about 10°) to the west by north- to north-northeast-striking normal faults. Scarps from the 1954 Dixie Valley earthquake are present along the east side of the Stillwater Range for most of the north-south length of the Job Peak Quadrangle. Several other faults with late Holocene movement are present in unconsolidated alluvium on the piedmont just southeast of the mouth of East Lee Canyon.

HYDROTHERMAL ALTERATION AND MINERALIZATION

Hydrothermal alteration is widespread in the late Oligocene and early Miocene volcanic rocks related to the Stillwater caldera complex and in parts of the Freeman Creek pluton, but no mineralization is known to be associated with this alteration in the Job Peak Quadrangle. Major areas and types of alteration include: (1) pervasive alteration (mostly propylitic or deuteric) of the tuffs of Job Canyon, Poco Canyon, and Elevenmile Canyon and the megabreccia of Government Trail Canyon; (2) local quartz+sericite+pyrite alteration and stockwork quartz+pyrite veining of the Freeman Creek pluton; (3) local pyritic alteration of rocks of the older rhyolite unit; (4) argillic and(or) sericitic alteration (+pyrite) of the granite porphyry dike; and (5) several types of hydrothermal alteration associated with circulation of hydrothermal fluids along the Dixie Valley fault (Parry and others, 1991).

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