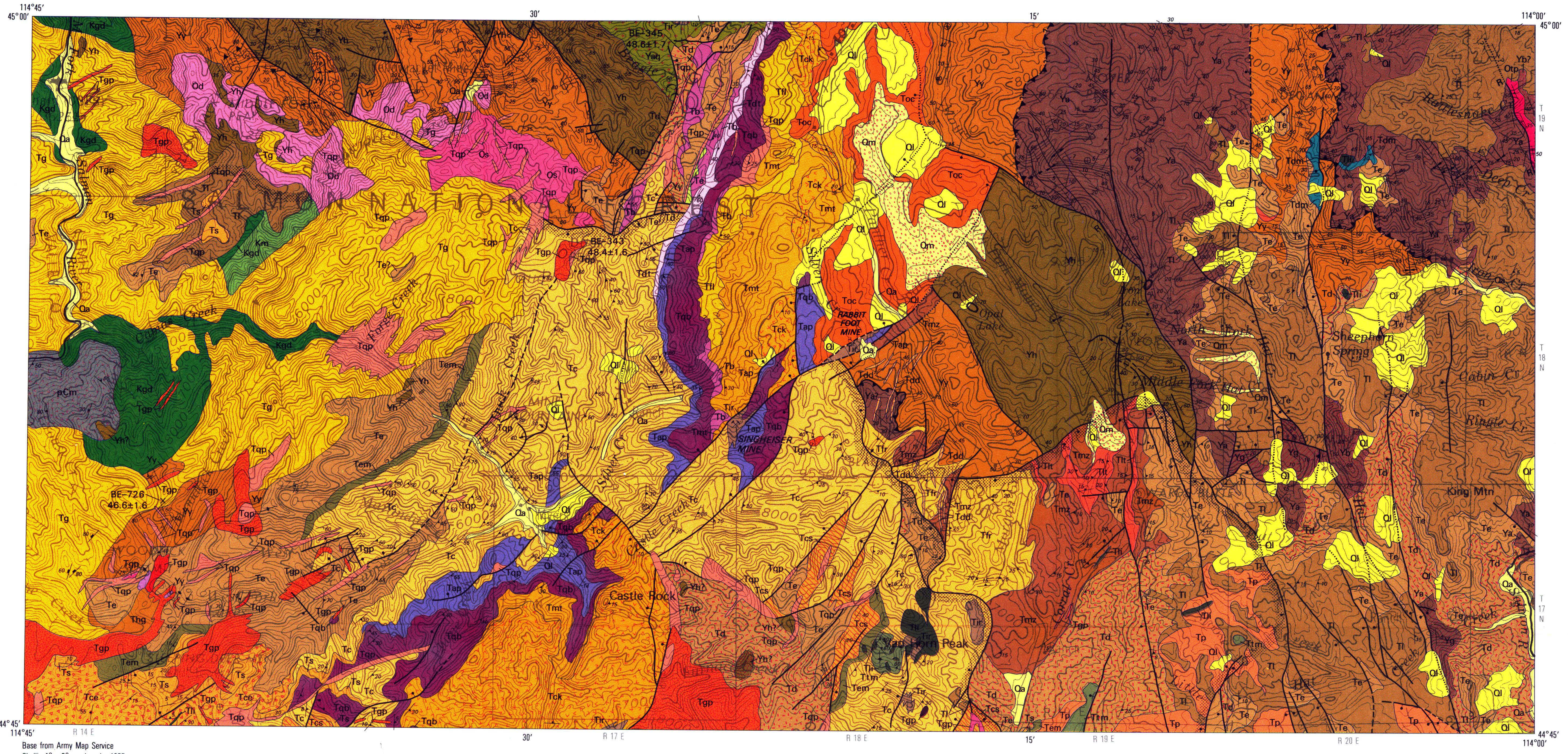
DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

BULLETIN 1570
PLATE 2



Base from Army Map Service
Challis 1° x 2° quadrangle, 1957,
1:250,000

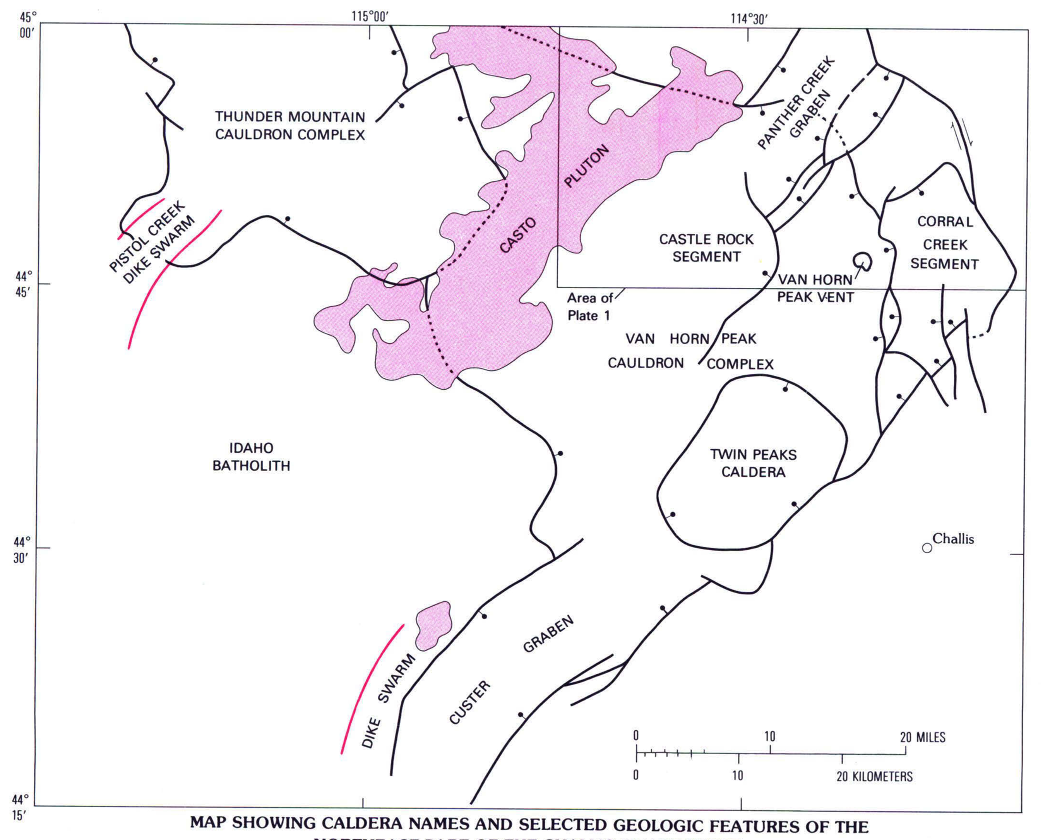
18°
TRUE NORTH
MAGNETIC NORTH
APPROXIMATE MEAN DECLINATION, 1987

SCALE 1:125 000

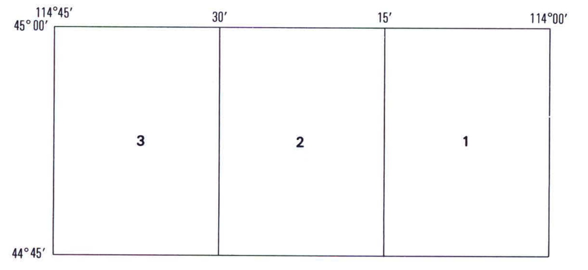
2 0 2 4 6 8 MILES

2 0 2 4 6 8 KILOMETERS

CONTOUR INTERVAL 200 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929



MAP SHOWING CALDERA NAMES AND SELECTED GEOLOGIC FEATURES OF THE NORTHEAST PART OF THE CHALLIS QUADRANGLE

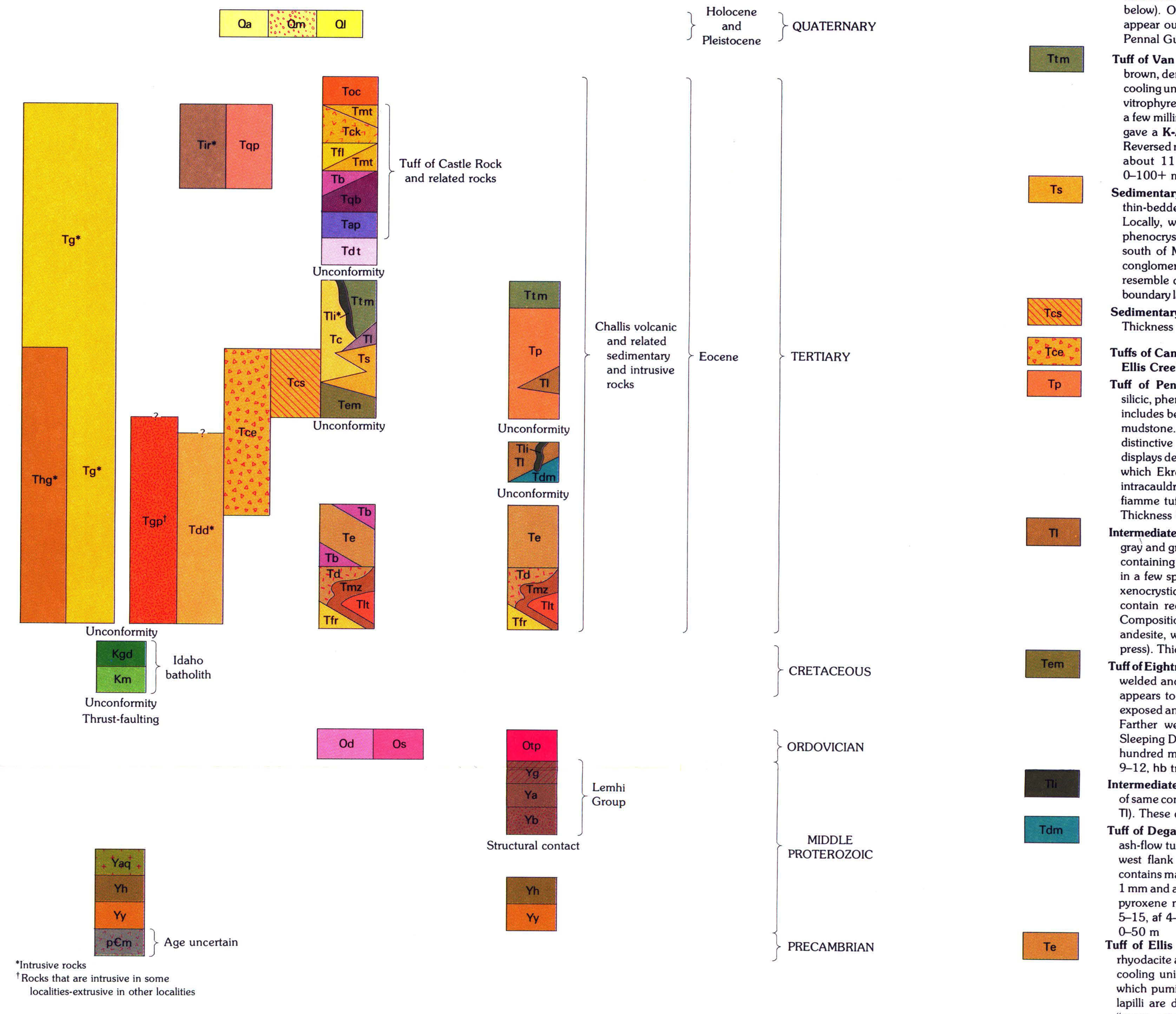


MAPPING CREDITS

1. E. B. Ekren and P. J. Modreski in Fisher and others (1983)
2. E. B. Ekren with some data in western part from Peale (1982) in Fisher and others (1983)
3. E. B. Ekren with data from Ross (1934), Carter (1981), M. Lennon (unpub. mapping, 1980) and Peale (1982) in Fisher and others (1983)

GEOLOGIC MAP OF THE REGION BETWEEN THE MIDDLE FORK OF THE SALMON RIVER AND THE SALMON RIVER, IDAHO (lat 44°15′N.–45°N., long 114° W.–114°45′W.)

CORRELATION OF MAP UNITS



DESCRIPTION OF MAP UNITS

[Modal analyses are reported as follows: phenocryst abundance as percentage of rock sample ("Phenocrysts 30" means that 30 percent of the rock consists of phenocrysts.) Phenocryst mineral abundance is reported as percentage of total phenocrysts. Names of phenocryst minerals are abbreviated as follows: q=quartz, af=alkali feldspar, pf=plagioclase feldspar, b=biotite, hb=hornblende, px=pyroxene, cpx=clinopyroxene, opx=orthopyroxene, ol=olivine, op=opaque oxides. All **K-Ar** ages are calculated using the constants of Steiger and Jaeger (1977)]

Surficial deposits (Holocene and Pleistocene)

Qa **Alluvium**—Unconsolidated sand, gravel, silt, and clay in valleys and washes. Thickness 0–30 m

Qm **Glacial moraine**—Bouldery gravel and sand; mostly unsorted and unstratified; inferred to be primarily side moraine. Thickness 0–30 m

Ql **Landslide debris and talus**—Thickness 0–50 m

Challis Volcanics and related sedimentary and intrusive rocks (Eocene)

Toc **Older colluvium of Panther Creek**—Poorly consolidated sandstone, mudstone, boulder conglomerate, and tephra; locally carbonaceous; includes large landslide masses of variegated volcanic rocks. Unit was deposited in Panther Creek graben, which subsided rapidly after extrusion of the younger monolith-forming ash-flow tuff (unit Tmt). Some subsidence of the graben may have been due to magma withdrawal related to extrusion of Tmt, but most was probably due to regional rifting concurrent with volcanism. This incompetent, graben-filling sequence of rocks is easily eroded and has landslipped everywhere to a considerable degree

Tuff of Castle Rock and related rocks—Except for strata perserved within the Castle Rock half-moon or trapdoor cauldron, the sequence is mostly partially welded and forms slopes

Tmt **Monolith-forming tuff**—Varicolored, nonwelded to partially welded ash-flow and ash-fall rhyolite tuff. Sequence overlies and underlies a genetically related densely welded cooling unit (unit Tck) with identical phenocryst mineralogy. Locally mapped to include nonrelated, soft-bedded tuff in lower part that contains abundant biotite; includes several zones rich in small variegated volcanic lithic fragments. Rock above and below the densely welded part weathers to tepee-shaped hoodoos and other variously shaped monoliths. Typically with vitric, silky pumice lapilli and fresh black glass shards, but zeolitized and otherwise altered in many locales. Phenocrysts 15–25: q 30–50, af 50–60, pf 0–3, b 0–1, hb 0–trace, px (mostly pseudomorphs) 0–3; commonly with smoky quartz and chatoyant alkali feldspar. Thickness 0–300 m

Tck **Tuff within Castle Rock cauldron segment and one densely welded outflow cooling unit**—Within the cauldron includes five cooling units of reddish ash-flow tuff with interbedded thin beds of ash-fall tuff; consists of a densely welded unit at top about 230 m thick; two thin, partially welded, lithic-rich cooling units, each about 30 m thick; a lower cliff-forming, moderately welded cooling unit about 150 m thick; and a lowermost slope-forming, partially welded, lithic-rich cooling unit about 190 m thick. The densely welded upper unit possibly correlates with the densely welded outflow unit. If this is the case, the soft tuff preserved above the densely welded unit in the Panther Creek graben has been stripped away at Castle Rock. Phenocrysts, upper cliff-former, 28: q 47, af 50, pf 0.7, b 0.3–0.7, altered cpx 0.7 (base) to 2.9 (top); except for abundance of altered clinopyroxene, unit has same phenocryst content at top as at base. Phenocrysts in lower cliff-former show considerable variation from base to top; q 15 (base) to 45 (top), af 78 (base) to 49 (top), pf 3.8 (base) to 4.1 (top). Thin cooling units between cliff formers and thick partially welded unit below show virtually same phenocrysts. Quartz is slightly smoky throughout the sequence and all units contain zones of chatoyant alkali feldspar. Thickness 620 m

Tfl **Flow-layered rhyolite or remobilized tuff**—Probably as least two cooling units of reddish flow-laminated and layered rhyolite; source lies outside the Castle Rock cauldron, but unit is intercalated with the Castle Rock tuffs within the Panther Creek graben. Phenocrysts 8–11: q 0–2.9, at 78–95, pf 0–5, b 0–trace, altered px 2–12

Tqp **Quartz porphyry intrusive masses**—Dikes and plugs of pink porphyry with phenocryst sizes and groundmass textures that vary exceedingly; typically with smoky quartz phenocrysts as much as 3 or 4 mm, tabular alkali feldspar and sparse plagioclase as much as 6–8 mm, and sparse flakes or books of biotite as much as 3 mm; groundmass of quartz and alkali feldspar, dense and micrographic or, commonly, microgranular or cryptocrystalline; locally graphic-textured groundmass and extremely coarse phenocrysts of worm-eaten quartz bipyramids as much as 1 cm in diameter and both alkali feldspar and plagioclase as long as 3 cm. A single sanidine crystal 3 cm long from a dike east of Yellowjacket Creek yielded a **K-Ar** age of 44.4±1.0 m.y. (R. F. Marvin, written commun., 1980). The quartz porphyry corresponds to the pink granophyre of Ross (1934). Some dikes are composite masses containing quartz rhyolite like that described above and rhyolite without quartz phenocrysts; in places these quartz-free or quartz-poor dikes were included with unit Tqp, in other places with Tir (see below). Phenocrysts 19–35: q 15–58, af 37–83, pf 0–12, b trace–4

Tir **Rhyolite intrusive masses**—Dikes and plugs of mostly light-gray, dense, phenocryst-poor rhyolite. Locally, as at Red Rock Peak, along the northern border of plate 2 at 114°25′30″ W. with conspicuous phenocrysts of sanidine as long as 8 mm and with sparse phenocrysts of quartz. The rhyolite is compositionally gradational with and forms composite masses with the quartz porphyry (Tqp)

Tb **Basaltic lavas**—Black and brownish-gray, mostly vesicular lavas that probably range in composition from potassium-rich basalt to trachyandesite or latite; mostly dense with scattered small (0.5–2 mm) phenocrysts of pyroxene and plagioclase in a pilotaxitic groundmass composed of plagioclase laths, pyroxene, and glass; locally with small altered olivine phenocrysts and commonly with xenocrysts of quartz with reaction rims composed of tiny pyroxene prisms and glass; unit is intercalated with tuffs as young as the rocks of Castle Rock (unit Tck) and with rocks as old as the tuff of Ellis Creek (unit Te, see below). Thickness 0–50 m

Tqb **Quartz-biotite tuff**—Light-green-gray and reddish-gray, locally flow-layered, densely welded ash-flow tuff that consists of at least two cooling units. Locally, the unit in the Panther Creek graben is flow laminated and layered from base to top, indicating that the hot ash flows there coalesced to liquids before coming to rest; elsewhere, especially in slopes south of the West Fork of Camas Creek, the rock is only locally flow layered and displays zones with abundant brown-green pumice lapilli that are darker than the light-gray or light-greenish-gray enclosing matrix. Phenocrysts show large variations in abundance and relative proportions of quartz, alkali feldspar, and plagioclase. Mostly 20–35 percent phenocrysts; q 19–50, af 25–45, pf 15–40, b 2–20, hb trace–5, px trace. Some quartz phenocrysts in this unit show a peculiar tendency to be biaxial even where they obviously are not strained. They tend to be smoky and nearly everywhere are incipiently to strongly resorbed. Allanite is a common accessory mineral. Thickness 0–300 m

Tap **Alkali feldspar-plagioclase tuff**—Light-green-gray and reddish-gray (commonly altered to yellow and various pastel shades), flow-layered and laminated, quartz-free densely welded tuff; locally with recognizable well-flattened pumice lapilli. Most of the ash flows in this unit coalesced to liquids before coming to rest. Named for the sparse, but conspicuous, euhedral phenocrysts of water-clear, "plate glass" tabular alkali feldspars as long as 5–6 mm and altered and inconspicuous plagioclase, equally euhedral, as long as 5–6 mm. Spherulitic in several localities; unit has a metaperlite basal vitrophyre. Phenocrysts 6–10: af 30–40 (locally to 50), pf 45–66, altered mafic mineral (probably pyroxene) 2–8. This unit is intruded by dense rhyolite at the Singheiser and Rabbit Foot mines and is weakly mineralized. Thickness 0–300 m

Tdt **Dirty tuffs**—Three thin vitric cooling units of densely welded, lithic-rich ash-flow tuffs; locally flow laminated and devitrified; typically with vitric gray matrices and well-flattened black glassy pumice fragments as long as 15 cm. "tiger rock" of local usage. These three units presumably are the distal ends of hot ash flows erupted from the Thunder Mountain cauldron complex to the west, but their counterparts there have not been positively identified. They are crystal-poor plagioclase-bearing tuffs that most closely resemble some of the crystal-poor plagioclase tuffs in the "dime and quarter tuffs" (unit Tdq) exposed near Shellrock Peak (see Fisher and others, 1983). Phenocrysts 1.6–8.6; q 0, af 0–6, pf 73–98 (0.4–2 mm, extensively resorbed), b 0–trace, hb 0–trace, opx trace–18.5. Thickness 0–150 m

Tuffs of Camas Creek-Black Mountain and related rocks

Tc **Tuffs of Camas Creek-Black Mountain, undivided**—A cauldron-filling sequence of mostly very densely welded ash-flow tuff consisting of 10 or more separate cooling units that are characterized by small phenocrysts (about 2 mm) which, in the upper part of the sequence, consist of plagioclase and fairly abundant mafic minerals; plagioclase and sparse to moderate amounts of alkali feldspar in the middle part; and plagioclase with sparse alkali feldspar and quartz in the lower part. The entire sequence contains abundant to fairly abundant mafic minerals consisting mostly of altered pyroxene, but with variable amounts of biotite and sparse hornblende. The lower part of the sequence contains the same kind of phenocrysts as the tuff of Eightmile Creek (unit Tem, see below), but they are smaller and less abundant. This lower part, like the Eightmile Creek, contains more biotite and hornblende than pyroxene. Phenocrysts (upper) 11–40: q 0–trace, af 0–trace, pf 65–75, b trace–10; altered hb 0–trace, altered pyroxene 10–20. Phenocrysts (middle) 5–25: q 0–trace, af trace–20, pf 65–77, altered b trace–9, altered hb trace–3, altered px 3–10. Phenocrysts (lower) 3–15: q 2–12, af 2–8, pf 60–75, altered b 2–10, altered hb trace–3, altered px trace–10. This sequence appears to have been almost entirely confined to the cauldron complex formed principally as a result of the eruption of the tuff of Eightmile Creek and the tuff of Ellis Creek (units Tem and Te, see below). Only thin, partially welded ash-flow tuffs and minor ash-fall tuffs appear outside the complex. The outflow units are mapped with the tuff of Pennal Gulch (unit Tp, see below). Thickness 0–3,000 m

Ttm **Tuff of Van Horn Peak and Table Mountain**—Pale-grayish-red to yellowish-brown, densely welded rhyolite or quartz latite ash-flow tuff; probably a simple cooling unit. Phenocrysts 10–13: pf 80–90, b 7–13, altered px 2–5. Black basal vitrophyre a few meters thick contains abundant small volcanic lithic fragments a few millimeters to a few centimeters in diameter. Biotite from the vitrophyre gave a **K-Ar** age of 47.8±1.7 m.y. (R. F. Marvin, written commun., 1982). Reversed magnetic polarity. The source for this unit is a vent at Van Horn Peak, about 11 km northwest of Table Mountain (Ekren, 1981). Thickness 0–100+ m

Ts **Sedimentary rocks and bedded tuffs**—Principally yellowish-brown and buff, thin-bedded, tuffaceous feldspathic sandstones of fluviolacustrine origin. Locally, with thin-bedded ash-fall tuffs and minor ash-flow tuff, both with phenocrysts of Camas Creek-Black Mountain lithology. Sedimentary rocks south of Middle Fork Peak include tuffaceous sandstone and concretelike conglomerate containing varicolored volcanic rocks. These concretelike rocks resemble caldera-fill deposits and possibly indicate that an ancient cauldron boundary lay between these exposures and Middle Fork Peak. Thickness 0–50 m

Tcs **Sedimentary rocks and tuffs of Camas Creek-Black Mountain, undivided.** Thickness 0–150+ m

Tce **Tuffs of Camas Creek-Black Mountain, tuff of Eightmile Creek, and tuff of Ellis Creek undivided.** Thickness 0–500 m

Tp **Tuff of Pennal Gulch**—White, pale-green-gray, and pale-yellowish-brown, silicic, phenocryst-poor ash-flow tuff and tephra; massive to distinctly bedded; includes beds of fluvial and lacustrine volcanic sandstone, conglomerate, and mudstone. Tuff of Eightmile Creek (see below) locally included in basal part. A distinctive densely welded tuff also in the lower part, but above unit Tem, displays delicate fiamme characteristic of tuff of Camas Creek-Black Mountain, which Ekren (1981) and McIntyre and others (1982) consider to be the intracauldron equivalent of part of the Pennal Gulch. Phenocrysts of delicate-fiamme tuff 4–5: q 4–5, af 35–40, pf 50–55, b 0, hb 1.5–3.5, opx 1.5–6. Thickness 0–300 m

Tl **Intermediate and mafic lavas**—Predominantly aphyric reddish-brown weathering, gray and greenish-gray, brittle, columnar-jointed, blocky to platy lavas; locally containing minor interbedded oxidized breccias. Pyroxene phenocrysts visible in a few specimens. Microphenocrysts include ol, cpx, opx, and, commonly, xenocrystic q; trachytic and pilotaxitic pf-rich groundmass that also may contain reddish-brown strongly pleochroic mica and considerable apatite. Compositions range from potassium-rich basalt (McIntyre and others, 1982) to andesite, with probable predominance of andesite (McIntyre and Hobbs, in press). Thickness 0–700 m

Tem **Tuff of Eightmile Creek**—Light-gray and green-gray massive-weathering, partly welded and densely welded quartz latite or rhyodacite ash-flow tuff; outflow appears to be a simple cooling unit in eastern map area where it is poorly exposed and was not separately mapped at the base of the Pennal Gulch rocks. Farther west and southwest within the cauldron complex, especially at Sleeping Deer Mountain, it composes a thick compound cooling unit several hundred meters thick. Phenocrysts 25–35: q 13–17, af 12–16, pf 45–55, b 9–12, hb trace–2, cpx trace. Thickness 0–300(?) m

Tli **Intermediate and mafic dikes and small plugs.** Mostly phenocryst-poor rocks of same composition as the intermediate and mafic lavas described above (unit Tl). These crosscutting masses undoubtedly served as feeders for the lavas

Tdm **Tuff of Degan Mountain**—Pink and reddish-gray, densely welded rhyodacite ash-flow tuff; unusually rich in mafic minerals; appears to have erupted from west flank of Degan Mountain where a composite vent occurs that also contains mafic fluidal rock (Tli). Contains numerous small q phenocrysts about 1 mm and a few slightly larger q xenocrysts with reaction rims consisting of tiny pyroxene microlites and glass. Phenocrysts 20–32, q (includes xenocrysts) 5–15, af 4–18, pf 29–58, b 2–8, hb 14–36, cpx 6–26, opx trace. Thickness 0–50 m

Te **Tuff of Ellis Creek**—Light-green-gray, massive-weathering, densely welded, rhyodacite ash-flow tuff, multiple-flow compound cooling unit or possibly, two cooling units; everywhere with conspicuous pumice; contains zones within which pumice lapilli are lighter than the matrix and zones within which the lapilli are darker than the matrix. Phenocrysts 36–50: q 4–15 (commonly "worm eaten" and as much as 4 mm), af 0, pf 60–75 (as long as 6 mm), b 12–20, hb 8–16, cpx trace. Thickness 0–300 m

Td **Intermediate lavas**—Principally cliff-forming, dark-gray, conspicuously porphyritic lavas of dacitic composition; blocky weathering with inconspicuous flow layering; locally including phenocryst-poor dark-purplish-gray latite or andesite. Phenocrysts (dacitic lavas) 25–40: q 0–trace, pf 60–70 (as long as 6 mm), b 0–4, hb 15–23, cpx trace–15, opx trace. All mafic minerals are locally oxidized to black opaque iron oxides or replaced by chlorite and iron oxide. Latite or andesite lavas contain 5–15 percent small phenocrysts (0.5–2 mm) of pf and cpx with traces of opx and oxidized hb. Near mouth of Hat Creek, unit is interbedded with mud flows and white sillar-like aphyric tuff that contains abundant reddish rhyolite lithics. Thickness 0–900 m

Tmz **Intermediate lavas and breccias of mixed zone**—A heterogeneous mixture of mafic and dacitic lavas and flow breccias interbedded with tuff breccias, mud flows, and debris flows; locally with well-stratified boulder and cobble conglomerates containing petrified tree stumps and logs; entire sequence is principally slope forming, but in and adjacent to canyons weathers to weird hoodoos and monoliths; matrix of breccias and mud flows is rich in montmorillonite and weathers frothy; slimy when wet. Individual tabular lava flows are mostly latites or andesites that appear to be the same composition as lavas in the younger map unit Tl. These lavas are dark purplish gray and brownish gray; vesicular. Phenocrysts 5–30: pf 50–70 (0.5–2 mm), cpx 10–20 (mostly less than 3 mm), opx 10–20 (mostly less than 2 mm), hb trace–5. Some of these mafic lavas contain only cpx (as long as 1 cm) as phenocrysts; some contain hb as long as 3 cm as the sole phenocryst. Groundmasses are principally pilotaxitic. Dacitic lavas and breccias are identical in composition to the cliff-forming conspicuously porphyritic lavas of unit Td but, in this unit, they consist mostly of slope-forming flow breccias. A porphyritic rhyodacite lava near the base contains the same phenocryst assemblage as the tuff of Ellis Creek. This lava crops out on the east side of Morgan Creek Summit and just east of Opal Creek. Thickness 0–900 m

Tdd **Dikes of dacitic composition**—Principally gray dacite or rhyodacite with pf as long as 1 cm (mostly 3 mm), q to 4 mm (mostly "worm eaten" and 2–3 mm); subequal biotite and hornblende. Some dikes have essentially the same phenocryst mineralogy as the tuff of Ellis Creek

Tlt **Lithic tuff of mixed zone**—Reddish-gray, green-gray, and yellowish-gray, densely welded, cliff-forming, lithic-rich ash-flow tuff; possibly comprising two separate multiple-flow cooling units. Phenocrysts 13–38: q 0–1, pf 72–85, b 0–4, hb 3–5, opx 7.5–22. The extrusion of this tuff apparently triggered the subsidence of the Corral Creek segment of the Van Horn Peak cauldron complex; in places the tuff grades upward into a debris flow containing abundant latite and dacite clasts. Thickness 0–200 m

Tfr **Flow-laminated rhyolite or quartz latite lava**—Yellowish-brown, slope-forming, massive-weathering, aphyric rhyolite and lava; in most exposures this rock more closely resembles a massive siltstone than a volcanic rock. In thin section may contain a crystal or two of albite (2 mm) and a single flake of biotite; the groundmass is a dense felt of feldspar microlites; X-ray studies by D. H. McIntyre (written commun., 1980) indicate that these microlites are mostly potassium feldspar. The rock contains (in percent) SiO_2, 68.5; Al_2O_3, 15.6; Fe_2O_3, 1.02; **FeO**, 0.16; **MgO**, 0.57; **CaO**, 1.51; Na_2O, 2.10; K_2O, 3.85; TiO_2, 0.25; H_2O+, 1.89; H_2O-, 2.93; CO_2, 0.32. Thickness 0–100 m

Tgp **Gray porphyry**—A mixed sequence of gray and green-gray extrusive and intrusive rocks of intermediate composition. Some display flow layering and flow brecciation and dense to glassy groundmasses that indicate they are lavas; most are massive with crystalline groundmasses. This massive rock, in places, exhibits intrusive contacts with country rock as young as the basal part of the tuffs of Camas Creek-Black Mountain (unit Tc). Therefore, the unit, as mapped, probably includes intermediate lavas as old as 51 m.y. and younger dikes and irregular intrusive masses 48 m.y. old or less. Phenocrysts 30–45: q O (in most rocks) to 5, af O, pf 60–75, b 1–12, hb trace–25, px (mostly altered but in places including both fresh opx and cpx) trace–20. The rocks grade, without sharp contacts, from hornblende- and biotite-rich varieties to pyroxene-rich varieties within short distances. Thickness 0–500+ m

Granitic rocks (Eocene)—(43.9–46.6 m.y.)

Tg **Pink granite and light-gray quartz monzonite**—Corresponds to the "Casto pluton" of Ross (1934) and Cater and others (1973). Mostly pink granite: q 22–34 (0.2–5 mm), af (perthitic cloudy orthoclase and microcline) 31–57 (0.5–10.0 mm), pf 18–33, b 20–67, hb 0–3.5, trace amounts of sphene and allanite. The pink rocks plot in the granite field of Johannsen (1948) and the monzo and syenogranite fields of Streckeisen (1973). The light-gray rocks are distinctly richer in plagioclase and fall in the quartz monzonite field of Johannsen (1948). Biotite from fine-grained light-gray rock exposed near Grouse Lake gave a **K-Ar** age of 46.6±1.6 m.y. (R. F. Marvin, written commun., 1981)

Thg **Hornblende granite of Ross (1934)**—Buff to pink, medium-grained hornblende granite (Johannsen, 1948) or quartz syenite (Streckeisen, 1973) for two samples; one from Marble Creek a few kilometers west of map area, the other from Loon Creek a few kilometers south of map area. A sample from Woodtick Summit contained less quartz and alkali feldspar and is quartz monzonite according to both classifications. Rock in all three localities tends to weather rusty. Composition: q 8.3 (Woodtick area), 9.3 (Loon Creek), 13.4 (Marble Creek); af (most cloudy orthoclase) 39.7, 54.9, 57.4; pf 36.7, 20.1, 12.1, b 2.2, 0.6, 1.3, hb 13.1, 12.5, 15.1. The Loon Creek and Marble Creek thin sections each contained several grains of allanite

Granitic rocks of Idaho batholith (Cretaceous)

Kgd **Granodiorite and quartz diorite**—Light-gray, medium-grained biotite granodiorite and hornblende-biotite quartz diorite. One thin section of granodiorite from outcrops near the mouth of Camas Creek showed q 27.8, af 11.2, pf 50.8, b 9.6. A thin section of quartz diorite from same locality: q 5.3, pf 51.9, hb 28.2, b 11.7, op 1.9, apatite 1. According to Ross (1934, p. 38), the quartz diorite is the predominant rock type

Km **Migmatite**—According to Cater and others (1973) the rock consists of intricately intermixed and interlayered gneiss and quartz monzonite

Intrusive rocks (Ordovician)

Od **Diorite, quartz diorite, gabbro, and syenite**—In the Yellowjacket area, unit corresponds to the Tertiary "hornblende quartz diorite" of Ross (1934). This unit is a mixed sequence of mostly gray melanocratic rock ranging in composition from reconstituted gabbro to mafic-rich quartz syenite. The composition of gabbro from near Middle Fork Peak: pf (1–10 mm) 34.4, b 2.8, hb (mostly after px) 18.4, fibrous actinolite-tremolite 5.2, nonfibrous actinolite-tremolite 15.1, chlorite 7.6, black opaque oxides 10.8, apatite 5.7. Syenite from near Middle Fork Peak contains q 2.1, af (mostly perthite) 67.4, pf (mostly late interstitial albite) 16.3, hb 13.4, b 0.4, op 0.4. The hornblende is ferrohastingsite or ferroedenite with a very small 2V. According to Ross (1934, p. 58), the typical hornblende quartz diorite is nearly white and contains q trace–5 (locally as much as 20), af trace–10, pf 60, hb and b (mostly intergrown) 20–40 (locally hb 43, b 38). The rock commonly is altered to epidote, chlorite, sericite, and calcite. Cater and others (1973) considered the rocks in this map unit to be mostly syenite in composition and Precambrian in age; K. Evans (written commun., 1984) obtained a lead-uranium Ordovician age, 490±5 m.y., on zircons from syenite

Os **Quartz syenite, syenite, and granite**—A composite mass that Ross (1934) considered to be Tertiary in age, ranging in composition from quartz diorite to granite. According to Peale (1982, p. 61–62), the rocks all contain quartz except for the syenite, which is rare. The mode is q 5–32, af (mostly microcline-microperthite) 37–85, pf 1–28, b 0–5, ferrohastingsite 0–15. Syenite in this sequence is virtually the same as that analyzed by K. Evans (see above)

Otp **Quartzite at Twin Peaks of Starr (1955) (Ordovician)**—Upper 30+ m consists of medium-gray, fine-grained, mostly foliated dolomite, locally massive; interbedded in lower 10 m with foliated dolomitic quartzite, which grades downward to massive, cliff-forming, white to light-gray quartzite about 200 m thick consisting of virtually pure quartz in two size fractions—a framework fraction 0.4 to 0.6 mm and a matrix fraction 0.1 to 0.2 mm. Landreth (1964) noted a few pale-red-purple beds near the lower part of the unit; he considered the entire sequence to be Kinnikinic Quartzite. Dolomite sampled by P. J. Modreski from the upper 30 m contains conodonts of Middle or Late Ordovician age (J. Repetski, written commun., 1983) and an orthoid brachiopod identified by J. T. Dutro, Jr. (written commun., 1983) as probably genus *Valcourea*. Dutro has further suggested that the collection might well represent the Ella Dolomite. This allows the possibility that the quartzite is older than the Kinnikinic and equivalent to the Summerhouse Formation of Ruppel (1975) and McCandless (1982)

Lemhi Group (Middle Proterozoic)—All correlations within this group are tentative

Yg **Gunsight Formation**—Light-brownish-gray, fine- to medium-grained (0.3–0.6 mm) thin- and thick-bedded sericitic quartzite; thin sections from Iron Mountain and vicinity contained about 60–65 percent q, 30 percent sericite, 2–4 percent orthoclase and perthite, 3–6 percent microcline, 0.4–0.6 percent pf. The rock is not well sorted; quartz "berries" as large as 0.7 mm commonly occur in a matrix averaging about 0.3 mm. Quartz grains are mostly well rounded. Quartzite exposed at the south end of Iron Mountain contains only trace amounts of af and pf, and less than 15 percent sericite; this rock appears to be gradational with the Swauger Formation, which overlies the Lemhi Group (Ruppel, 1975; Hobbs, 1980). Likewise, quartzite at the junction of Hat Creek and Little Hat Creek in the deep antecedent canyon carved into the upthrown fault block probably corresponds to the upper part of the Gunsight at the type locality. Thickness 400 m (incomplete)

Ya **Apple Creek Formation**—Thin-bedded, greenish-gray, green, and dark-gray siltite and argillite, fine-grained, gray, argillaceous quartzite, and, in the highest exposures just east of Iron Lake a few beds as much as 3 m thick of white, clean, fine-grained quartzite containing 15 percent or less feldspar and sericite. Slaty cleavage is well developed and conspicuous; because of this cleavage the rock weathers splintery to form pencil-shaped fragments and long angular blocks ranging in diameter from a few centimeters to 0.5 m and as much as 1 m or more in length; locally, with ripple marks and mud cracks. Recognition of this formation proved to be extremely difficult because of its overall similarity with strata in the Yellowjacket Formation. According to Ruppel (oral commun., 1981) the well-cleaved, thin- and thick-bedded siltite and fine-grained quartzite exposed east of Iron Lake and along the ridge road north of Iron Lake is "typical Apple Creek." The thrust or detachment fault inferred herein in the Iron Creek and Moyer Creek drainages, previously considered to be intraformational within the Yellowjacket (see Fisher and others, 1983), apparently places Apple Creek Formation over the Yellowjacket. Thickness unknown because of extensive folding but apparently at least 1,000 m

Yb **Big Creek Formation**—Light-greenish-gray, thin- and thick-bedded, fine- to medium-grained micaceous and feldspathic quartzite; thicker beds are conspicuously crossbedded; magnetite grains abundant in some laminae and scattered through the rock. In canyon wall exposures south of Sheephorn Spring, the greenish-gray quartzite grades upward to reddish-gray feldspathic quartzite that weathers brown and brownish gray. The rock contains 45–57 percent quartz (0.1–0.3 mm), 10–20 percent orthoclase and microcline, 10–20 percent pf, and 7–20 percent sericite, b, and iron oxide. The abundance of pf is distinctive. Rocks tentatively assigned to the Big Creek Formation in the extreme northeastern part near Rattlesnake Creek consist of even-bedded, thin-bedded quartz-rich quartzite and phyllite; quartzite is dominant and occurs in beds up to 3 m; phyllite mostly in beds only a few centimeters thick. Thickness 600 m (incomplete)

Older rocks (Middle Proterozoic)

Yaq **Argillaceous quartzite, siltite, and argillite**—See plate 1

Yh **Hoodoo Quartzite**—See plate 1

Yy **Yellowjacket Formation**—See plate 1

pЄm **Metamorphic rocks, undivided (Precambrian)**—Siliceous gneiss and schist, quartzite, and calc-silicate rocks, mostly strongly foliated

Contact

Fault—Dashed where approximately located or inferred, dotted where concealed; bar and ball on downthrown side. Arrows show relative horizontal movement; queried where doubtful or direction of relative movement is uncertain

Thrust or detachment fault—Sawteeth on upper plate; dashed where approximately located or inferred; queried where location is uncertain

Reverse fault—R on relatively upthrown side; arrows show inferred relative horizontal movement during a period of later Tertiary wrench faulting; dotted where concealed; arrows queried where horizontal displacement is uncertain

75 **Strike and dip of inclined sedimentary beds**—Top directions may be uncertain

75 **Strike and dip of overturned sedimentary beds**—Top directions determined from internal structures

20 **Strike and dip of foliation in metamorphic and volcanic rocks**

Anticline

Syncline

Approximate boundaries of calderas and other volcanic-tectonic structures

BE–345
48.6±1.7
× **Location of radiometrically dated rock**—Showing locality number and age of rock in millions of years