U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

PRELIMINARY GEOLOGIC MAP OF THE PAROWAN QUADRANGLE, IRON COUNTY, UTAH

By

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DESCRIPTION OF MAP UNITS

[PHENOCRYST CONTENTS ARE AVERAGES FROM VARIOUS CITED REFERENCES; AGES CORRECTED FOR NEW DECAY CONSTANTS (STEIGER AND JÄGER, 1977); ROCK CHART COLORS FROM GODDARD (1948)]

Qac **Alluvium and colluvium undivided (Holocene)**--Pebbles, cobbles, and boulders in a silt and sand matrix. Poorly sorted. Composed of locally derived material deposited along streams, bordering flood plains, and local depressions. Estimated maximum thickness 5 m

Qfa **Fan alluvium (Holocene)**--In Parowan Valley deposits are composed of poorly sorted pebbles, cobbles, and lesser amounts of boulders supported by silty sand matrix. Unit includes well rounded clasts derived from conglomerate beds of the Grand Castle (Tgc), Claron (Tc), and Brian Head (Tbh) formations. Approximate thickness 20 m

QTfa **Basin-fill deposit (late Pleistocene-Tertiary)**--Shown in cross section only. Includes basin-fill alluvial deposits approximately 470 m thick

Qt **Terrace alluvium (late Pleistocene)**--Medium to coarse sand and pebbly to bouldery gravel. Found in the upper part of First Left Hand Canyon. Clasts are predominantly from Baldhills Member of Isom Formation (Tib) and also may have been eroded from landslide debris (QTli) in Yankee Meadows. Estimated maximum thickness 20 m

Qbw **Trachy-basalt lava flows of Water Canyon (middle Pleistocene)**--Black to dark-gray, dense to vesicular, olivine-clinopyroxene bearing flows. Quartz xenocrysts common. Vent is located in Water Canyon approximately 3 km east from eastern edge of Parowan Valley where flows fill a paleovalley. K-Ar whole rock date of lava is 0.45±0.04 Ma (Fleck and others, 1975). Table 1 shows chemical analysis and CIPW normative analysis. Thickness about 120 m

Qbwc **Cinder cone of vent area**--Composed of grayish-red scoria approximately 90 m thick

Qbwd **Feeder dike for basalt lava flows**--Dark gray dense olivine-clinopyroxene bearing. Width about 2 m

Qbh **Breccia and basaltic dike of Second Hand Canyon (Pleistocene?)**--Breccia and dikes are located in Second Left Hand Canyon west of Henderson Hill. Breccia contains predominantly angular fragments of Claron Formation, Grand Castle Formation (?), cinder blocks of mafic rock, and sparse Needles Range Group rocks and Isom Formation in a gray matrix. The breccia and dike may represent a vent complex. Approximate thickness 60 m

Qdh **Basaltic dikes**--Dikes are medium gray and fine grained, and contain olivine and clinopyroxene phenocrysts, rare quartz xenocrysts(?) and rare sandstone xenoliths. Dikes intrude the breccia and parallel mapped faults. Exposure may represent remnants of a vent breccia with feeder dike (roots of a cinder cone)

Qp **Pediment alluvium (middle? Pleistocene)**--Poorly sorted deposit composed of subangular pebbles, cobbles, and sparse boulders of Tertiary volcanic rocks, and Tertiary-Cretaceous sedimentary rocks in a silty sand matrix. Deposited as thin veneers on fan-shaped surfaces. Estimated thickness 3-12 m

Landslide debris (Pleistocene)

Ql **Debris undivided**--Landslide debris deposited in grabens or against the downthrown side of normal faults. May contain pebble- to boulder-size Tertiary volcanic and Tertiary-Cretaceous sedimentary rocks in a matrix of sand, silt and clay. Estimated maximum thickness 90 m

Qli **Debris of Baldhills Tuff Member of Isom Formation**--Deposit composed of blocks of brecciated grayish-red ash-flow tuff. Deposited along plateau front near edge of Parowan Valley. Estimated thickness 15 m

Qlc **Debris of Claron Formation**--Deposit of broken blocks of moderate-red, bluish-white, grayish-orange sandstone, siltstone and limestone. May be same as gravity-slide block of Claron Formation shown in Sections 9 and 16, T. 34 S., R. 8 W. Deposited along plateau front near edge of Parowan Valley. Estimated thickness 30 m

Qlg **Debris of Grand Castle formation**--Deposit composed of broken blocks of pale-red and bluish-white conglomerate that contain well-rounded clasts mostly of quartzite and limestone. Deposited along plateau front near Parowan Valley edge. Estimated thickness 60 m

Qlk **Debris of Iron Springs Formation**--Deposit composed of broken blocks of yellowish-gray sandstone and some conglomerate. Deposited along plateau front near Parowan Valley edge. Estimated thickness 30 m

QTli **Landslide debris predominantly Isom Formation (late Pleistocene to Pliocene?)**--Found in the southeast corner of quadrangle. Debris is predominantly composed of blocks of Baldhills Member of Isom Formation and may contain some Blue Meadows Member of Isom Formation. The landslides have broken away from Black Ledge, a long scarp-line cliff located in adjacent Red Creek Reservoir quadrangle located just east of southeast corner of quadrangle. The landslides partly fill the topographic low Yankee Meadows and probably broke away from scarps topographically above Yankee Meadows along Black Ledge. Estimated thickness 190 m

QTs **Older alluvium (early Pleistocene and late Tertiary?)**--Remnants of older alluvial fans, composed of Tertiary volcanic and Cretaceous clasts of pebble to boulder size in a silty sand matrix. Estimated maximum thickness 25 m

Tmd **Mafic dike (Miocene?)**--Medium-gray fine-grained, olivine- and plagioclase-bearing dike. Intrudes tuffaceous sandstone of the Brian Head formation northeast of Parowan in Section 8, T. 43 S., R. 8 W.

Th **Harmony Hills Tuff (Miocene)**--Pale pink to grayish-orange-pink, moderately welded, crystal-rich trachic andesitic-andesitic (Le Bas and others, 1986), ash-flow tuff. Contains about 50 percent phenocrysts of plagioclase (63 percent), biotite (16 percent), hornblende (9 percent), quartz (7 percent), pyroxene (5 percent), and trace of sanidine (Williams, 1967). Located in Parowan Canyon in southwestern part of quadrangle. Source area is thought to be in the Bull Valley Mountains (Blank, 1959). First defined as member of Quichapa Formation by Mackin (1960), later elevated to formation by Williams (1967) and Anderson and Rowley (1975). Average K-Ar date of 21.6 Ma based on biotite and plagioclase (Armstrong, 1970, and Noble and McKee, 1972) but more acceptable age of 22-22.5 Ma based on age of plutons and ash-flow tuff in the Iron Springs district that postdate the Harmony Hills tuff (Rowley and others, 1989; and Sider and others, 1990). Thickness as much as 15 m

Tcb **Bauers Tuff Member of Condor Canyon Formation (Miocene)**--Resistant, light-brown-gray, densely welded rhyolite ash-flow tuff. Contains about 15 percent phenocrysts of plagioclase (55 percent), sanidine (35 percent), biotite (7 percent), Fe-Ti oxides (3 percent), and trace amount of pyroxene (Anderson and Rowley, 1975). Characterized by conspicuous bronze biotite and light-gray flattened lenticules that may be flattened pumice. Source area is Clover Creek caldera (Rowley and Siders, 1988), within the Caliente caldera complex, Lincoln County, Nevada (Ekren and others, 1977). Defined by Mackin (1960). $^{40}Ar/^{39}Ar$ Sanidine date is 22.78 Ma (Best and others, 1989b). Thickness as much as about 15 m

Tmb **Mudflow and lava-flow breccia and tuffaceous sandstone (Miocene and Oligocene)**--Mudflow breccia contain clasts mostly of olive-gray pyroxene-rich mafic lava, hornblende-rich mafic lava, gray-olive-black lava and flow breccia of intermediate composition, and lesser amounts of tuffaceous sandstone, Isom Formation, and Needles Range Group in a yellowish-gray and pale-yellowish-brown matrix of clay. Mudflow breccia interbedded with pyroxene-rich mafic lava flow breccia and tuffaceous sandstone. Sandstone is nonresistant, olive gray and yellow gray, contains subangular to well-rounded grains of quartz, ferromagnesium minerals, and feldspars; sandstone is crossbedded in places suggesting eolian origin. Resembles but is not the tuffaceous sandstones of the formation of Brian Head (informal) and the Bear Valley Formation, a unit defined by Anderson (1971). Clasts of Isom Formation and Needles Range Group range from about 3 cm to about 200 m in length. These clasts and blocks are supported in a sandstone matrix. The large blocks are exposed one km east of Parowan Canyon in Section 12, T. 35 S., R. 9 W. The mudflow breccias are the thickest in the P-Hill area, about one km southeast of Parowan, and the tuffaceous sandstone sequence is the thickest east of Parowan Canyon. These interbedded rock units may be equivalent to sandstone of the Bear Valley Formation and mudflow breccia of the Mount Dutton Formation of Anderson and Rowley (1975) mapped in the northern part of the Markagunt Plateau. Thickness as much as 200 m

Tib **Baldhills Tuff Members of Isom Formation (Oligocene)**--Many cooling units of moderately resistant to resistant, pale-red, grayish-red, pale-reddish-brown, pale-reddish-purple, and yellowish-gray densely welded, trachydacite (Le Bas and others, 1986), ash-flow tuff. Contains 5-20 percent phenocrysts, of mostly plagioclase and minor pyroxene, and Fe-Ti oxides in a glassy to devitrified groundmass (Anderson and Rowley, 1975). Unit characterized by elongated vesicles and secondary flowage structures that are both flattened and folded and resemble flowage features in lava flows. In the Red Hills area, west of map area, nine cooling units have been described but are not described in this quadrangle because of poor exposures (Maldonado and Williams, in press a,b). Commonly brecciated west of Maple Spring Hollow and poorly exposed in grabens. Unit defined by Mackin (1960). Caldera source of the Baldhills is probably at northwest edge of Escalante Desert 70 km west of map area (Best and others, 1989a). K-Ar age 27 Ma (Best and others, 1989a). Thickness as much as about 275 m

Tn **Needles Range Group, undivided (Oligocene)**--Shown only as gravity slide blocks. May include Wah Wah Springs Formation and Cottonwood Wash Tuff. Wah Wah Springs Formation is a grayish orange pink, dacitic, moderately welded, simple cooling ash-flow tuff unit (Anderson and Rowley, 1975). Contains approximately 35 percent phenocrysts composed of the following: plagioclase (70 percent), hornblende (15 percent), biotite (5 percent), quartz (5 percent), Fe-Ti oxides (3 percent), sanidine (2 percent), and trace amounts of pyroxene, apatite, and zircon (Anderson and Rowley, 1975). Source area of formation is Indian Peak caldera (Best and Grant, 1987; Best and others, 1989a; Best and others, 1989b) along central Utah-Nevada border. Defined by Mackin (1960) and later elevated to formational status by Best and Grant (1987). Average K-Ar age 29.5±0.5 Ma (Best and others, 1987). Cottonwood Wash Tuff is a grayish orange pink to light brownish gray, dacitic, moderately welded simple cooling ash-flow tuff unit (Anderson and Rowley, 1975). Contains approximately 40 percent phenocrysts composed of plagioclase (65 percent), hornblende (15 percent), quartz (10 percent), biotite (5 percent), Fe-Ti oxides (3 percent), sanidine (2 percent), and trace amounts of pyroxene, apatite, and zircon (Anderson and Rowley, 1975). Source area probably located in an alluvial valley between Fortification Range of eastern Nevada and Mountain Home Range of southwestern Utah (Best and others, 1989a). Defined by Mackin (1960) and later elevated to formational status by Best and Grant (1987). Average K-Ar age about 30.6 (Best and Grant, 1987)

Tbl **Mudflow breccia and lava flows (Oligocene)**--Volcanic mudflow breccia and intermediate composition lava flows and flow breccia. Known only locally and poorly exposed in the eastern-central part of the quadrangle in T. 34 S., R. 8 W., Section 28. May correlate with poorly exposed parts of "local volcanic and sedimentary strata" units of Anderson and others (1987). Approximate thickness as much as 185 m

Tbh **Brian Head formation (informal) (Oligocene)**--Unit is mostly poorly resistant tuffaceous sandstone interbedded with pebble- to boulder-size conglomerate, sandstone, minor limestone, and mudflow breccia. Tuffaceous sandstone is yellowish gray and light gray, laminated and crossbedded and contains abundant biotite that gives them a salt-and-pepper texture. Locally contains chalcedony zone. Conglomerate beds contain pebble- to boulder-size clasts of (1) predominantly ash-flow tuff, (2) lesser amounts of lava flows of intermediate composition, and (3) minor amounts of quartzite and light-gray, micritic limestone. Mudflow(?) breccia contains volcanic clasts and grains of quartz, feldspar, hornblende, pyroxene, and trace amounts of garnet. Map unit is equivalent to part of "local volcanic and sedimentary strata," a unit mapped on the Markagunt Plateau by Anderson and others (1987), "sedimentary and volcanic rocks of the Red Hills" in the Red Hills (Maldonado and Williams, in press a,b), and to upper-most part of "white" subunit of the Claron Formation of Anderson and Rowley (1975), and Doelling and others (1989). Brian Head formation is mapped separately from the uppermost part of the "white" subunit Claron Formation largely on the basis of its abundant volcaniclastic content. In the Red Hills, an ash-flow tuff present in the upper part of the sedimentary and volcanic rocks of the Red Hills unit is correlated to a similar tuff (Maldonado and Williams, in press a) dated at about 31.9 ± Ma based on biotite (Fleck and others, 1975). Poorly exposed with incomplete thickness as much as about 120 m

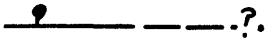
Tc **Claron Formation (Eocene and Paleocene?)**--Formation is composed of an upper part that is characterized by prominent cliff-forming white limestone beds with some sandstone and conglomerate, and a slope and a cliff forming lower part that contain fewer limestone beds of dominantly red to orange hues; these two parts have been referred to as the "white" and "red" subunits of the Claron Formation, respectively by Anderson and Rowley (1975). The "white" Claron is present locally with average thickness of about 60 m (Moore, 1982); contact with red Claron is gradational. The "red" subunit is composed of poorly to moderately resistant fluvial and lacustrine deposits predominantly of sandstone intercalated with mudstone, limestone, and pebble conglomerate beds; conglomerate clasts are well-rounded quartzite and limestone. "Red" subunit is mottled and varicolored in beds of pale red, pale reddish brown, moderate red, gray yellow, moderate reddish orange, very pale orange, and gray orange pink. Deposits are interpreted to be paleo-soil, that is, to have been altered by pedogenic processes (Mullett and others, 1988; Mullett, 1989). Red and white subunit equivalent to "pink" subunit and lower part of the overlying "white" subunit of Doelling and others (1989) of the Claron Formation. Thickness is as much as about 395 m

Tgc **Grand Castle formation of Goldstrand (1991) (Paleocene)**--Type section is at Grand Castle in First Left Hand Canyon in Section 5, T. 35 S., R. 8 W. Divided into an upper red massive cliff-forming conglomerate, a middle white slope-forming sandstone, and a lower hoodoo or "beehive"-shaped cliff-forming conglomerate by Goldstrand (1991). Contains well-rounded clasts of mostly quartzite and limestone and lesser amounts of sandstone and chert of pebble-, cobble-, and boulder-size. Some of the quartzite clasts resemble the Ordovician Eureka Quartzite, a unit exposed in western Utah and eastern Nevada. In the Red Hills, in the Parowan Gap area, correlative conglomerate deposits mapped as conglomerate of Parowan Gap (Maldonado and Williams, in press b), are found locally as channel fill on an erosional surface with angular unconformable relationships cut on underlying Iron Springs Formation. This unit was previously mapped as lower part of the Claron Formation by Threet (1952) in the Red Hills but in this report, unit was mapped separately from the Claron. Unit is correlative with the informal beehive unit of Moore (1982). Thickness ranges from 120 to 275 m

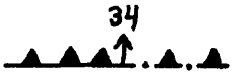
Kis **Iron Springs Formation (Upper? Cretaceous)**--Defined by Mackin (1947) for exposures in the Iron Springs mining district about 25 km southwest of quadrangle, where unit is about 1,000 m thick. Moderately resistant fluvial deposits composed of yellowish-gray, grayish-yellow, moderate-yellow, and dark-yellowish-orange, fine- to medium-grained, thin-bedded to massive sandstone and interbedded with some siltstone, shale, and conglomerate. Shale may make up 70 percent of formation locally (E.G. Sable, U.S. Geological Survey, written commun., 1992). Locally contains coal lenses. Contains several interbedded, thin, light-gray siltstone beds, approximately 5 cm thick towards top of unit. Correlative with Free Thought unit of Moore (1982). Base not exposed. Exposed thickness about 335 m but may be as much as 940 m (Stokes, 1986)

Jc **Carmel Formation (Middle Jurassic)**--Shown only in cross section. Light-gray, bluish-gray, yellowish-gray, and tan, platy to massive, dolomitic and fossiliferous limestone; white, gray to light-olive-gray and reddish-brown to pale-red thin-bedded to massive, calcareous sandstone, interbedded with pale-red silty shale (Threet, 1952, 1963). Exposed thickness about 250 m in the Red Hills (Threet, 1952) 10 km west of quadrangle

Contact--Dashed where approximate. Contacts between bedrock and surficial deposits approximately located

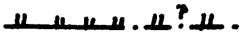


Normal Fault--Bar and ball on downthrown side; bar and ball not shown where sense of displacement not known; dashed where approximately located; dotted where concealed; queried where uncertain



Tertiary thrust (?) fault--Sawteeth on upper plate; arrow indicates direction and amount of dip; dotted where concealed

Boundary of megabreccia deposit interpreted as Miocene-Oligocene (?) gravity-slide block--Showing parent bedrock unit symbol. Dotted where concealed; queried where uncertain



Red Hills low-angle shear zone--Double hachures on upper plate, approximately located; dotted where concealed; queried where uncertain. Shear zone has detached part of unit Tbh and overlying rocks from underlying rocks and has been referred to as the Red Hills shear zone (Maldonado and others, 1990, 1992). It may occur along contact between unit Tbh and base of Tertiary volcanic rocks, or in some areas within upper part of unit Tbh. Shear zone is arbitrarily placed at contact between unit Tbh and base of Tertiary volcanic rocks even though it may occur below that contact. Shear zone is variously characterized by comminuted rock, folding, and discordance in attitudes and thinning or omission of rocks overlying shear zone. Approximately located in geologic section

Low-angle fault--Dashed when approximately located, dotted where concealed. Locally, fault becomes high-angle along part of its segment. Locally, low-angle fault may be same as the Red Hills shear zone.

Anticline--Showing approximate trace of axial plane

Strike and dip of sedimentary beds and of foliation of pumice in ash-flow tuff

Inclined

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Table 1. [1]Major-oxide, normative mineral, and [2]trace-element composition of basalt of Water Canyon

[4]Sample number NP 9

Major-oxide composition		Normative mineral composition	
SiO_2	51.10	or	11.38
Al_2O_3	15.20	ab	29.71
$^3Fe_2O_3$	2.87	an	20.15
FeO	6.30	di-wo	7.33
MgO	8.27	di-en	5.00
CaO	8.25	di-fs	1.75
Na_2O	3.50	hy-en	3.26
K_2O	1.92	hy-fs	1.14
TiO_2	1.37	ol-fo	8.69
P_2O_5	0.61	ol-fa	3.35
MnO	0.14	mt	4.17
ZrO_2	0.02	cm	0.04
Cr_2O_3	0.03	il	2.61
NiO	0.02	z	0.03
BaO	0.16	ap	1.42
SrO	0.13		
Total	99.87	Total	100.0

[1]Major elements determined by wavelength dispersive X-ray spectroscopy: J.S. Mee and D.F. Siems, analysts.

[2]Trace elements determined by energy dispersive X-ray spectroscopy: J. Kent, analyst.

[3]Fe_2O_3 calculated as $TiO_2 + 1.5$.

[4]Sample location lat 37°52´25" and long 112°46´46".

CORRELATION OF MAP UNITS