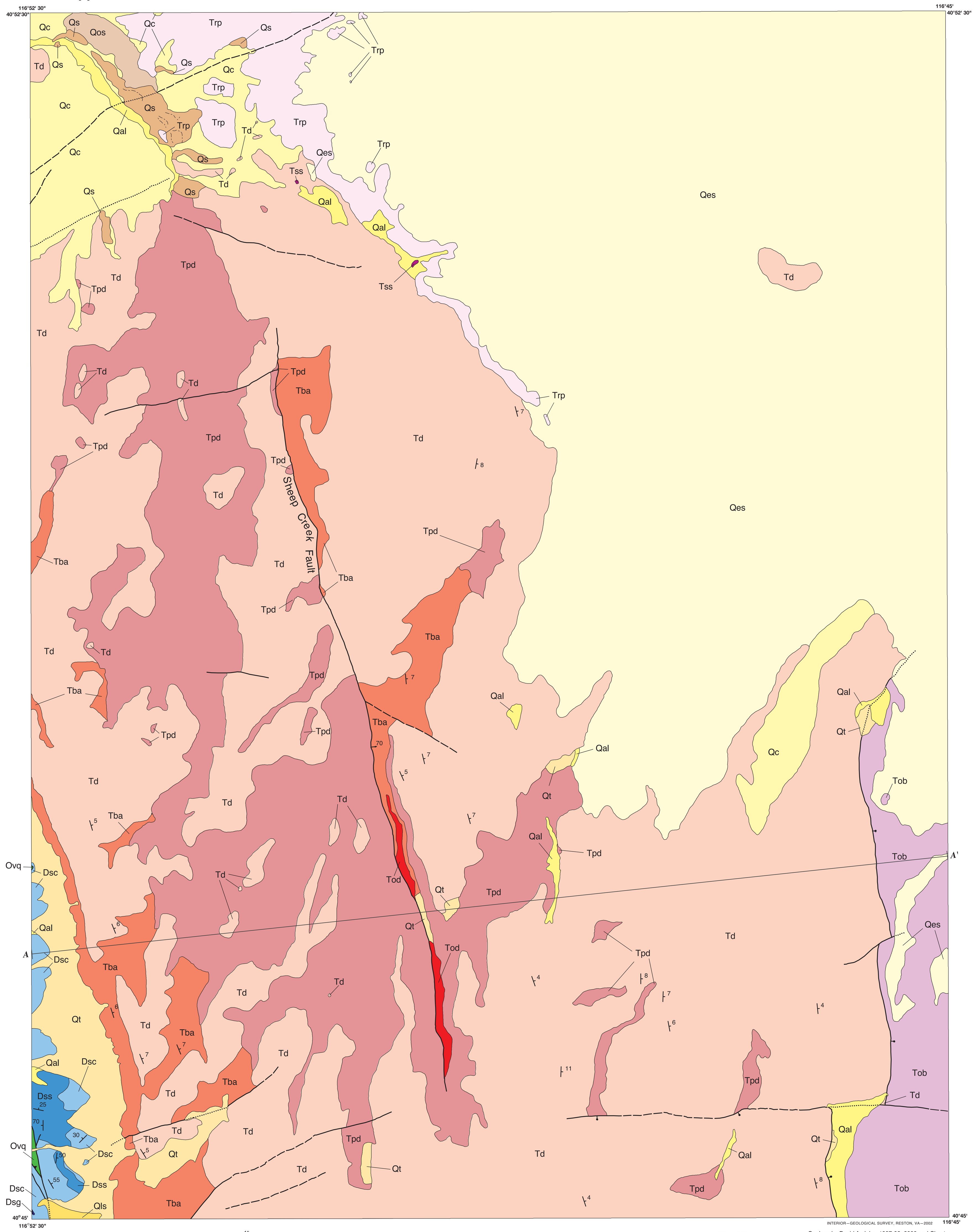

Base from U.S. Geological Survey, 1965
Universal Transverse Mercator projection

SCALE 1:24 000

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS

Geology by David A. John, 1997-98, 2000 and Chester T. Wrucke, 1996-97
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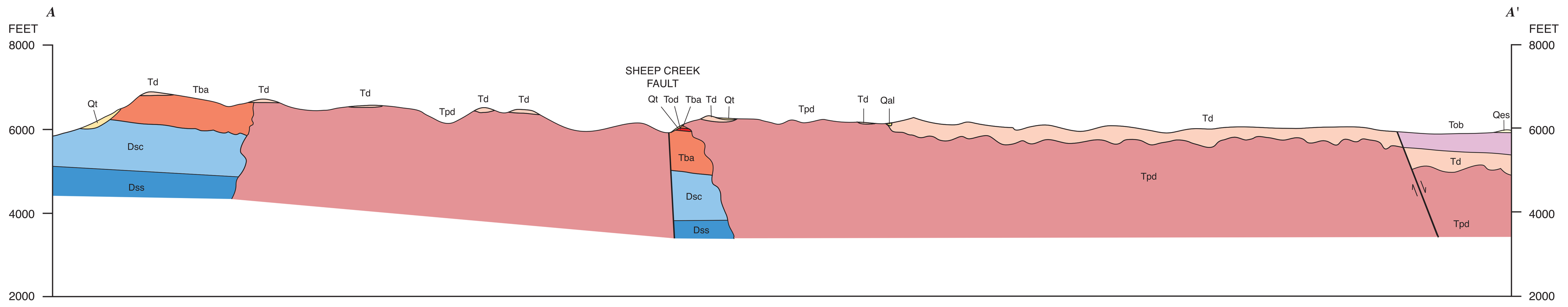

Geologic Map of the Izzenhood Spring Quadrangle, Lander County, Nevada

By
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2002

CORRELATION OF MAP UNITS

Qs, Qos, Qes, Qal, Qc, Qt, Qls — QUATERNARY

Unconformity

Tob, Trp, Tss, Tpd, Td, Tba, Tod — TERTIARY

Unconformity

Dsc, Dsg, Dss — DEVONIAN

Unconformity

Ovq — ORDOVICIAN

DESCRIPTION OF MAP UNITS

[Rock names based on I.U.G.S. chemical classification (Le Bas and others, 1986)]

SURFICIAL DEPOSITS

Qs **Sand dunes (Holocene)**—Unconsolidated sand forming small dunes in the northwest corner of the map area. Dunes have well preserved crests

Qos **Older sand dunes (Quaternary)**—Unconsolidated sand forming dunes in the northwest corner of the map area. Dunes are partly eroded and stabilized with vegetation

Qes **Eolian silt and sand (Quaternary)**—Mostly thin(?) eolian deposits covering dip slopes of trachydacite and olivine basalt lava flows and rhyolite porphyry in northeast and east parts of map area. Consists mostly of fine sand, silt, and caliche mantling colluvium and talus derived from underlying units. Locally includes colluvium derived from trachydacite unit in east-central part of map area

Qal **Alluvium (Quaternary)**—Unconsolidated sand, silt, and gravel in active stream channels. Locally includes colluvium and talus debris

Qc **Colluvium (Quaternary)**—Soil and unconsolidated alluvium locally partly covered by eolian sand and silt. Mapped mostly in northwest part of map area

Qt **Talus (Quaternary)**—Unconsolidated fragments of basalt and trachydacite forming deposits on steep slopes, notably along western escarpment of Sheep Creek Range in southwest part of map area. Fragments range in size from sand to blocks several meters in maximum dimension

Qls **Landslide deposit (Quaternary)**—Broken and rotated mass of basalt in southwest corner of map area

VOLCANIC, VOLCANICLASTIC, AND HYPABYSSAL INTRUSIVE ROCKS

Tob **Olivine basalt (Miocene)**—Dark-gray to black olivine basalt lava flows. Contain scattered, small (<2 mm) olivine phenocrysts in a fine-grained, subophitic groundmass of plagioclase, clinopyroxene, and ilmenite. Abundant, very fine-grained cavities give the rocks a diktytaxitic texture. Small (≤1 cm) vesicles are common near tops of flows. Whole rock $^{40}Ar/^{39}Ar$ age of 14.7±0.2 Ma (John and others, 2000). Minimum thickness of 100–150 m along southeast edge of map area. Thin (<2 meter thick) bed of dark-orange crystal-lithic rhyolite(?) air-fall tuff present locally along west side of unit

Trp **Rhyolite porphyry (Miocene)**—Light pinkish-gray, black, and red, coarse-grained rhyolite porphyry domes and related lava flows. Extrusive parts of the unit are chilled against the underlying trachydacite unit and form black vitrophyre that grades upward into red to pinkish-gray, devitrified, subhorizontally flow-banded rock. Contains about 15 to 30 percent seriate phenocrysts of sanidine, quartz, plagioclase, and fayalitic(?) olivine in glassy to microcrystalline groundmass. Feldspar and rounded quartz phenocrysts are as much as 8 mm across. Intrudes and unconformably overlies trachydacite unit. Sanidine $^{40}Ar/^{39}Ar$ age of 14.84±0.04 Ma (John and others, 2000)

Tss **Sandstone (Miocene)**—Two small outcrops of dark-gray volcaniclastic sandstone near top and overlying the trachydacite unit in northwest part of map area

Tpd **Porphyritic dacite (Miocene)**—Black, reddish-brown, and lavender-gray, porphyritic high-potassium dacite containing 5 to 20 percent 0.1 to 4 mm phenocrysts of plagioclase, clinopyroxene, ilmenite, and minor olivine. Phenocrysts commonly form small glomeroporphyritic clots. Mostly intrusive, forming large north-northwest-elongated stock and smaller satellite bodies. Margins of intrusions are black vitrophyre. Locally in the upper few meters, the vitrophyre is strongly vesiculated and scoriaceous. Vitrophyre grades downward and inward into irregular zones of spherulitic devitrified dacite characterized by abundant reddish-brown spherulites 0.5 to 6 cm in diameter. Spherulitic zones grade downward and inward to massive, dark-red to lavender-gray, devitrified dacite that is subhorizontally layered. Intrudes trachydacite and basalt and basaltic andesite units. Plagioclase $^{40}Ar/^{39}Ar$ age of 15.34±0.10 Ma (John and others, 2000)

Td **Trachydacite (Miocene)**—Black to light-gray, aphanitic to sparsely porphyritic trachydacite lava flows. Contains 1 to 2 percent fine- to medium-grained plagioclase and (or) clinopyroxene and sparse sieve-textured sanidine phenocrysts in trachytic to pilotaxitic groundmasses of plagioclase and Fe-oxide minerals. Consists of several flows marked by glassy, highly vesicular flow tops and devitrified, massive flow interiors that commonly have platy joints. Vesicles commonly are elongated into narrow tubes several cm long. Plagioclase $^{40}Ar/^{39}Ar$ age of 15.42±0.10 Ma (John and others, 2000). Minimum thickness is about 500–600 m in central part of quadrangle

Tod **Older dacite (Miocene)**—Dark-gray to brown, fine-grained, porphyritic dacite lava flows containing about 10 percent phenocrysts consisting of plagioclase, clinopyroxene, opaque minerals, and minor olivine. Forms small outcrops as much as 120 m thick interbedded within the upper part of the basalt and basaltic andesite unit along east side of Sheep Creek canyon in the central part of the quadrangle

Tba **Basalt and basaltic andesite (Miocene)**—Black to light-gray, aphanitic to sparsely porphyritic basalt and basaltic andesite lava flows. Contains sparse, fine-grained plagioclase, olivine, and (or) clinopyroxene phenocrysts in intergranular to intersertal groundmasses of plagioclase, clinopyroxene, olivine, and ilmenite. Consists of as many as 30 thin flows marked by highly vesicular, glassy flow tops and devitrified, massive flow interiors. Unit is about 250–300 m thick along cliff faces on southwest side of quadrangle. Unconformably overlies Paleozoic rocks. Whole-rock $^{40}Ar/^{39}Ar$ age of 15.58±0.10 Ma (John and others, 2000) on a lava flow collected at the base of the sequence and whole rock K-Ar age of 15.2±0.5 Ma on a flow collected about 1 km south of the Izzenhood Spring quadrangle (age recalculated from McKee and Silberman (1970) using modern decay constants)

SEDIMENTARY ROCKS

Slaven Chert (Devonian)—Chert, sandstone, argillite and minor greenstone. Unconformably overlies Valmy Formation

Dsc **Chert**—Very dark gray to black chert and less abundant black to dull greenish-gray argillite. Chert commonly in beds 2–8 cm thick called ribbon chert, but beds may locally be as thick as 20 cm. Argillite is highly siliceous and in beds 2–10 cm thick. Unit locally intensely folded and in places stained brown and yellow brown from Fe-oxides. The northernmost outcrops are sheared, brecciated, and contain abundant yellow and yellow-brown, clay-rich gouge and numerous quartz veins. Several turquoise prospects are centered 1 km southwest of Sterritt Peak

Dsg **Greenstone**—Dark greenish gray and fine-grained. Exposure at southwest corner of quadrangle is end of unit that extends more than 2 km to northwest and locally contains pillows 20–40 cm across. Deeply weathered and poorly exposed

Dss **Sandstone**—Interbedded sandstone, chert, and argillite. Predominantly yellowish-brownish-gray, very fine- to fine-grained feldspathic sandstone consisting of angular quartz grains, about 20 percent plagioclase, sparse microcline, and a few percent each of collophane and white mica. Locally calcareous or contains abundant dolomite rhombs. Sandstone contains locally interbedded fine- to coarse-grained quartz-limestone arenite consisting of rounded quartz grains and 25 percent limestone clasts as large as 2.3 mm across. Some sandstone beds laminated in mostly planar sets as thick as 40 cm, but a few sets are crossbedded and show upright bedding. Locally interbedded with medium-dark to dark-gray, well-indurated sandstone consisting of well-rounded, very fine- to coarse-grained quartz and locally containing limestone clasts 1–3 mm across. Limestone clasts consist of oolites or structureless calcite or contain abundant quartz silt and fine sand. Unit locally has interbedded black chert, dull greenish-gray siliceous argillite, and rare limestone

Valmy Formation (Ordovican)— Consists of:

Ovq **Quartzite**—Mainly medium-dark to very dark gray, locally faintly purplish-gray, medium-grained, bimodal quartzite. Mostly massive with no indications of original bedding. Interbedded with lesser amounts of black and dark-gray to greenish-gray chert and siliceous argillite. Weathers medium to medium dark gray

Contact

High-angle normal fault—Dashed where approximately located; dotted where concealed. Bar and ball on downthrown side. Arrow shows dip

Thrust fault—Barbs on upper plate

8 **Strike and dip of inclined beds**

Crest of sand dunes

GEOLOGY

The Izzenhood Spring quadrangle covers about 145 km² of the southwestern part of the Sheep Creek Range in northern Lander County, Nevada (fig. 1). The quadrangle is underlain by Lower Paleozoic rocks that are unconformably overlain and intruded by thick sequences of Miocene igneous rocks related to the northern Nevada rift (Stewart and McKee, 1977; Wallace and John, 1998; John and others, 2000). Much of the eastern part of the quadrangle is covered by thin Quaternary surficial deposits.

ROCK UNITS

Paleozoic sedimentary rocks

Lower Paleozoic sedimentary rocks of the Roberts Mountain allochthon crop out in a narrow belt along the west flank of the Sheep Creek Range in the southwest corner of the Izzenhood Spring quadrangle (Stewart and McKee, 1977). They form more extensive outcrops in the adjacent Stony Point and Russells quadrangles and are present in the northeast corner of the adjacent Battle Mountain quadrangle (fig. 1; House and others, 2001; Ramelli and others, 2001). Paleozoic rocks in the Izzenhood Spring quadrangle consist of the Ordovician Valmy Formation and the Devonian Slaven Chert. In the Izzenhood Spring quadrangle, the Valmy Formation is composed mostly of quartzite and lesser amounts of chert and argillite. Black ribbon chert, typical of the Slaven Chert in northern Nevada, is the principle rock in the formation in the Izzenhood Spring quadrangle, but lesser amounts of sandstone, argillite, and greenstone are also present. The Valmy Formation and the Slaven Chert were juxtaposed by thrust faults that probably formed during the Late Paleozoic Antler orogeny and were offset by late Cenozoic normal faults.

Miocene igneous rocks

Miocene igneous rocks unconformably overlie the Paleozoic rocks and cap most of the Sheep Creek Range. These igneous rocks formed along the northern Nevada rift, which was the site of middle Miocene igneous activity and related precious-metal mineralization (Wallace and John, 1998; John and others, 2000). The northern Nevada rift extends approximately 500 km in a north-northwest direction from east-central Nevada to near the Nevada-Oregon border. The rift is expressed as a fairly narrow positive anomaly on regional aeromagnetic maps. The anomaly reflects the presence of abundant dikes of mafic rocks (Zoback and Thompson, 1978; Blakely and Jachens, 1991).

In the Izzenhood Spring quadrangle, a sequence of five major igneous rock units has been identified: basalt and basaltic andesite, trachydacite, porphyritic dacite, rhyolite porphyry, and olivine basalt. Available geochronologic data suggest that all these units formed during a brief time interval between about 15.6 and 14.7 Ma. In contrast to other parts of the rift farther south, mafic dikes have not been identified in the southwestern Sheep Creek Range.

Basalt and basaltic andesite

The oldest Tertiary igneous rocks in the southwestern Sheep Creek Range consist of aphanitic to sparsely porphyritic basalt and basaltic andesite lava flows (unit Tba) that form the upper part of the cliffs along the west flank of the range. More than 30 thin lava flows that range in composition from basalt to basaltic andesite (about 47 to 54 weight percent SiO_2) are present in the cliffs. Individual flows are marked by glassy, highly vesicular flow tops and devitrified, massive flow interiors. These rocks contain less than 2 volume percent phenocrysts which include fine- to medium-grained plagioclase, olivine, and (or) clinopyroxene in intergranular to intersertal groundmasses of plagioclase, olivine, clinopyroxene, and ilmenite.

John and others (2000) reported a whole-rock $^{40}Ar/^{39}Ar$ age of 15.58±0.10 Ma on the lowest exposed lava flow along the west flank of the Sheep Creek Range about 1 km south of the Izzenhood Spring quadrangle, and McKee and Silberman (1970) reported a whole-rock K-Ar age of 15.2±0.5 Ma (recalculated using modern decay constants) on a lava flow from this unit collected along the crest of the Sheep Creek Range about 1 km south of the Izzenhood Spring quadrangle.

Older dacite

Small areas of fine-grained porphyritic dacite lava flows (unit Tod) as much as 120 m thick are exposed on the east side of Sheep Creek canyon and are interbedded with the upper parts of the basalt and basaltic andesite unit. These rocks contain about 10 percent fine-grained (≤0.5 mm) phenocrysts of plagioclase, clinopyroxene, opaque oxides, and minor olivine. The rocks locally are strongly flow banded and show flow folds. Similar appearing flows are present locally between the top of the basalt and basaltic andesite unit and the overlying trachydacite unit in the cliffs along the south flank of the Sheep Creek Range in the Stony Point quadrangle and along the Argenta Rim in the northern Shoshone Range about 20 km to the southeast.

Trachydacite

The basalt and basaltic andesite unit is overlain by a series of trachydacite lava flows (unit Td) that form the crest of Sterritt Peak and much of the uplands of the Izzenhood Spring quadrangle. The unit consists of aphanitic to sparsely porphyritic lava flows that contain 1 to 2 percent fine- to medium-grained plagioclase and (or) clinopyroxene and sparse sieve-textured sanidine phenocrysts in a trachytic to pilotaxitic groundmass of plagioclase and Fe-Ti-oxide minerals. Several of the flows are marked by glassy, highly vesicular flow tops and devitrified, massive flow interiors that commonly have platy jointing. Vesicles in the flow tops commonly are elongated, forming narrow tubes several cm long. The flows have a minimum thickness of about 500-600 m in the central part of quadrangle. John and others (2000) reported a plagioclase $^{40}Ar/^{39}Ar$ age of 15.42±0.10 Ma on a flow collected in the northwestern corner of the Izzenhood Spring quadrangle. These rocks are compositionally and petrographically identical to dacite lava flows that locally cap the Malpais and Argenta Rims in the northern Shoshone Range, although the trachydacite lava flows overlie porphyritic dacite in the northern Shoshone Range, whereas they appear to be intruded by similar-appearing porphyritic dacite in the Sheep Creek Range (Struhsacker, 1980; Wallace and John, 1998; John and others, 2000).

Porphyritic dacite

Much of the western and southern parts of the Izzenhood Spring quadrangle are underlain by bodies of porphyritic dacite (Tpd). Most of these rocks are interpreted to form the uppermost parts of a large dacite stock that is inferred to underlie much of the southern part of the Sheep Creek Range (section A-A'; Wallace and John, 1998; John and others, 2000). Thick sequences of lava flows of similar composition and appearance are present in the northern Shoshone Range, principally in the Mule Canyon quadrangle, along the Argenta Rim, and on much of the upper slopes of the Malpais Rim farther to the south (fig. 1; Struhsacker, 1980; Thomson and others, 1993; John and others, 2000).

Most of the porphyritic dacite in the Sheep Creek Range appears intrusive. The largest intrusion is a north-northwest-elongated stock about 11 km long and as much as 3 km wide on the west side of the N20°W-striking Sheep Creek fault. Several smaller dacite bodies, which are inferred to connect at depth with the large stock, are present east of this fault.

The texture of the porphyritic dacite varies significantly. Margins of the intrusions are black vitrophyre. Locally, the upper few meters of the vitrophyre are strongly vesiculated, forming a scoria-like rock. The vitrophyre grades downward and inward into irregular zones of spherulitic devitrification characterized by abundant reddish-brown spherulites 0.5 to 6 cm in diameter. The spherulitic zones grade downward and inward to massive, dark-red to lavender-gray, devitrified dacite that is subhorizontally layered, forming a platy rock. The dacite contains 5 to 20 percent phenocrysts that consist of plagioclase, clinopyroxene, ilmenite, and minor olivine. The phenocrysts range in size from 0.1 to 4 mm but are mostly less than 1 mm. They commonly form small glomeroporphyritic clots.

Chemical analyses of the porphyritic dacite indicate a relatively restricted range of composition between about 64 to 69 weight percent SiO_2, making the rocks trachydacites and dacites, according to the IUGS chemical classification (Le Bas and others, 1986). These rocks have notably high K_2O contents that are comparable to compositions reported by Struhsacker (1980) for similar lava flows in the Malpais Rim area about 30 km to the southeast (Wallace and John, 1998). John and others (2000) reported a plagioclase $^{40}Ar/^{39}Ar$ age of 15.34±0.10 Ma for a sample of the porphyritic dacite unit collected in the northwest part of the Izzenhood Spring quadrangle.

Rhyolite porphyry

Coarse-grained rhyolite porphyry domes and related lava flows (unit Trp) crop out in the northwest corner of the Izzenhood Spring quadrangle. These rocks are the southernmost part of a large rhyolite dome field that forms much of the area between the Sheep Creek Range and the Midas trough about 35 km to the northwest (fig. 1; Fries, 1942; Stewart and Carlson, 1978; Stewart and McKee, 1977; Wallace, 1993).

In the Izzenhood Spring quadrangle, rhyolite porphyry is both intrusive and extrusive; the northern half of the porphyry forms domes that intrude the trachydacite unit, whereas the northern half of these exposures are lava flows that overlie the trachydacite unit. The intrusive rocks are devitrified, commonly strongly flow banded, and spectacularly jointed, as described by Stewart and McKee (1977, p. 46-47). Extrusive parts of the unit are chilled against the underlying trachydacite unit and forming black vitrophyre that grades upward into red to pinkish-gray, devitrified, subhorizontally flow-banded rock. The rhyolite porphyry contains about 15 to 30 percent seriate phenocrysts of sanidine, quartz, plagioclase, and fayalitic(?) olivine in a glassy to microcrystalline groundmass. Feldspar and rounded-quartz phenocrysts are as much as 8 mm across. John and others (2000) reported a sanidine $^{40}Ar/^{39}Ar$ age of 14.84±0.04 Ma on a rhyolite porphyry flow from the Izzenhood Spring quadrangle. McKee and Silberman (1970) reported sanidine K-Ar ages of 14.2 and 14.3 Ma (recalculated) for rhyolite porphyry flow domes about 7 km north of the Izzenhood Spring quadrangle.

Olivine basalt

The southeastern part of the Izzenhood Spring quadrangle is underlain by dark-gray to black olivine basalt lava flows (unit Tob) that are downfaulted against the trachydacite unit. The basalt flows make up most of the large tableland of the Sheep Creek Range to the northeast (Stewart and McKee, 1977). They contain scattered, small (≤2 mm) olivine phenocrysts in a fine-grained, subophitic groundmass of plagioclase, clinopyroxene, and ilmenite. Abundant, very fine-grained cavities are present, producing a spongy, diktytaxitic texture. John and others (2000) reported a whole-rock $^{40}Ar/^{39}Ar$ age of 14.7±0.2 Ma on a lava flow collected in the southeastern corner of the Izzenhood Spring quadrangle. These lava flows are compositionally and petrographically identical to basalt flows that cap the Malpais and Argenta Rims in the northern Shoshone Range (Struhsacker, 1980; Thomson and others, 1993; John and others, 2000).

SURFICIAL DEPOSITS

Late Quaternary surficial deposits (units Qs, Qos, Qes, Qc, Qal, Qls, and Qt) cover most of the northeastern quarter of the Izzenhood Spring quadrangle and are extensively exposed on the west side of the quadrangle. The most extensive units are thin(?) deposits of caliche and eolian silt and sand that cover a pediment surface in the northeast quarter of the quadrangle. Prominent sand dunes and other alluvial deposits are present in the northwest corner of the quadrangle, and extensive talus deposits are present along the west edge of the quadrangle, where they mantle contacts between Paleozoic sedimentary rocks and Miocene volcanic rocks.

LATE CENOZOIC STRUCTURE

The Sheep Creek Range is a gently east-tilted horst formed by late Cenozoic Basin and Range faulting. The range is bounded on the west by a north-northwest-striking fault zone with late Quaternary displacement (Dohrenwend and Moring, 1991) that parallels the northern Nevada rift and results in nearly 1 km of topographic relief between the crest of the range and the Humboldt River valley to the west. The total offset on this fault zone estimated using gravity data is 2 to 2.5 km (D.A. Ponce, oral commun., 1997). These range-bounding faults may be reactivated middle Miocene faults that were active during development of the northern Nevada rift. The Sheep Creek Range has undergone relatively little post-middle Miocene tilting. Average dips on lava flows in the basalt and basaltic andesite and trachydacite units are about 5° east, with strikes ranging from about N30°W to N-S.

The structure of the Izzenhood Spring quadrangle is dominated by high-angle normal faults. Relatively few faults were mapped in the Miocene igneous rocks in the quadrangle, due in part to the lack of marker units. Two orientations of high-angle faults are evident: north- to north-northwest and east-northeast to east-southeast. The east-northeast-striking faults generally appear to cut the north-northwest-striking faults and are subparallel to young faults at the southern end of the Sheep Creek Range and the Argenta and Malpais Rims to the south (fig. 1; Stewart and McKee, 1977; Dohrenwend and Moring, 1991). The north-northwest-striking faults parallel the northern Nevada rift and probably influenced emplacement of the large porphyritic dacite stock that is elongated in this direction.

The north-northwest-striking fault that offsets Paleozoic rocks at the southwest corner of the Izzenhood Spring quadrangle is part of the fault zone on the west side of the Sheep Creek Range. The zone consists of several faults of similar trend that cut across the Izzenhood Spring, Russells, Battle Mountain, and Stony Point quadrangles. Offset on most of these faults is west-side down, but it may be east-side down on the fault in the Izzenhood Spring quadrangle. Faults of north-northwest strike also cut Quaternary deposits along the west margin of the range (see House and others, 2001).

The most prominent fault in the Izzenhood Spring quadrangle is the N20°W-striking Sheep Creek fault in the upper parts of Sheep Creek. The fault dips about 70-80° east and is traceable along strike for 7 km. It is truncated on the north by an east-northeast-striking fault and appears to die out to the south, although a prominent topographic lineament continues 5 km farther south. For much of its length, the fault juxtaposes the porphyritic dacite (unit Tpd) on the west with the trachydacite (unit Td) on the east. These relations may indicate that the porphyritic dacite was emplaced in multiple pulses which alternated with movement on the Sheep Creek fault. Although the fault appears to have down-to-the-west displacement, cross section A-A' suggests that there is little net displacement across this fault.

Another prominent north-striking fault in the southeast corner of the quadrangle drops the olivine basalt unit against the trachydacite unit. This fault appears to have Quaternary displacement (Dohrenwend and Moring, 1991). This fault also is offset in two places by east- to east-northeast-striking faults.

Zoback and others (1994) have shown that the east-northeast-striking faults reflect a change in the regional stress regime that began at about 10 Ma. North-northwest-striking faults characteristic of the northern Nevada rift formed during a period of extension when the least principal stress direction was oriented approximately N65-70°E. Between about 10 to 6 Ma, the least principal stress direction rotated approximately 40° clockwise, and the northeast- to east-northeast-striking faults bounding the southern end of the Sheep Creek Range and the northern end of the Shoshone Range (Argenta Rim) formed subsequently. The east-northeast-striking faults, such as those forming the Argenta Rim, are dominantly left-lateral oblique-slip faults that laterally displace the northern Nevada rift as much as 3.5 km along the Argenta Rim (Zoback and others, 1994).

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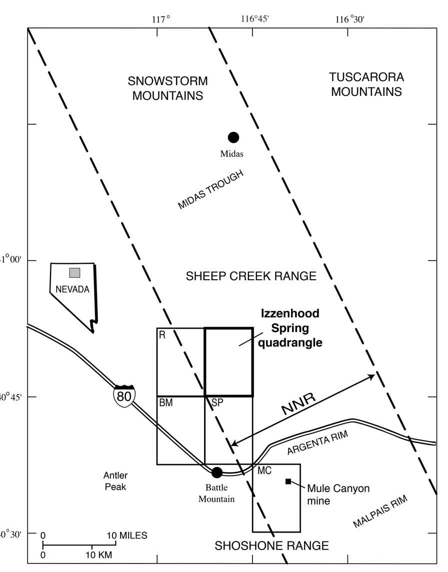

Figure 1. Index map showing location of the Izzenhood Spring 7 1/2-minute quadrangle and geographic features mentioned in the text. BM, Battle Mountain 7 1/2-minute quadrangle; MC, Mule Canyon 7 1/2-minute quadrangle; NNR, northern Nevada rift (approximate boundary); R, Russells 7 1/2-minute quadrangle; SP, Stony Point 7 1/2-minute quadrangle.

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