GEOLOGIC MAP OF SWANSEA-COPPER PENNY AREA, CENTRAL BUCKSKIN MOUNTAINS, WEST-CENTTRAL ARIZONA

by

Jon E. Spencer and Stephen J. Reynolds

Arizona Geological Survey
Open-File Report 87-2

Arizona Geological Survey
416 W. Congress, Suite #100, Tucson, Arizona 85701

includes 8 pages, 2 figures, 1 plate

This report is preliminary and has not been edited
or reviewed for conformity with Arizona Geological Survey standards

GEOLOGIC MAP OF THE SWANSEA-COPPER PENNY AREA, CENTRAL BUCKSKIN MOUNTAINS, WEST-CENTRAL ARIZONA

Jon E. Spencer and Stephen J. Reynolds

Arizona Bureau of Geology and Mineral Technology

845 N. Park Ave., Tucson, AZ 85719

OPEN-FILE REPORT 87-2

(8 pages + 2 figures + 1 plate)

INTRODUCTION

The Buckskin-Rawhide detachment fault separates a variety of Proterozoic through Cenozoic rock types from underlying mylonitic crystalline rocks. In the Swansea-Copper Penny area of the central Buckskin Mountains, the detachment fault defines a gently ENE-plunging synform. Upper-plate rocks are preserved in the synform, whereas lower-plate mylonitic crystalline rocks compose the flanking, topographically higher, ENE-trending antiforms. Mylonitization of lower-plate crystalline rocks was the result of ductile shearing along the down-dip projection of the Buckskin-Rawhide detachment fault early in its movement history.

Two assemblages of rocks are preserved in the upper plate of the Buckskin-Rawhide detachment fault in the Swansea-Copper Penny area: (1) Pre-Tertiary rocks, especially Paleozoic and Mesozoic metasedimentary rocks, are complexly deformed and have undergone greenschist-facies metamorphism. Metamorphism, folding, cleavage development, and tectonic interleaving of diverse rock types is interpreted to be the result of Mesozoic thrust faulting. (2) A lithologically diverse stratigraphic sequence of Miocene and upper Oligocene(?) volcanic and sedimentary rocks generally dips moderately to steeply to the southwest and is folded into two north-south trending, south-plunging anticlines.

Both upper- and lower-plate rocks have been affected by middle-Tertiary mineralization, alteration, and replacement by carbonate near the detachment fault. Paleozoic marble at the Swansea mine has been locally replaced by specular hematite with fracture-filling chrysocolla. Underground mining in the late 1800's exploited chalcopyrite enclosed within massive specular hematite. Pervasive iron-oxide staining with local copper and iron sulfides characterizes rocks directly below the detachment fault at the Copper Penny mine (Wilkins and Heidrick, 1982; Spencer and Welty, 1986). Hydrothermal carbonate locally replaces a variety of upper-plate rock types directly above the detachment fault.

DESCRIPTION OF MAP UNITS

Postdetachment Units

Qa YOUNG ALLUVIAL DEPOSITS (QUATERNARY) — Unconsolidated gravel, sand, and silt in washes.

Qo OLD ALLUVIAL DEPOSITS (QUATERNARY) — Light-gray to light-tan,

This report is preliminary and has not been edited or reviewed for conformity with Arizona Bureau of Geology and Mineral Technology standards.

unconsolidated to very poorly consolidated, poorly sorted conglomeratic sandstone and conglomerate. Typically forms perched terraces and flats topographically above washes.

QTo VERY OLD ALLUVIAL DEPOSITS (QUATERNARY TO LATE TERTIARY) -- Deeply weathered, calcite-cemented, light-tan to medium-brown alluvial deposits.

Tbf BASIN-FILL DEPOSITS (LATE TERTIARY) -- Massive to crudely stratified, unsorted to poorly sorted, unconsolidated to weakly consolidated, tan to medium-brown conglomerate, conglomeratic sandstone, and sedimentary breccia.

Tbfx BASIN-FILL BRECCIA DEPOSITS (LATE TERTIARY) -- Resistant cobbles and boulders up to 2 m in diameter of Tertiary volcanic rocks, Paleozoic metasedimentary rocks, and other lithologies in an unconsolidated, unsorted to poorly sorted matrix of cobbles, sand, and silt.

Tbfv BASIN-FILL VOLCANICLASTIC DEPOSITS (LATE TERTIARY) -- Light-yellow lapilli tuff and tuffaceous sandstone. Exposed only in the center of section 25 where it dips approximately 10 degrees to the east.

Upper-Plate Units

Copper Penny Section. Numbers associated with each unit indicate stratigraphic position in Copper Penny section.

Tss_{24} SANDSTONE (#24)(MIOCENE) -- Brown, medium-grained sandstone and conglomeratic sandstone. Locally contains conglomerate with clasts up to 10 cm diameter and thin sedimentary breccia(?) layers. Clasts are composed of carbonate rocks, Tertiary sandstone, and Tertiary volcanics. Volcanic-clast layers are possibly volcanic agglomerate. Sandstone has been variably but generally strongly impregnated and probably replaced with secondary carbonate, resulting in weathered surfaces with the roughness and texture of weathered limestone.

Ts_{23} SEDIMENTARY ROCKS (#23)(MIOCENE) -- Tan to reddish-brown, medium-grained, calcareous sandstone and tan, buff, and gray limestone. Unit is medium to thin bedded.

Tv_{22} VOLCANIC FLOWS AND FLOW BRECCIAS (#22)(MIOCENE) -- Pinkish-brown, reddish-brown, or gray breccia composed of 1- to 10-centimeter-diameter angular fragments of fine-grained volcanic rock with less than 5-percent partially altered feldspar phenocrysts. Alteration is due to K-metasomatism. Unit is generally monolithologic, but locally contains clasts of other Tertiary and pre-Tertiary rock types. Bedding in breccia is locally defined by variations in average clast size and ratio of matrix to clasts. Matrix commonly includes broken rock fragments, and outcrops variably resemble volcanic flow breccia, monolithologic megabreccia, and sedimentary breccia.

Ts_{21} SEDIMENTARY ROCKS (#21)(MIOCENE) -- Calcareous sandstone and limestone similar to unit 23.

Tv_{20} VOLCANIC FLOWS AND FLOW BRECCIAS (#20)(MIOCENE) -- Maroonish-gray to medium-gray volcanic breccia similar to unit 22, but less altered. Alteration is due to K-metasomatism. Unit contains 1 to 2 percent phenocrysts of sanidine, altered plagioclase, and a trace biotite. Rims of secondary adularia(?) on some plagioclase phenocrysts are visible in hand sample, and feldspar microlites are almost entirely converted to adularia(?) as seen in thin section. Sample of unit yielded a K-Ar feldspar date of 20.1 $\pm$ 0.5 Ma, which is interpreted as the time of K-metasomatism and a minimum age of the rock.

Tx_{19} SEDIMENTARY BRECCIA (#19)(MIOCENE) -- Coarse sedimentary breccia containing large blocks of phyllitic Jurassic metavolcanic rocks, nonphyllitic quartz-feldspar-phyric Jurassic volcanic rocks, foliated but unlineated, coarse-grained, porphyritic granite, and Paleozoic(?) carbonate rocks. Matrix is reddish, poorly sorted quartzose sandstone.

Ta_{18} ANDESITIC VOLCANIC FLOWS (#18)(MIOCENE) -- Dark-weathering, massive to thickly layered andesite to basalt flows and local flow breccias. Rock is commonly vesicular, dark gray on fresh surfaces, and extensively altered. Brownish carbonate material is common in vesicles and in patchy to pervasive replacements, especially near the detachment fault.

Tcg_{17} CONGLOMERATE (#17)(MIOCENE) -- Reddish-brown, poorly sorted conglomerate and conglomeratic sandstone. Clasts are dominantly of Jurassic quartz-feldspar-phyric volcanic and metavolcanic rocks, medium- to coarse-grained granite, and Mesozoic chloritic schist, with lesser amounts of Proterozoic(?) high-grade metamorphic rocks and reworked Tertiary clastic rocks. Clasts of Jurassic volcanic rocks are variably rounded to angular, but granitic clasts are generally rounded to subrounded. Unit is 1 to 10 m thick.

Ta_{16} ANDESITIC VOLCANIC FLOWS (#16)(MIOCENE) -- Similar to unit 18.

Tcg_{15} CONGLOMERATE (#15)(MIOCENE) -- Reddish-brown conglomerate and sedimentary breccia composed of clasts up to 1 m in diameter of light-colored, massive, weakly metamorphosed, and schistose, metamorphosed, Jurassic volcanic rocks. Unit is locally as thick as 25 m.

Ta_{14} ANDESITIC VOLCANIC FLOWS (#14)(MIOCENE) -- Similar to unit 18.

Tl_{13} LIMESTONE (#13)(MIOCENE) -- Brownish-gray, brownish-tan, and gray limestone with dark-brown, locally shattered siliceous layers. Limestone is generally thin to medium bedded, and locally forms resistant ledges and ridge crests. Limestone is 1 to 5 m thick.

Txv_{12} SEDIMENTARY BRECCIA (#12)(MIOCENE) -- Massive, unbedded, generally monolithologic sedimentary breccia composed of angular clasts of

light-colored phyllitic Jurassic metavolcanic rocks (quartz-feldspar-sericite-magnetite schist).

Tl_{11} LIMESTONE (#11)(MIOCENE) -- Brown and gray, thin- to medium-bedded limestone. Unit is closely associated with and not everywhere mapped separately from the underlying tuff (unit 10). Unit is laterally discontinuous but generally several meters thick.

Tt_{10} TUFF (#10)(MIOCENE) -- Brownish-tan, lithic-poor, welded tuff with 0.5 to 2 percent phenocrysts. Unit locally includes lithic tuff, flow breccia, and laharic(?) breccia with clasts of Tertiary limestone and Jurassic volcanics. Unit is 6 m thick.

Tl_9 LIMESTONE (#9)(MIOCENE) -- Similar to unit 11, but is more commonly gray than brown and includes some pinkish-gray silty limestone and calcareous siltstone. Also includes local chaotic flexural-flow (penecontemporaneous) folds, probably formed during emplacement of overlying monolithologic sedimentary breccia. Limestone is 2 to 12 m thick.

Txv_8 SEDIMENTARY BRECCIA (#8)(MIOCENE) -- Massive, monolithologic sedimentary breccia composed of angular to subrounded clasts of brown-weathering, unfoliated to weakly foliated, quartz-feldspar-phyric Jurassic volcanic rocks. Some clasts contain a trace biotite and some others are derived from volcaniclastic rocks. Top of unit is dominated by clasts of light-colored, strongly foliated and phyllitic Jurassic metavolcanic rocks. Unit is approximately 30 m thick.

Tl_7 LIMESTONE (#7)(MIOCENE) -- Gray to brown, thin- to medium-bedded limestone, generally 1 to 5 m thick.

Tt_6 TUFF (#6)(MIOCENE) -- Tan to buff-colored, massive, welded ash-flow tuff, varies from approximately 5 to 20 m thick, with 1 to 2 percent phenocrysts of biotite, quartz, and feldspar up to 1 mm in diameter. Unit locally consists of two tuffs, separated by several meters of altered (tuffaceous?), fine-grained sandstone. One of the tuff units yielded K-Ar dates of 20.3 $\pm$ 0.4 (feldspar) and 21.8 $\pm$ 0.5 (biotite). This unit is closely associated with and not everywhere mapped separately from underlying and overlying limestones (units 5 and 7). Combined thickness of tuff and limestones varies from 5 to 30 m.

Tl_5 LIMESTONE (#5)(MIOCENE) -- Tan, brown, and gray, thinly bedded limestone and silty limestone, associated with pinkish-gray, buff, and pale tan siltstone and moderately sorted lithic sandstone. Interbedded with unit 6 in the SE 1/4 of sec. 35.

Tt_5 TUFF (#5)(Miocene) -- Ash-flow tuff similar to unit Tt_6.

Tsl_4 SANDSTONE, SILTSTONE, AND LIMESTONE (#4)(MIOCENE) -- Pinkish-gray- to purplish-gray- or pale-orange- to brown-weathering, thin- to medium-bedded, calcareous siltstone and mudstone; poorly sorted, locally pebbly, brown arkosic sandstone and gritty sandstone; medium- to dark-gray or greenish gray, poorly sorted

volcaniclastic sandstone; medium-brown, fine-grained sandstone; brown silty limestone; brown to gray, laminated to thinly bedded, variably siliceous limestone; and rare tuff.

Tt_3 TUFF (#3)(MIOCENE) -- Slope- and ledge-forming tuff, including the following varieties: (1) light-cream-colored tuff with 2 to 5 percent quartz phenocrysts 0.5 to 2 mm in diameter; (2) slightly purplish-gray tuff with 1 to 2 percent altered feldspar (plagioclase) phenocrysts; and (3) pinkish- to purplish-gray tuff with approximately one-percent dark volcanic lithic fragments and one-percent fine-grained phenocrysts, including a trace biotite.

Tss_2 SANDSTONE (#2)(MIOCENE TO UPPER OLIGOCENE(?)) -- Dark-weathering, fine-grained, variably calcareous sandstone that is pale green, greenish brown, or medium to light brown. Contains interbedded gray to dark-greenish gray siltstone and mudstone, and gray and brown limestone beds 0.5 to 1 m thick containing siliceous layers 2 to 5 cm thick. Unit contains a thin, locally mappable marker tuff similar in character to unit 3.

Tbs_1 BASAL SANDSTONE (#1)(MIOCENE TO UPPER OLIGOCENE(?)) -- Maroon, pale red, pale gray, purplish-gray, or light cream-colored, medium- to fine-grained arkosic sandstone and conglomerate. Clasts are subrounded to rounded pebbles and cobbles up to 15 cm diameter of massive and foliated feldspar-biotite-phyric Mesozoic volcanic rocks, white quartzite with some quartz grains 1mm in diameter, granite, alaskite, granodiorite, altered andesite, Jurassic volcaniclastic rocks, and slightly feldspathic Mesozoic quartzose sandstone. Unit is locally interbedded with pale-grey to tan, dark-brown weathering, thinly bedded to laminated, variably calcareous siltstone. Basal conglomerate is two- to several-meters thick along north edge of NW1/4, sec. 31 where it contains cobbles to boulders of primarily foliated Mesozoic metasedimentary and metavolcanic rocks with sparse clasts of Tertiary volcanic rocks and megacrystic granite.

Section East of Swansea Fault.

Ts SEDIMENTARY ROCKS (MIOCENE) -- Thin- to medium-bedded, tan to brown conglomerate largely composed of clasts of the underlying volcanic breccia. Stratigraphically higher part of unit contains tan, buff, and brownish-gray, thin-bedded calcareous sandstone and limestone.

Tv VOLCANIC ROCKS (MIOCENE) -- Breccia composed of maroonish- to purplish-gray volcanic rock with 1 to 8 percent phenocrysts of feldspar (plagioclase?), a trace biotite, and vugs less than 0.5 mm in diameter. Unit weathers maroon, tan, and brown, and is probably in part flow breccia.

Tdfv DEBRIS FLOWS (MIOCENE) -- Massive, clast- or matrix-supported, unsorted conglomerate and sedimentary breccia. Matrix is dark-brown to reddish-brown sandstone and mudstone, with blocks and cobbles of Jurassic volcanic rocks, vesicular Tertiary andesite, granite, Tertiary sandstone, carbonate rocks, and Mesozoic

phyllite. Some matrix material contains coarse-grained quartz and feldspar, probably derived from granitic rock. Some blocks of granite are more than 6 m in diameter.

Txgr SEDIMENTARY BRECCIA, GRANITIC PROTOLITH (MIOCENE) -- Coarse, massive sedimentary breccia, including megabreccia interpreted as catastrophic debris-avalanche deposits, derived from coarse-grained granite with a well-defined mylonitic to gneissic foliation, but no lineation. Granite clasts contain biotite and some bluish quartz. Sedimentary breccia at top of unit contains blocks of Paleozoic rocks, including gray, foliated calcite marble, Coconino Sandstone, and brownish carbonate rocks, and at least one block of banded gneiss 10 m in diameter.

Txv SEDIMENTARY BRECCIA, VOLCANIC PROTOLITH (MIOCENE) -- Coarse, massive sedimentary breccia, including megabreccia interpreted as catastrophic debris-avalanche deposits, composed of large, angular clasts of light-gray, foliated Jurassic metavolcanic rocks and more rounded clasts of medium-gray, unfoliated Jurassic quartz-feldspar-phyric volcanic rocks. Unit is locally capped by 1 to 4 m of reddish-brown sedimentary breccia with a muddy matrix and large Paleozoic carbonate blocks.

Ta ANDESITIC VOLCANIC FLOWS (MIOCENE) -- Dark-gray, locally vesicular andesite to basalt flows and local flow breccias.

Tcg CONGLOMERATE (MIOCENE) -- Massive to poorly bedded, reddish brown, indurated conglomerate, with subangular clasts, 1-30 cm diameter, of Mesozoic volcanic rocks. Locally includes sandstone.

Other Upper-Plate Rock Units.

Tsu SEDIMENTARY ROCKS, UNDIVIDED (MIOCENE) -- In the west-central part of sec. 35, this unit consists of thinly bedded (2-20 mm layers), light- to medium-gray, tan, or pale-red, silty, platy-weathering limestone and calcareous siltstone. Locally includes 2 to 20-cm-thick gray limestone beds. In the northeastern corner of sec. 29, this unit is composed of conglomerate with cobbles up to 30 cm diameter of primarily reworked Tertiary sandstone and less abundant porphyritic granite, limestone, Tertiary volcanic rocks and sparse mylonite clasts probably derived from the lower plate.

Txvu SEDIMENTARY BRECCIA, UNDIVIDED (MIOCENE) -- Massive, clast-supported sedimentary breccia with clasts of Mesozoic volcanic rocks. Located in west-central part of sec. 35.

Tlu LIMESTONE, UNDIVIDED (MIOCENE) -- Located in west-central part of sec. 35.

Tc HYDROTHERMAL CARBONATE (MIOCENE) -- Generally dark chocolate-brown to medium-brown hydrothermal carbonate rock that replaces various host rocks. Typically located above and along the basal detachment fault. In SE1/4, sec. 36, carbonate forms invasive veins into Tertiary andesite that has undergone

progressively greater replacement toward the carbonate.

Tm MAFIC DIKE (MIOCENE) -- Fine-grained, dark- to medium-gray, northwest-trending mafic dikes. Youngest intruded unit is Txv_{12}.

Mzb BUCKSKIN FORMATION (MESOZOIC) -- Dark-orangish-brown- and brown-weathering, ledge- and cliff-forming, massive to moderately bedded quartzite, calcareous quartzite, and greenish calc-silicate rocks. Siliciclastic rocks are generally fine to medium grained and well sorted, but are locally only moderately sorted, coarse grained, and probably slightly feldspathic. Unit contains gray, greenish-gray, and purplish-gray phyllite and cream-colored gritty sandstone.

Mzp PHYLLITE (MESOZOIC) -- Gray, greenish-gray, and purplish-gray phyllite and calcareous phyllite that is interpreted as stratigraphically overlying unit Mzsc.

Mzsc SANDSTONE AND CONGLOMERATE (MESOZOIC) -- Gritty quartzose to quartzofeldspathic sandstone, fine-grained conglomerate, quartzite, and calcareous quartzite. Conglomerate contains clasts of quartz and probable decomposed granite. Unit is interpreted to be in overturned depositional contact with granite of unit MzYi, and is most conglomeratic adjacent to this contact.

Mzsh SCHIST (MESOZOIC) -- Includes quartz-sericite-chlorite schist, phyllite, calc-silicate and carbonate rocks, and local slivers of Mesozoic volcanic rocks, quartzite, and variably mylonitic crystalline rocks, including coarse-grained, porphyritic biotite granite, banded gneiss, and alaskite. Chloritic schist is locally calcareous and associated with gypsiferous soil, probably derived from bedded gypsum. Many of the various lithologies have gradational contacts and are widely interlayered. Carbonate is orange, brown, or gray. Well-developed foliation and cleavage and complex interleaving of diverse lithologies suggest that Mesozoic thrust faults, possibly of large displacement, are contained within this unit. Rocks included in this unit probably range in age from Proterozoic to Mesozoic.

Pk KAIBAB LIMESTONE (PERMIAN) -- Light- to medium-gray, tan, light-brown, and yellowish-cream-colored limestone and dolomitic marble, locally with abundant dark-weathering, resistant siliceous layers, stringers, blobs, and irregular knots, typically 0.5 to 10 cm thick. Lithologic layering (bedding?) is defined by the orientation of siliceous layers and by color banding in the carbonate rocks.

Pc COCONINO SANDSTONE (PERMIAN) -- Pinkish-tan-weathering, vitreous quartzite.

Ps SUPAI GROUP (PERMIAN AND PENNSYLVANIAN) -- Dark-brown- to orangish-tan-weathering, ledge- and cliff-forming, thin-bedded to laminated quartzite and calcareous quartzite. Quartzite is well sorted and generally fine grained. Unit locally includes thin marbles.

Pzc CARBONATE ROCKS, UNDIVIDED (PALEOZOIC) -- Tan, gray, and tannish-brown, calcite and dolomite marble, massive to well bedded with local siliceous layers and stringers.

Pzcc CALCITE MARBLE (PALEOZOIC) -- Generally gray, thick-bedded to moderately bedded, calcite marble with or without siliceous layers and stringers.

Pzcd DOLOMITE MARBLE (PALEOZOIC) -- Generally tan, thick-bedded dolomite marble with or without siliceous layers and stringers.

MzYi MAFIC INTRUSIVE ROCKS (MESOZOIC OR PROTEROZOIC) -- Foliated and locally lineated, medium- to dark-green, aphanitic metavolcanic(?) to fine-grained, locally medium-grained, dioritic intrusive rock. Probably primarily represents shallow-level mafic intrusions of Mesozoic age.

MzYid DIORITIC INTRUSIVE ROCKS (MESOZOIC OR PROTEROZOIC) -- Fine- to medium-grained dioritic granitoids. Gradational with unit MzYi.

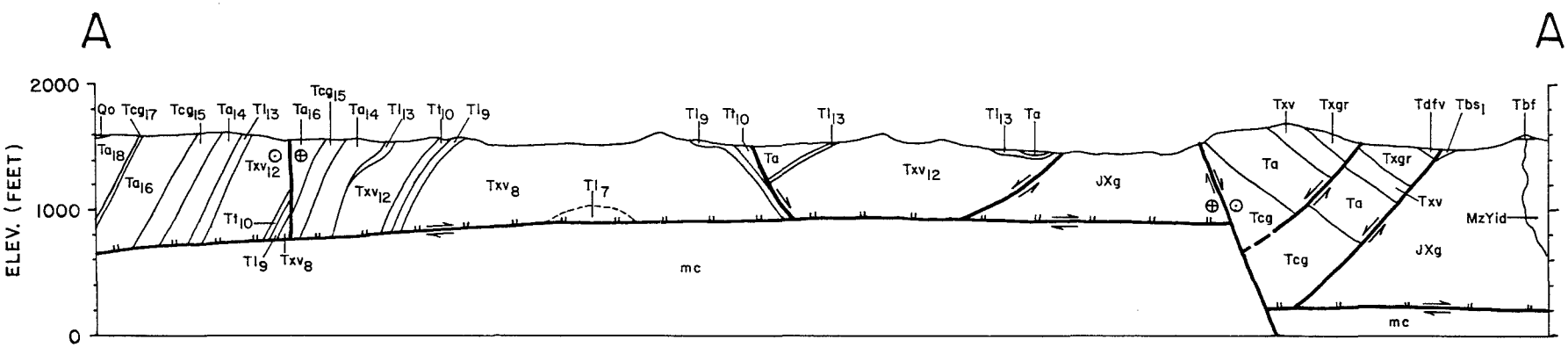
JXg GRANITIC ROCKS (PROTEROZOIC?) -- Primarily megacrystic biotite granite, but locally includes fine-grained equivalents. Medium- to fine-grained, leucocratic granite in S1/2, sec. 29 could be Mesozoic. The megacrystic granite was considered to be Mesozoic by Wicklein (1979) based on Rb-Sr data from a pegmatite, but a genetic relationship between the pegmatite and the granite has not been established. We consider the granite to be Proterozoic in age based on lithologic similarity to Proterozoic granitic rocks elsewhere in west-central Arizona.

gr_1 GRANITOID (MESOZOIC?) -- Foliated medium-grained granite(?). Forms fault-bounded blocks in NE1/4, sec. 36 and in S1/2, sec. 25. Could be Proterozoic, but is probably Mesozoic.

gr_2 GRANITOID (MESOZOIC?) -- Leucocratic, fine-grained granite(?) or granodiorite(?) with weak to moderate mylonitic foliation and local lineation.

Lower-Plate Unit

mc MYLONITIC CRYSTALLINE ROCKS (PROTEROZOIC TO CENOZOIC) -- Mylonitic granitic and high-grade metamorphic rocks. Includes foliated megacrystic granite with K-feldspar augen up to 3 cm long. Moderate- to well-developed, ENE-trending lineation is present on mylonitic foliation. Top-to-the-northeast shear during Tertiary mylonitization is indicated by S-C fabrics. Near the Buckskin-Rawhide detachment fault, these rocks have been converted to chloritic breccia and, directly below the fault, to microbreccia.


A
A'
2000
1000
0
ELEV. (FEET)
Qo
Tcg17
Tcg15
Ta14
Tl13
Ta16
Tcg15
Ta14
Tl13
Tl10
Tl9
Ta18
Ta16
Txv12
Txv12
Tl10
Tl9
Txv8
Txv8
Tl7
Tl9
Tl10
Tl13
Ta
Tl13
Ta
Txv12
JXg
mc
Txv
Txgr
Tdfv
Tbs1
Tbf
Ta
Txgr
Ta
Txv
Tcg
Tcg
JXg
MzYid
mc

CORRELATION OF MAP UNITS