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Geologic map of the Rustler Park quadrangle, southeast Arizona

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This map is preliminary and has not been reviewed for conformity with U.S. Geological Survey editorial standards or with the North American stratigraphic code.

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NOTE:

The revision of stratigraphic nomenclature presented herein has been officially approved by the Geologic Names Unit (Denver, CO) of the U.S. Geological Survey. Formal redefinition of rocks formerly included in the Rhyolite Canyon Formation is presented in U.S. Geological Survey Geologic Quadrangle Map 1696: Geology of the Rustler Park Quadrangle, southeast Arizona, by John S. Pallister, Edward A. du Bray, and John S. Latta, IV.

DESCRIPTION OF MAP UNITS

[Ages for Tertiary igneous rocks are $^{40}Ar/^{39}Ar$ determinations by L.W. Snee (Pallister and others, 1990), except where otherwise noted. Plutonic and volcanic names are in accord with the IUGS system (Streckeisen and others, 1973; Le Bas and others, 1986) except the subalkaline-alkaline division of Irvine and Baragar (1971) is used. The terms accessory and trace, where referring to mineral abundances, indicate <1 percent and <0.1 percent, respectively. SiO_2 ranges based on the mean values and standard deviations of Pallister and du Bray (1989). Descriptions of Cretaceous and older rocks condensed from Drewes (1982)]

SURFICIAL DEPOSITS

Qal **Alluvium (Holocene and Pleistocene)**--Unconsolidated to poorly consolidated silt, sand, gravel, and peaty material in valley bottoms. Includes alluvial-fan deposits and colluvial deposits at valley margins

Qc **Colluvium (Holocene and Pleistocene)**--Poorly sorted silt- to boulder-size material on slopes and in steep valleys. Locally includes small alluvial-fan, talus, and landslide deposits

QTls **Landslide deposits (Quaternary or Tertiary)**--Deposits formed by gravity sliding or flowage. Includes lobate accumulations of poorly sorted soil and rock debris (earthflow deposits) characterized by hummocky topography; occurs on slopes and as eroded outliers. Cuspate breakaway scarps (hachured on map) exposed at heads of some deposits. Degree of erosion, and alteration, as well as proximity to Tertiary normal faults and to margin of Turkey Creek caldera suggest a Tertiary age for some deposits

TERTIARY ROCKS ASSOCIATED WITH THE TURKEY CREEK CALDERA

Moat deposits and related dikes

A sequence of rhyolite lava flows and tuffs, their feeder dikes, and subordinate sedimentary rocks deposited in moat of Turkey Creek caldera. The tuff map units contain block-and-ash flows, probably derived from collapse of lava domes, as well as variably welded pumiceous ash-flow tuffs. Gradational contacts between welded tuffs and overlying rhyolite lavas in several localities suggest that some of the lavas are rheomorphic tuffs

Aphyric rhyolite lava and rhyolite tuff (Oligocene)--Aphyric or sparsely porphyritic high-silica rhyolite lava flows and tuffs. Divided into two eruptive units on the basis of stratigraphic position, subtle petrographic differences, and distinct trace-element geochemistry (Pallister and du Bray, 1989). Arcuate map distribution, tabular form, lack of preserved lava dome morphology, and aphyric character suggest accumulation of hot (near or above liquidus) and relatively low-viscosity lava flows within caldera moat

Tmr_2 **Unit 2 (rhyolite lava)**--Light-gray to reddish-gray phenocryst-poor rhyolite lava (76-78 percent SiO_2). Flow layered and intricately flow folded, locally massive. Aphyric or sparsely (0-2 percent) porphyritic or microporphyritic with small (<1 mm) phenocrysts of sanidine, quartz, and Fe-Ti oxides; accessory biotite and zircon present in some samples. Devitrified, except at basal flow contact where black or green glassy carapace breccia (shown on map) or flow-layered perlite is locally exposed. Spherulitic and axiolitic (with respect to flow layers) devitrification and granophyric recrystallization common. Contains secondary (vapor-phase) quartz and feldspar crystals, commonly (1) within or between thin flow bands, (2) concentrated in amygdules, (3) in cores of spherulites, or (4) forming a patchy granophyric groundmass. Forms resistant ledges and massive cliffs in exhumed moat of Turkey Creek caldera. Maximum thickness approximately 300 m

Tmt_2 **Unit 2 (tuff)**--Pyroclastic-flow deposits and intercalated air-fall tuff and volcaniclastic sedimentary rocks. Mainly light-gray to orange or pink, poorly to densely welded, crystal-poor, rhyolite ash-flow tuff. Typically very sparsely porphyritic (<1 percent) with small (<1 mm) phenocrysts of quartz and sanidine, and microphenocrysts of oxide minerals. Similar in phenocryst assemblage and chemistry to overlying rhyolite lava (Tmr_2). Some ash flows contain more abundant (about 1 percent) phenocrysts of plagioclase, sanidine, and accessory biotite. Pumice fragments show axiolitic devitrification and granophyric cores. Degree of welding variable within and between flows. Individual ash flows and intercalated volcaniclastic sedimentary beds range in thickness from <1 m to several tens of meters. Forms multiple low-relief cliffs or slopes below steeper cliffs of rhyolite lava (Tmr_2). Maximum thickness approximately 100 m

Tmr_1 **Unit 1 (rhyolite lava)**--Light-gray to reddish-gray or brown rhyolite lava (76-78 percent SiO_2). Flow layered and intricately flow-folded, locally massive. Typically aphyric or crystal poor (<5 percent) with sanidine, quartz, and oxide minerals; locally contains trace plagioclase, hornblende, and clinopyroxene. Some plagioclase and mafic silicates form crystal clots, are resorbed, and are likely xenocrystic. Similar to rhyolite lava of eruptive unit 2 (Tmr_2), except for more variable phenocryst assemblage, less evolved trace-element composition (Pallister and du Bray, 1989), and stratigraphic position. Devitrified, except at basal flow contact where perlitic glass is exposed and locally contains spherulitic zones and geodes. Carapace breccia locally exposed at margins of lava flows (shown on map). Flow interiors show granophyric groundmass recrystallization and contain vapor-phase quartz and feldspar in amygdules. Forms cliffs and slopes below eruptive unit 2 within exhumed moat of Turkey Creek caldera. $^{40}Ar/^{39}Ar$ ages: 26.64±0.13 Ma and 26.93±0.17 Ma for lava samples from near Ida Peak and at Flys Peak (0.2 km south of map area), respectively. Thickness 0-150 m

Tmt_1 **Unit 1 (tuff)**--Pyroclastic flow and surge deposits. Gray to dark-brown or purplish-brown, densely to poorly welded, typically aphyric or crystal-poor (<2 percent quartz and sanidine) rhyolite ash-flow tuff and light-gray surge beds. Basal vitrophyre passes upward into rheomorphic tuff with convoluted flow banding where member is well exposed near Rock Canyon in adjacent Fife Peak 7½-minute quadrangle. Thickness 0-30 m

Tmrq **Quartz-sanidine rhyolite lava (Oligocene)**--White to light-gray, flow-folded lava. Contains phenocrysts and microphenocrysts of sanidine (10-15 percent) and quartz (5-10 percent), and trace amounts of Fe-Ti oxides, biotite, and hornblende. Correlation uncertain; chemically similar to rhyolite lava of eruptive unit 2 (Tmr_2), but abundance of phenocrysts is anomalous for unit 2; appears to underlie rhyolite lavas of eruptive units 1 and 2. Only mapped between Ida and Barfoot Peaks. Rhyolite dike to north (Tmrd) is sanidine quartz porphyry, and may be eroded feeder for unit Tmrq. Maximum thickness 70 m

Tmrd **Rhyolite dikes (Oligocene)**--White, aphyric or quartz-phyric rhyolite and silicified rhyolite. Dikes near El Tigre mine probably represent feeders for moat deposit rhyolites

Tmrb **Biotite rhyolite lava (Oligocene)**--Biotite-bearing rhyolite lava flows and domes. Gray to brownish- or yellowish-gray (devitrified) or black (glassy), crystal-rich (5-20 percent) rhyolite (73-74 percent SiO_2). Contains crystals of plagioclase, sanidine, quartz, biotite, Fe-Ti oxides, and trace zircon and monazite. Plagioclase forms small (<1 mm) oscillatory zoned (andesine cores) crystals; xenocrystic origin suggested by common resorption, wormy glass inclusions, and occurrence in small crystal clots, commonly with biotite. Obsidian or perlite may be preserved at basal contact and is locally spherulitic; flow interiors devitrified and locally granophyric. Thickness 0 to >300 m; maximum thickness in graben near Rattlesnake Peak and at Fife Peak (west of map area)

Tmtb **Biotite rhyolite tuff (Oligocene)**--Biotite-bearing pyroclastic-flow deposits. Yellow-brown to orange, massive to poorly bedded block-and-ash deposits composed of 30-40 percent pumice blocks (1-20 cm in diameter) and 10-20 percent rhyolite lithic clasts in an ashy matrix; pumice blocks and ashy matrix both contain 2-5 percent small (<1-2 mm) phenocrysts of plagioclase, sanidine, quartz, conspicuous biotite, and Fe-Ti oxides. Pink to orange pumiceous ash-flow tuffs exposed locally. Pyroclastic equivalent of biotite rhyolite lava (Tmrb); formed by explosive eruptions and by collapse of biotite rhyolite lava domes. Slope forming, and typically poorly exposed, except where block-and-ash flows are thick, as in Fife Canyon 7½-minute quadrangle to west. Only exposed at western edge of map area in Fife Canyon. Thickness 0-120 m

Tms **Sedimentary rocks (Oligocene)**--Red to reddish-brown or orange, interbedded volcaniclastic breccia, conglomerate, and sandstone. All contain abundant volcanic debris; clasts of Rhyolite Canyon Tuff and dacite porphyry present at some localities. Matrices typically are fine grained, highly altered, hematitic, and probably ash rich. Thickness approximately 0-10 m in map area; thicker to south in Chiricahua Peak 7½-minute quadrangle

Resurgent intrusion, ring dike, and extrusive equivalents

Dacite and monzonite porphyry (Oligocene)--Gray to tan, feldspar porphyritic dacite (63-67 percent SiO_2). Modal compositions on relatively coarse grained holocrystalline samples vary from monzonite to quartz monzonite, and locally to monzogranite. Forms resurgent intrusion (Tdpi) and ring dike within Turkey Creek caldera; ring dike is feeder for, and is buried by, dacite porphyry lava flows (Tdpl). Intrusive and extrusive phases of porphyry both contain megacrysts (5 mm to >3 cm across) of alkali feldspar and plagioclase, and small (typically 1 cm across) hornfels inclusions. Alkali feldspar (sanidine) is commonly zoned, forms overgrowths on plagioclase, and is variably exsolved to microperthite where slowly cooled within interiors of thick lava flows (Tdpl) and in the resurgent intrusion (Tdpi); cores of some alkali feldspar grains are resorbed. Plagioclase phenocrysts are zoned from albite rims to andesine cores. Porphyry also contains phenocrysts (1-3 mm) or glomerocrysts of albite-andesine, and phenocrysts or microphenocrysts of sanidine, quartz, biotite, hornblende, clinopyroxene, Fe-Ti oxides, and trace apatite, zircon, and sphene. Phenocryst assemblage highly variable. Phenocrysts of quartz are present locally and are resorbed (although groundmass quartz is abundant in granophyre); plagioclase is absent in some samples, but alkali feldspar megacrysts or phenocrysts are ubiquitous. Clinopyroxene and hornblende are common accessory or trace phases, but are less common than biotite. Groundmass grades from coarse "cuneiform" granophyre, most common at lowest exposed levels of resurgent intrusion (Tdpi), through medium- or fine-grained granophyre to glassy textures (hyalopilitic to holohyaline) at shallow levels and in lava flows vented from ring intrusion.

$^{40}Ar/^{39}Ar$ ages: 26.97±0.13 for a sample of dacite lava (Tdpl) from northeast of Barfoot Peak, and 26.84±0.13 Ma for a sample from resurgent intrusion (Tdpi) near Turkey Pen Canyon (0.15 km south of map area)

Tdpi **Resurgent intrusion**--Massive, highly jointed dacite and monzonite porphyry exposed within center of caldera. Chemically equivalent to dacite porphyry lava flows (Tdpl); petrographically similar to all but the most shallow exposures of unit Tdpl. Intrudes and metamorphoses intracaldera Rhyolite Canyon Tuff (Trci) along a contact that dips away from center of caldera. Absence of caldera floor rocks between resurgent intrusion and intracaldera tuff, scarcity of megabreccia (br) in tuff, and lack of chemical equivalents of lower (Trcl) and middle (Trcm) members of outflow facies within intracaldera tuff suggest that resurgent phase of porphyry may be a thick (>1 km) sill within caldera fill, possibly analogous to a dacite porphyry sill in the slightly older Portal caldera to southeast (Bryan, 1989). Emplacement at a level above intracaldera equivalents of lower and middle members of outflow facies tuff may explain their absence within intracaldera tuff. Resurgent intrusion is probably continuous in subsurface (beneath Trci) as a ring dike feeder for dacite porphyry lava flows (Tdpl)

Tdpl **Dacite porphyry lava flows**--An accumulation of thick lava flows within moat of caldera. May include endogenous sills and exposures of ring dike feeder at low stratigraphic levels. Petrographically and chemically similar to resurgent intrusion (Tdpi), except for flow-folded upper zones and dacite porphyry glass (gl). Locally displays vesicles or miarolitic cavities. Dacite porphyry lava flows overlie and extend outward from ring intrusion into caldera moat, producing the wide arcuate exposure and series of thick cliffs and ledges that characterize unit. Individual flows (flow contacts shown on map) >200 m thick and form a section at least 0.5 km thick near topographic margin of caldera

gl **Dacite porphyry glass**--Flow breccia composed of black perlitic dacite porphyry glass, locally in devitrified matrix. Forms zones of carapace breccia at base of uppermost dacite porphyry lava flows (Tdpl). Best exposed on ridgecrest southwest of Buena Vista Peak. Thickness 0-10 m

Rhyolite Canyon Tuff (Oligocene)

As used here is redescribed as a quartz-sanidine rhyolite ash-flow tuff (76-78 percent SiO_2) erupted from Turkey Creek caldera (see "Revision of Stratigraphic Nomenclature" section). Phenocrysts almost entirely sanidine and quartz; sanidine typically more abundant (ratios vary from 2:1 to about 1:1). Divided into intracaldera and outflow facies; intracaldera facies (Trci) is chemically equivalent to only the uppermost member of outflow facies (not present in map area); lower and middle members (Trcm, Trcl) are slightly more siliceous and have distinct trace-element abundances (Latta, 1983; Pallister and du Bray, 1989). $^{40}Ar/^{39}Ar$ ages for samples from type section of outflow facies (north of map area) are 26.94±0.16 and 26.93±0.12 Ma for upper and lower members, respectively. Contact between Rhyolite Canyon and underlying Jesse James

Canyon Tuff (Tjj) is a disconformity, locally marked by several meters of fluvial sandstone and breccia. Intracaldera facies tuff contains rare zones of megabreccia (br) and is locally melted to produce intrusive bodies of aplite and rhyolite (Trca)

Trca **Aplite and rhyolite**--Rootless dikes and sills of quartz-sanidine rhyolite and aplite formed by in situ melting of intracaldera Rhyolite Canyon Tuff (Trci) at the contact with dacite porphyry of resurgent intrusion (Tdpi)

Trci **Intracaldera facies**--Reddish-brown, red, pink, orange, or gray rhyolite ash-flow tuff. Lithic poor to lithic rich (typically <5-20 percent) and crystal rich (10-30 percent). A compound cooling unit consisting of a thick (>1 km) lower cooling unit and an upper composite(?) cooling unit composed of several thin ash flows, locally rich in dark-gray fiamme. Contacts between lower and upper cooling units, and between ash flows in upper unit, marked by light-gray ash beds (shown on map) and locally by vitrophyre at base of upper unit.

Sanidine chalky (partly replaced by clay minerals), except at high stratigraphic levels and near contact with resurgent intrusion (Tdpi) where chatoyant crystals are present; quartz rounded and resorbed. Accessory Fe-Ti Fe-Ti oxides and trace clinopyroxene variably hematized and replaced by alteration minerals. Dark-gray fiamme in upper cooling unit contain variably disaggregated feldspar megacrysts in an aphanitic groundmass; fiamme macroscopically similar to glassy and fine-grained extrusive phases of dacite and monzonite porphyry (Tdpl). Densely welded, but recrystallization commonly obscures eutaxitic foliation. Foliation dips radially away from center of caldera due to doming, presumably accompanying intrusion of resurgent intrusion. Intracaldera tuff is intruded and metamorphosed by porphyry (Tdpi) at base. Tuff near contact recrystallized to granophyre and locally melted to produce rhyolite and aplite dikes and sills (Trca). Thickness 1-1.5 km above intrusive contact with porphyry

br **Megabreccia**--Isolated outcrops of variably brecciated volcanic and sedimentary rocks in a tuff matrix (Trci); thought to represent landslide megablocks (as much as 400 m long) and breccias derived from walls of Turkey Creek caldera during collapse. Unit contains a slab of fossiliferous limestone (shown on map) north of Fitch Corral and several lenses of brecciated dacite. The latter are mainly biotite dacites (67 percent SiO_2) that contain large (1-4 mm), oscillatory zoned crystals of oligoclase, resorbed quartz, biotite, and opacite pseudomorphs after euhedral-subhedral biotite and hornblende(?) in a devitrified and recrystallized hyalopilitic or pilotaxitic groundmass. Groundmass textures suggest that the dacites are fragments of lava flows. Petrographically and chemically distinct from other dacites associated with Turkey Creek caldera (Pallister and du Bray, 1989); similar to dacites of the Faraway Ranch Formation (Tfv) by virtue of having biotite phenocrysts and similar trace- and major-element chemistry

Limestone megabreccia block--Gray, fossiliferous limestone exposed in valley north of Fitch Corral

Outflow facies--Light-gray to tan quartz-sanidine rhyolite ash-flow tuff. Lithic poor (<5 percent) and crystal rich (10-20 percent). Sanidine chatoyant and forms subhedral, lath-shaped crystals, 1-4 mm in length. Quartz typically rounded and embayed, <1-3 mm in diameter. Also contains accessory Fe-Ti oxides and trace clinopyroxene (augite), zircon, and apatite. Eutaxitic and vitroclastic; locally spherulitic; granophyric recrystallization within interiors of thick cooling units. Pumice lapilli commonly display axiolitic devitrification and vapor-phase recrystallization.

A compound cooling unit (Smith, 1960), consisting of upper (not present in map area), middle (Trcm), and lower (Trcl) members (depositional units) separated by air-fall and surge deposits (fig. 1). Each member contains one or more individual ash-flow deposits that were erupted in rapid succession and cooled together. Trace clinopyroxene most common in upper member. Middle and lower members form prominent cliffs and dissected plateau near northern boundary of map area. Composite thickness at type section approximately 400 m

Trco **Outflow facies, undivided**

Trcm **Middle member of outflow facies**--Interior of member is densely to moderately welded pumiceous ash-flow tuff. Weakly-welded zone exposed at top, below basal surge beds of upper member of outflow facies, north of map area (Pallister and others, 1990). Basal vitrophyre locally present where directly in contact with underlying Jesse James Canyon Tuff (Latta, 1983). A thin (<2 m) densely welded ash flow occurs at contact with lower member (Trcl) north of map area in Chiricahua National Monument; it was presumably welded by overlying main part of middle member. Forms prominent cliffs and rock formations. Thickness approximately 270 m near northern edge of map area

Trcl **Lower member of outflow facies**--Distinct red-brown basal zone composed of vitrophyre and lithic-rich, densely welded tuff overlain by a light-gray, moderately to densely welded upper zone (contact shown on map). Bedded air-fall or surge deposits occur locally at base. Contact with overlying middle member is typically a sharp welding break; however, Latta (1983) described a gradational contact in northern part of Chiricahua National Monument. Thickness 0-145 m; pinches out to east against a lava dome in underlying Faraway Ranch Formation (Tfrh)

TERTIARY VOLCANIC AND SEDIMENTARY ROCKS THAT PREDATE THE TURKEY CREEK CALDERA

Tjj **Jesse James Canyon Tuff (Oligocene)**--See "Revision of Stratigraphic Nomenclature" section for complete definition of this new unit. Light-gray or pinkish-gray, typically lithic poor, moderately crystal rich (approximately 10 percent), biotite-bearing quartz-sanidine rhyolite (76-77 percent SiO_2) ash-flow tuff from undetermined source. Similar to middle and lower members of Rhyolite Canyon Tuff (Trcm, Trcl); distinguished by presence of trace biotite and sphene, absence of clinopyroxene, higher ratio of sanidine to quartz (3:1 or greater), less-evolved chemistry, and stratigraphic position. Forms a simple cooling unit; weakly welded upper zone grades downward into densely welded, eutaxitic lower zone; basal vitrophyre exposed locally. Thickness approximately 240 m at the type area near Jesse James Canyon, thins to north and northwest

Tc **Conglomerate (Oligocene?)**--Bedded cobble conglomerate and breccia. Unconformably overlies, and contains clasts derived from, sedimentary and volcanic rocks of Pinery Canyon (TKp). Also contains clasts of rhyolite and dacite of probable Oligocene age. Spatially associated with high-angle Tertiary faults and with topographic margin of Turkey Creek caldera, but does not contain clasts of Turkey Creek caldera rocks. Correlative with the informal El Tigre conglomerate of Tsugii (1984)

Faraway Ranch Formation (Oligocene)--An assemblage of interfingering lava flows and near-source pyroclastic rocks that underlie Jesse James Canyon Tuff at Erickson Ridge and west of Hands Pass in northern part of map area and in type area near Faraway Ranch just north of map area (Enlows, 1955; Fernandez and Enlows, 1966). K/Ar (biotite) ages 28.6±2.0 and 28.3±0.8 Ma (recalculated using IUGS constants--Steiger and Jäger, 1977) for samples of rhyolite lava from Erickson Ridge (Tfre) (Marjaniemi, 1969)

Tfre **Rhyolite of Erickson Ridge**--Light-gray (devitrified) to black (glassy) biotite rhyolite (73 percent SiO_2). Contains phenocrysts of oscillatory zoned oligoclase-albite (3-7 percent) and biotite (1-2 percent). Plagioclase is typically subhedral, but broken crystals are also present; biotite variably replaced by opacite. Accessory or trace sphene occurs as relatively large (as much as 1 mm) euhedral phenocrysts. Forms small lava domes and lobate flow-layered lava flows with black glassy carapace breccias. Equivalent to Faraway Ranch Formation member 7 of Fernandez and Enlows (1966). Thickness variable; as much as 150 m thick near Faraway Ranch, just north of map area

Tfpe **Pyroclastic flow deposits of Erickson Ridge**--Light-gray to orange block-and-ash flow, ash-fall, and surge deposits and ash-rich lahars interbedded with Rhyolite of Erickson Ridge (Tfre). Partly equivalent to Faraway Ranch Formation member 6 of Fernandez and Enlows (1966). Locally includes reworked volcaniclastic sedimentary deposits. Thickness 0-60 m

Tfrh **Rhyolite of Hands Pass**--Light-gray, quartz-sanidine rhyolite (77-78 percent SiO_2). Contains subhedral 1 to 3 mm sanidine (2-5 percent) and resorbed 1 to 2 mm quartz (1-4 percent) phenocrysts and accessory or trace opacitized biotite and Fe-Ti oxides, typically in a spherulitic to granophyric devitrified groundmass. Forms a prominent lava dome overlain by Rhyolite Canyon Tuff near Hands Pass. Thickness 0-130 m

Tfph **Pyroclastic flow deposits of Hands Pass**--Light-gray to orange block-and-ash flow, ash-fall, ash-rich lahar, and volcaniclastic sedimentary deposits underlying and forming a pyroclastic apron adjacent to Rhyolite of Hands Pass (Tfrh). Thickness 0-70 m

Tft **Welded tuff of Riggs Spring**--Gray to pink, crystal-rich (15-25 percent) biotite-quartz-sanidine rhyolite (72-73 percent SiO_2). Lithic-poor (<10 percent), crystal-rich (15-25 percent), moderately welded ash-flow tuff. Contains 10-15 percent sanidine, 5-7 percent quartz, 1-3 percent biotite, and about 1-2 percent plagioclase in a eutaxitic vitroclastic matrix. Forms remnant of outflow sheet atop ridges southwest of Riggs Spring at Pinery Creek. Weathers to bouldery gruss-covered upper surface. May be correlative with Faraway Ranch Formation member 3 of Fernandez and Enlows (1966), which has a K/Ar (sanidine) age of 29.6±1.9 Ma, although locality for this age uncertain (see Marjaniemi, 1969; Drewes, 1982). Thickness approximately 130 m; top eroded

Tfv **Volcanic and volcaniclastic rocks, undifferentiated**--Mainly red to brown, biotite- and hornblende-bearing plagioclase porphyritic dacite, andesite, and basaltic andesite. Poorly exposed and highly weathered; forms slopes and underlies landslide deposits in Pinery Canyon

TERTIARY INTRUSIVE ROCKS

Tr **Rhyolite dikes (Oligocene?)**--Light-gray to pink or tan aphyric or quartz and (or) feldspar porphyritic rhyolite dikes. Intrude pre-Turkey Creek caldera rocks

Td **Dacite dikes (Oligocene?)**--Gray to red-brown, plagioclase porphyritic dacite. One large dike grades into aplitic phase of granite porphyry of Jhus Canyon (Tg)

Tg **Granite porphyry of Jhus Canyon (Oligocene)**--Pinkish-gray to tan, highly weathered and altered syenogranite to alkali feldspar rhyolite and aplitic granite porphyry. Phenocrysts of highly altered feldspars (sanidine or orthoclase, 10 percent; oligoclase, 5 percent) and subhedral or resorbed quartz (5 percent) in a fine-grained granophyric groundmass of quartz and alkali feldspar; alaskitic. Chloritized biotite and Fe-Ti oxides common accessories; trace hornblende and sphene present locally. Propylitic, argillic, and phyllic alteration widespread; host rocks contact metamorphosed. Tan to reddish-brown outcrop colors dominate where porphyry is sericitized. Pyrite and minor chalcopyrite and molybdenite present locally. The stock and its alteration types were compared to Laramide-age porphyry base-metal deposits by Chakarun (1973). Locally gradational with granodiorite of Mackey Canyon (Tgd), probably as a subvolcanic cupola of high-silica magma developed at top of a composite pluton

Tgd **Granodiorite of Mackey Canyon (Oligocene)**--Light-gray, medium- to coarse-grained, hypidiomorphic-granular hornblende-biotite granodiorite to monzogranite. Biotite and hornblende subequal in abundance, together about 10 percent of rock. Accessory magnetite and sphene, and trace zircon and apatite; pyrite present locally. Weathers to gruss-covered surfaces; solid rock exposures only found in bottoms of ravines. $^{40}Ar/^{39}Ar$ ages 32.17±0.21 (hornblende) and 30.62±0.15 Ma (biotite) for a sample from approximately 2 km east of map area in Jhus Canyon

OLDER ROCKS

Sedimentary and volcanic rocks of Pinery Canyon (Cretaceous or Tertiary)

Interbedded mafic volcanic rocks, graywacke, and lacustrine(?) siltstone and limestone beds; intruded by diabase and microgabbro dikes and sills. Mafic volcanic and intrusive rocks typically altered. Characterized by facies changes from proximal volcanic and fluvial to relatively deep water over short lateral and vertical distances. Stratigraphic correlation and age uncertain. Considered by Harald Drewes (written communication, 1990) to be correlative with the Cintura Formation of the Lower Cretaceous Bisbee Group. May also be correlative with Nipper Formation of Sabins (1957). Stratigraphic position and inferred fluvial and lacustrine settings similar to Upper Cretaceous Fort Crittenden Formation in southern Chiricahua Mountains (Lindberg, 1987). Possible Tertiary age (31.8±0.7 Ma--Shafiqullah and others, 1978) based on whole-rock K/Ar determination on basalt within shale facies (TKps) 0.3 km east of map area on road to Portal, Ariz. Ages of approximately 32 Ma also reported for andesites near Cochise Head, 7.7 km north of map area (Drewes, 1982).

TKp **Sedimentary and volcanic rocks of Pinery Canyon, undivided**--Shown only on cross section A-A'

TKpa **Arkose facies**--Light-gray to tan, medium- to fine-grained arkose, siltstone, shale, pebblestone, and interbedded thin (<1m) silty limestone beds. Composed of angular to subangular grains of feldspar (zoned plagioclase as well as orthoclase and microcline, 10-40 percent), angular to rounded grains of quartz (both single- and multi-domain grains, 20-60 percent), and lithic clasts (mostly fine grained volcanic fragments or granophyres, 10-30 percent). Abundance and type of volcanic detritus highly variable. Some samples contain porphyritic andesite or basalt, and sparse flow-layered rhyolite lithic fragments. Commonly cemented with secondary silica. Interbedded with and overlies basalts or basaltic andesites (TKpv) near Onion Saddle. Thickness 50-100 m

TKpv **Basalt and graywacke facies**--Dark-green to dark-gray basalt, andesite, diabase, microgabbro, and interbedded sedimentary rocks. Variably altered to greenschist-facies assemblages of chlorite, calcite, albite, epidote, and magnetite; hypabyssal rocks typically less altered than volcanic and sedimentary rocks. Northern exposures of facies (well exposed in Horsefall Canyon) consist mainly of graywacke and laminated siltstone, both rich in basaltic debris, intruded by a complex of diabase dikes and sills, and locally overlain by basaltic breccias and lavas. Southern exposures, such as near Onion Saddle, consist of thin (1-3 m) basalt or andesite lava flows interbedded with arkose (TKpa). Some basalt flows contain olivine (pseudomorphed by chlorite and calcite) and plagioclase phenocrysts. Contact with underlying Bisbee Group (Kb) is a disconformity or (locally) an angular unconformity. Thickness >300 m south of Horsefall Canyon

TKps **Shale facies**--Interbedded black shale and siltstone, olive-green spheroidal-weathering graywacke, and subordinate arkose, chert, and fine-grained black limestone; well exposed in north fork of East Turkey Creek, southeast of Turkey Park. Interbedded limestone cobble conglomerate, basaltic lavas and diabase or microgabbro sills locally present. Thickness >200 m; base not exposed

Bisbee Group (Lower Cretaceous)

Kb **Bisbee Group(?), upper part, undivided**--Tan, thin-bedded, laminated silty limestone, interbedded with siltstone and shale. Blue-gray cherty limestone, and black fine-grained limestone beds locally present. Thickness approximately 1.2 km near Shaw Peak

Kg **Glance Conglomerate of Bisbee Group**--Cobble, pebble, and boulder conglomerate composed of subrounded to subangular clasts of Paleozoic limestone. Thickness 0-20 m; thicker north of map area

Paleozoic sedimentary rocks

Pcn **Concha Limestone (Lower Permian)**--Dark-gray, thick-bedded, fossiliferous, cherty limestone. Fossils include large productid brachiopods. Thickness 190-200 m

Ps **Scherrer Formation (Lower Permian)**--Light-gray to pinkish-gray, fine-grained, nearly massive sandstone and quartzite. Thickness >50 m

Pec **Epitaph Dolomite and Colina Limestone, undivided (Lower Permian)**--Dark-gray, coarse-grained, sparsely fossiliferous, slightly cherty limestone, and local light-gray, fine-grained, limy dolomite. Fossils include large echinoid spines and gastropods. Thickness 164 m

Pea **Earp Formation (Lower Permian)**--Pale-red siltstone and argillaceous limestone; interbedded with light-gray to yellowish-gray limestone. Thickness >300 m

P|Ph **Horquilla Limestone, undivided (Lower Permian and Pennsylvanian)**--Shown undivided where subdivision of formation impractical in small fault blocks

Phu **Upper member (Lower Permian)**--Light-gray thin- to thick-bedded fine-grained calcilutite, coarse-grained bioclastic and fossiliferous cherty limestone, and interbedded pink siltstone. Thickness about 400 m

|Phl **Lower member (Pennsylvanian)**--Light-gray, thick-bedded, fine-grained to coarsely bioclastic limestone and reddish-gray siltstone interbedded as partings a few centimeters thick. Chert occurs as small nodules and thin lenses. Fossils include corals, brachiopods, and fusulinids. Thickness about 500 m

Mp **Paradise Formation (Upper Mississippian)**--Light-gray to light-olive-gray, thin-bedded, nonresistant, shale, siltstone, and limestone. Thickness 47 m

Me **Escabrosa Limestone (Mississippian)**--Light- to medium-gray, thick-bedded, bioclastic cherty limestone; crinoid bearing. Chert nodules abundant in upper part. Thickness about 190 m

Dp **Portal Formation of Sabins (1957) (Upper Devonian)**--Typically olive-gray to dark-gray fissile shale interbedded with medium-gray, fine-grained, thin-bedded to nodular limestone. Thickness about 120 m

Oe **El Paso Limestone (Lower Ordovician)**--Mostly light-gray to medium-gray and light-brownish-gray, fine-grained, thin- to medium-bedded, slightly cherty dolomite, limestone, and some dolomitic siltstone. Sparsely fossiliferous. Thickness 137 m

Coronado Sandstone (Upper Cambrian)--Also called Bolsa Quartzite; name Coronado replaces Bolsa in this area (Hayes and Cone, 1975)

Ɛcs **Sandstone member**--Light-gray to light-brownish-gray, thin- to thick-bedded sandstone, arkose, and siltstone. Some beds glauconitic and slightly greenish brown. About 90 m thick

Ɛcq **Quartzite member**--Mostly light-gray to brownish-gray (some purplish-gray), thin- to thick-bedded quartzite and arkose.

Locally includes basal conglomerate and intercalated conglomerate lenses in lower half of member. About 25 m thick

Precambrian basement

Yg **Granodiorite (Middle Proterozoic)**--Brownish-gray, coarse-grained feldspar porphyritic biotite granodiorite and monzogranite. Locally orbicular. Includes small bodies of aplite. Biotite variably replaced by chlorite. Accessory Fe-Ti oxides, and trace sphene, apatite, and zircon

Contact--Dashed where approximately located

Contact between dacite porphyry lava flows (Tdpl)

Ash bed within intracaldera facies of Rhyolite Canyon Tuff (Trci)

Contact within lower member of outflow facies (Trcl) between red-brown basal zone and light-gray upper zone

Unconformity along caldera wall, between moat deposits and underlying Rhyolite Canyon Tuff--Semicircles on down-dip side. Dotted where concealed

Structural margin of Turkey Creek caldera--Dotted where concealed and position approximate. Hachures on downthrown side

Fault--Dashed where approximately located; dotted where concealed

High-angle fault--Bar and ball on downthrown side where relative movement known

Thrust fault--Sawteeth on upper plate

Quaternary and Tertiary landslide scarp--Hachures on downthrown side

Strike and dip of bedding

- Inclined
- Vertical
- Horizontal
- Overturned

Strike and dip of foliation

- Inclined
- Vertical

Strike and dip of joints

- Inclined

Radiometric-dating sample locality--Ages and uncertainties in Ma

- $^{40}Ar/^{39}Ar$ age
- K-Ar age

Quartz vein

Zones of silicification

Carapace breccia--Exposed at margins of rhyolite lava flows. Typically black perlitic glass blocks in a devitrified matrix

INTRODUCTION

The Rustler Park quadrangle straddles the northeastern margin of the Turkey Creek caldera, a mid-Tertiary (27 Ma) volcanic depression formed during eruption of the Rhyolite Canyon Tuff and partial evacuation of an underlying rhyolitic to dacitic magma chamber. The caldera is deeply eroded; volcanic and shallow plutonic levels are exposed. Shortly after eruption of the Rhyolite Canyon, the central part of the caldera was intruded and domed and the structural margin was intruded by dacite and monzonite porphyry. Porphyry was erupted from an associated ring dike and formed a series of thick lava flows within the caldera moat. A series of rhyolite lava flows, small-volume tuffs, and sedimentary rocks were then deposited in the caldera moat. A steep northeast-trending normal fault bisects the map area and provides adjacent exposures of both shallow and deep levels of the caldera moat. Wall rocks of the caldera are exposed on the upthrown (east) side of the fault, where a structurally complicated Paleozoic sedimentary section is overlain by Cretaceous and possibly Tertiary rocks. A change in basement rocks across the fault and occurrence of the outflow facies of the Rhyolite Canyon Tuff in a paleobasin on the downthrown (west) side of the fault suggest that it was active prior to, as well as after, caldera collapse.

Erosion has modified the topographic expression of the caldera. The former topographic high at the caldera rim was located within what is now Pinery Canyon. Erosion-resistant moat lavas and the ring intrusion now underlie the topographic highlands in the southeastern part of the map area.

REVISION OF STRATIGRAPHIC NOMENCLATURE

The outflow facies of the Rhyolite Canyon Tuff is herein restricted to include only informal members 3-8 of the Rhyolite Canyon Formation of Enlows (1955), which are equivalent to map units Trls, Trus, Trat, and Truw of Drewes (1982) and to the informal Monument member of the Rhyolite Canyon Formation of Latta (1983) (fig. 1). Enlows' informal member 2 of the Rhyolite Canyon Formation is excluded from the Rhyolite Canyon Tuff and reassigned to the herein named Jesse James Canyon Tuff, which is also equivalent to the Jesse James Canyon member of the Rhyolite Canyon Formation of Latta (1983). Enlows identified his member 1 only near Picket Park in Chiricahua National Monument, north of the map area. He described it as a dark-gray, 10-m-thick densely welded tuff that disconformably(?) underlies his informal member 6, and unconformably overlies the Faraway Ranch Formation. His member 1 may be the distal edge of the lower member of the Rhyolite Canyon Tuff (Trcl, as defined here) that was welded by the overlying thick middle member (Trcm). However, certain correlation of this informal unit is not currently possible; member 1 is not shown in figure 1. Enlows' uppermost member 9 is also excluded from the Rhyolite Canyon Tuff and reassigned to the informal dacite of Sugarloaf Mountain (Trrf; Drewes, 1982). It is probably correlative with the dacite porphyry lava flows (Tdpl) within the moat of the Turkey Creek caldera.

The type area for the Rhyolite Canyon Tuff is in Chiricahua National Monument, 1 km north of the map area. Representative sections in this area are located between Rhyolite Canyon and Sugarloaf Mountain, and at Riggs Mountain. The type area for the Jesse James Canyon Tuff is in the vicinity of Jesse James Canyon, for which the unit is named, near the northern edge of the map area. The Rhyolite Canyon Tuff is here assigned an Oligocene age on the basis of new high-precision $^{40}Ar/^{39}Ar$ ages of 26.94±0.16 and 26.93±0.12 Ma. Earlier K-Ar age determinations gave approximately 25 Ma, and a Miocene age was assigned to the Rhyolite Canyon Formation by Drewes (1982). Limited erosion between the Jesse James Canyon and overlying Rhyolite Canyon suggests that the Jesse James Canyon is only slightly older than the Rhyolite Canyon; an Oligocene age is assigned.

This stratigraphic revision is done to better accommodate modern concepts of ash-flow tuff deposition (Smith, 1960; Christiansen, 1979) and to allow assignment of formation-rank units to major ash-flow tuff deposits from individual calderas. The Rhyolite Canyon Tuff is a composite ash-flow sheet that was erupted from, and fills, the Turkey Creek caldera. The Jesse James Canyon Tuff as defined here consists of a simple cooling unit of high-silica ash-flow tuff that disconformably underlies the Rhyolite Canyon Tuff. The Jesse James Canyon Tuff is distinguished from the Rhyolite Canyon Tuff by the presence of trace biotite and sphene, absence of trace clinopyroxene, higher ratio of sanidine to quartz, less-evolved chemistry, and lower stratigraphic position. The Jesse James Canyon Tuff has higher abundances of Mg and Ca and lower Rb, Zr, and rare-earth elements than the Rhyolite Canyon Tuff (Pallister and du Bray, 1989; Pallister and others, 1990). These differences in petrography and chemistry suggest that the Jesse James Canyon Tuff was not derived from the Turkey Creek caldera; the source is currently unknown.

ACKNOWLEDGMENTS

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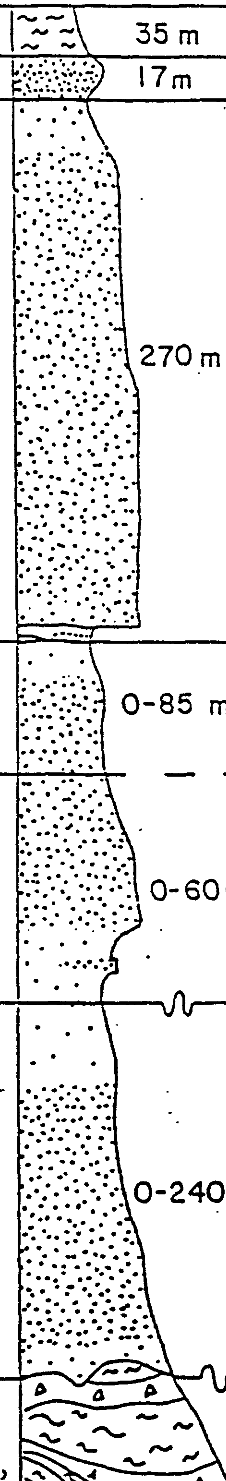
Fig. 1.

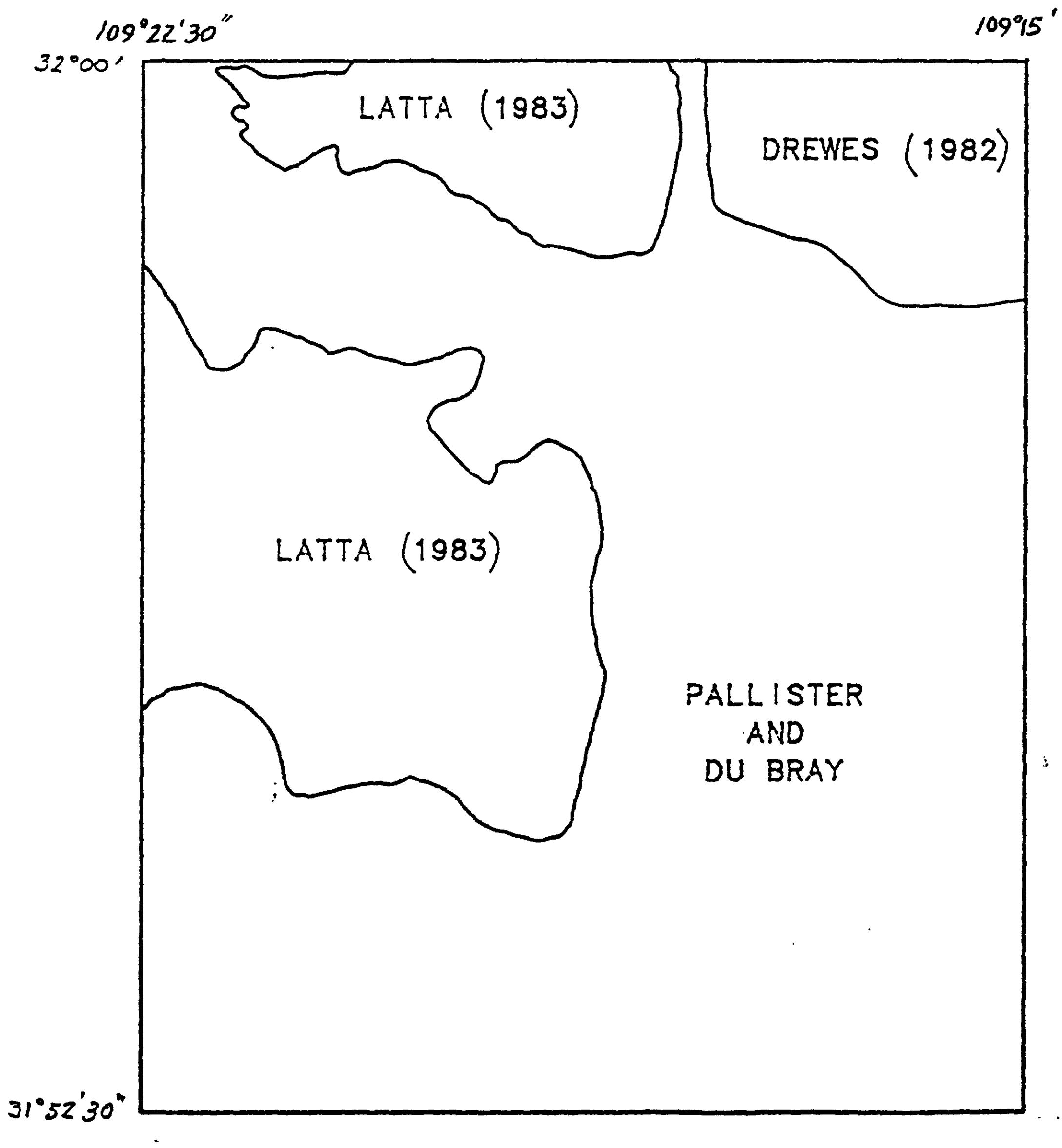


Enlows (1955) Formations	Enlows (1955) Informal members	Drewes (1982) Map units	Latta (1983) Informal members, units, section, and thicknesses				This map Map units		This map Formations
Rhyolite Canyon Formation	9	Trrf	Rhyodacite lava			35 m	Tdpl		Dacite porphyry lava flows
Rhyolite Canyon Formation	7 & 8	Trat & Truw	Monument member of Rhyolite Canyon Formation	Unit III		17 m	Trcu[1]	Trco	Rhyolite Canyon Tuff (outflow facies)
Rhyolite Canyon Formation	6	Trus	Monument member of Rhyolite Canyon Formation	Unit II		270 m	Trcm	Trco	Rhyolite Canyon Tuff (outflow facies)
Rhyolite Canyon Formation	5	Trus	Monument member of Rhyolite Canyon Formation	Unit II			Trcm	Trco	Rhyolite Canyon Tuff (outflow facies)
Rhyolite Canyon Formation	4	--?-- Trls	Monument member of Rhyolite Canyon Formation	Unit I	B	0-85 m	Trcl	Trco	Rhyolite Canyon Tuff (outflow facies)
Rhyolite Canyon Formation	3	Trls	Monument member of Rhyolite Canyon Formation	Unit I	A	0-60m	Trcl	Trco	Rhyolite Canyon Tuff (outflow facies)
Rhyolite Canyon Formation	2	Trb, Trlw, Trt	Jesse James Canyon member of Rhyolite Canyon Formation			0-240m	Tjj		Jesse James Canyon Tuff
Faraway Ranch Formation	Rhyolite tuff, lapilli tuff, basalt breccia, biotite dacite	Tfw, Tfiw, Tfd, Tff, Tfi, Tft, Tsv, Tsb, Tsf	Faraway Ranch Formation, undivided				Tfre, Tfpe, Tfrh, Tfph, Tft, Tfv		Faraway Ranch Formation

[1]Trcu not present in map area

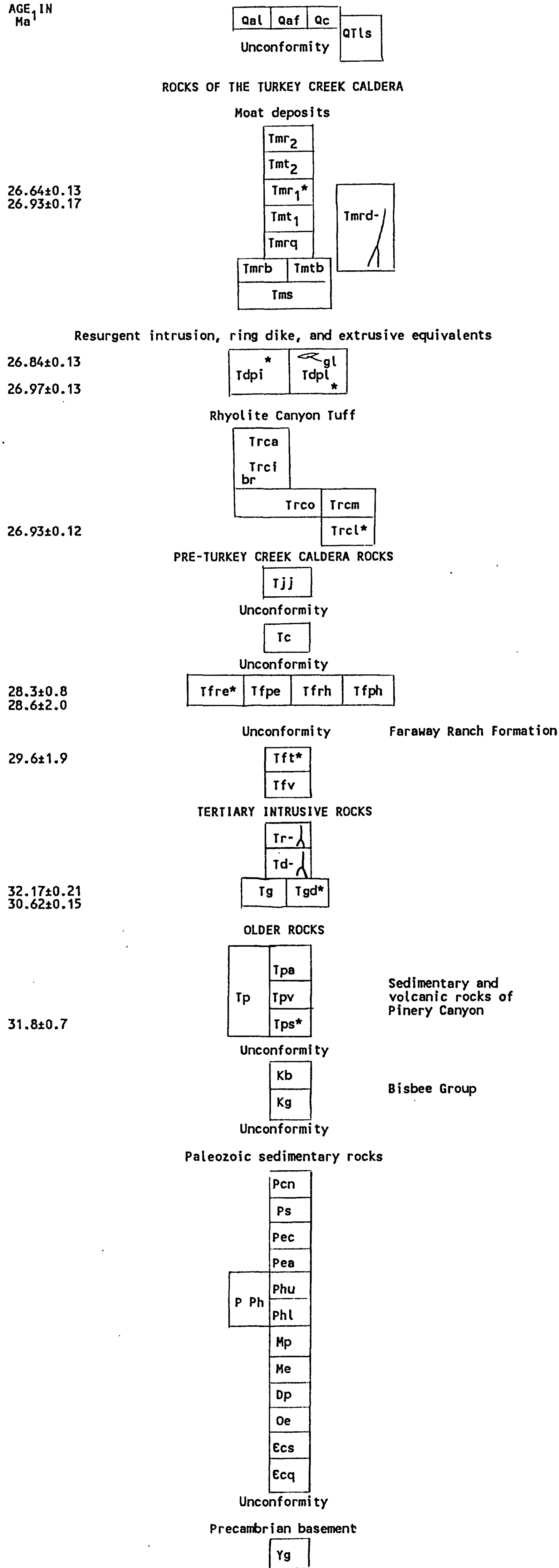
EXPLANATION

Lava flow; Welded tuff--Stipple density proportional to welding density; Sedimentary and local pyroclastic deposits

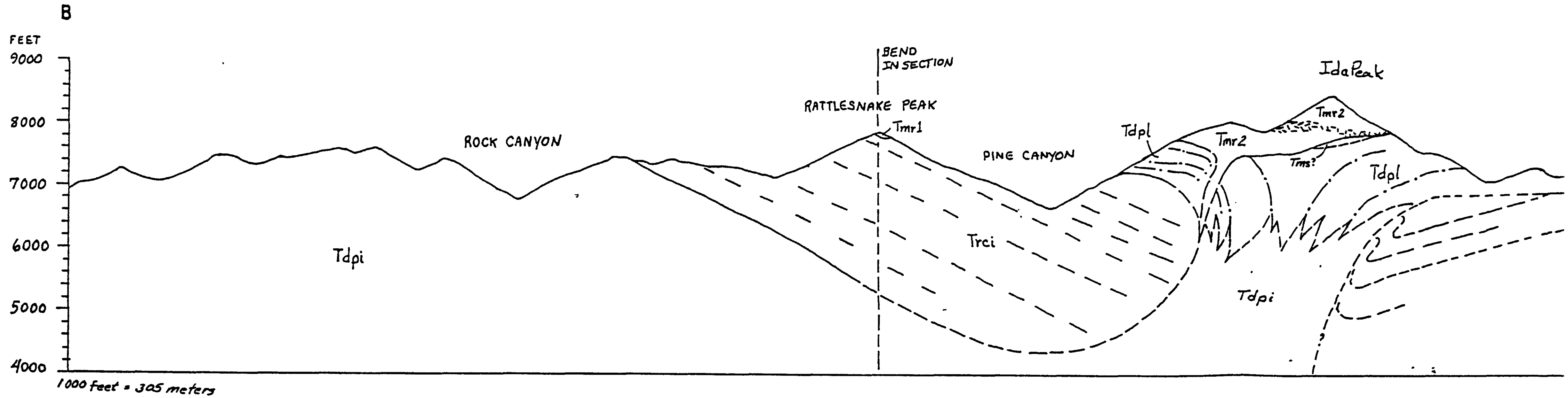


SOURCES OF GEOLOGIC MAPPING

CORRELATION OF MAP UNITS



[1]K/Ar ages given to one decimal place, $^{40}Ar/^{39}Ar$ ages to two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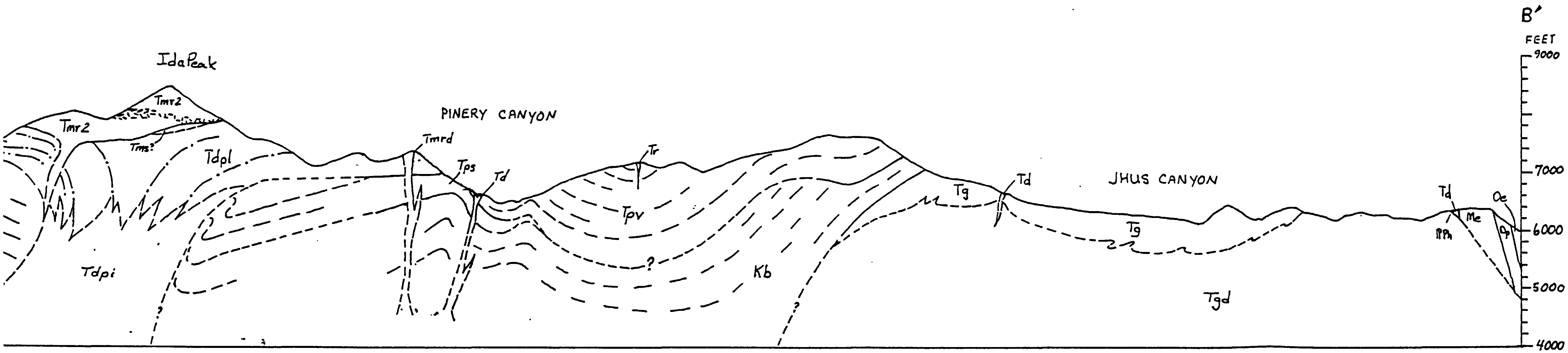

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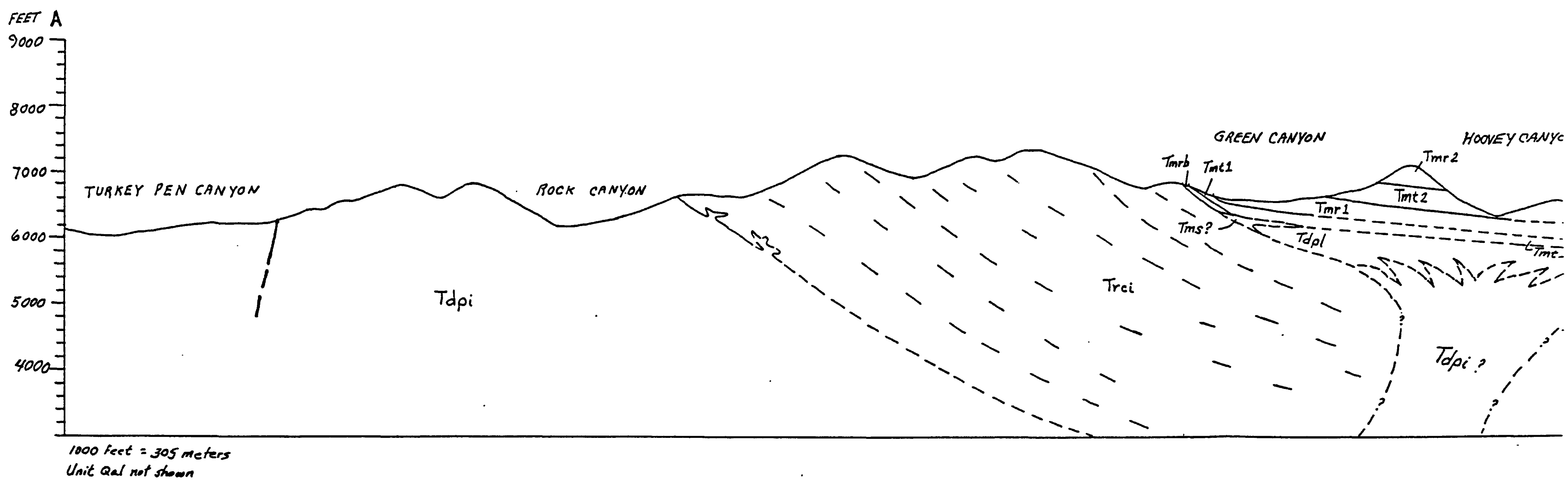
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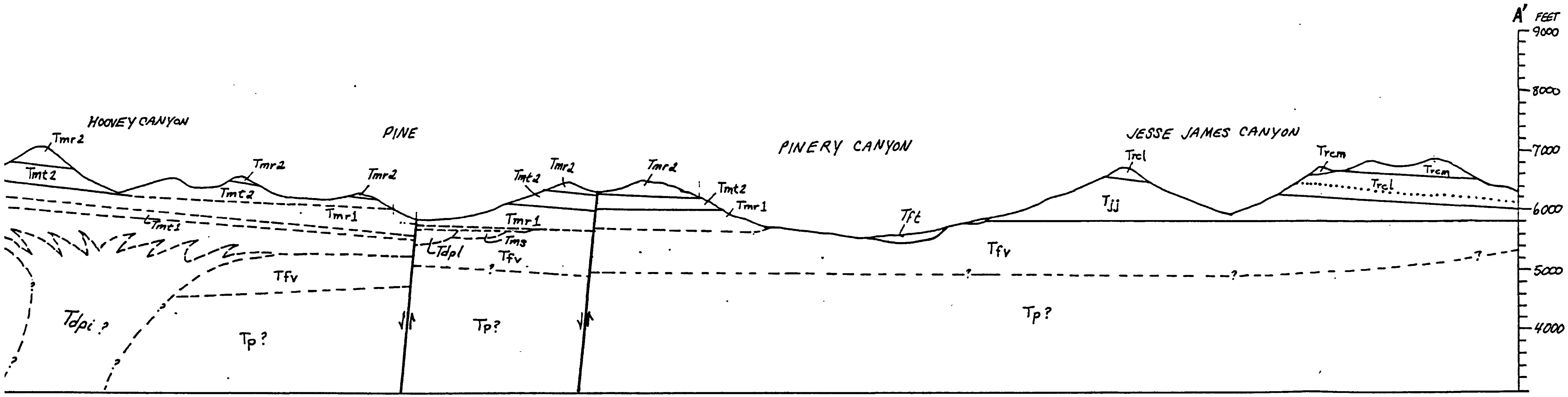
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