GEOLOGIC MAP OF THE HUMBOLDT MOUNTAIN 7.5' QUADRANGLE, MARICOPA COUNTY, ARIZONA

by

Wyatt G. Gilbert, Charles A. Ferguson, and Robert S. Leighty

Arizona Geological Survey
Open-File Report 98-11

August, 1998

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

Includes 17 page text, and 3 sheets: 1:24,000 scale geologic map, explanation, and cross-sections.

Funded by the U.S. Geological Survey through the STATEMAP program agreement #1434-HQ-97-AG-01824 and the Arizona Geological Survey.

INTRODUCTION

The Humboldt Mountain Quadrangle is located at the north edge of the Phoenix metropolitan area northeast of and adjacent to the town of Cave Creek, Arizona. The quadrangle straddles the hydrographic divide between the New River and Verde River basins. The quadrangle includes the upper Cave Creek drainage in the New River drainage basin, and the upper Camp Creek, lower Lime Creek, and upper Willow Springs Creek portions of the Verde River drainage basin. Geologic mapping of the Humboldt Mountain Quadrangle is one of a series of geologic maps covering the northeastern part of the Phoenix metropolitan area (Ferguson and others, 1998a, b; Leighty and others, 1997; Skotnicki, 1996a, b; and Skotnicki and others, 1997).

Primary access to the Humboldt Mountain Quadrangle was by Forest Road 24 (Camp Creek-Seven Springs-Bloody Basin road). This road provided additional access to the Juans Canyon, Walnut Springs Canyon, Humboldt Mountain, and Rackensack Canyon roads. Four-wheel drive trails from the Horseshoe Dam Road provided access to the eastern part of the quadrangle.

The study area, together with most of the adjacent New River Mesa Quadrangle (Ferguson and others, 1998) was mapped at a scale of 1:24,000 by Gilbert and Ferguson during the fall, winter, and spring of 1997-1998. Mapping was conducted by foot traverses from various access roads within the Humboldt Mountain Quadrangle. Petrologic infomation by Leighty (1997) was also incorporated into the report.

Production of this map and report was funded jointly by the Arizona Geological Survey and the United States Geological Survey STATEMAP program (contract agreement number 1434-HQ-97-AG-01824). The views and conclusions contained in this document are those of the authors and should not be interpreted as necessarily representing the official policies, either expressed or implied, of the U.S. Government.

PREVIOUS INVESTIGATIONS

Little previously published geologic mapping covered the Humboldt Mountain Quadrangle. Lewis (1920) published a reconnaissance map of the Cave Creek Mineral District that focused on minerals-bearing Proterozoic rock units, and the regional geologic map of Maricopa County by Wilson and others (1957) includes the Cave Creek-Humboldt Mountain area. Detailed geologic studies in the Humboldt Mountain Quadrangle are limited to an M.S. Thesis by Kayler (1978), who mapped at 1:9,600 an area near Humboldt Mountain and described the petrology and geochemistry of the various map units, and a Ph.D. Dissertation by Leighty (1997), who sampled and described the stratigraphy and geologic setting of different areas in the New River Mesa-Camp Creek area. Anderson (1989a) presented a simplified map of the Proterozoic geology of the Cave Creek-Humboldt Mountain area, as well as briefly summarizing the Proterozoic stratigraphy of the area. Surficial units in the southern part of the Humboldt Mountain Quadrangle are discussed by Pearthree and Demsey (1996)

SUMMARY OF GEOLOGY

Proterozoic

The oldest rocks in the Humboldt Mountain Quardrangle are composed of folded, greenschist metamorphic grade Early Proterzoic volcanic, plutonic, and siliciclastic units and Middle Proterozoic intermediate and felsic intrusions. These units lie within the Mazatzal Block of the Mazatzal orogenic province (Karlstrom and Bowring, 1993). Proterozoic units within the Mazatzal Block are less intensely deformed than in adjacent areas to the northwest and southeast (Anderson, 1989b; Karlstrom and Bowring, 1993). In general, the Proterozoic succession of the Mazatzal Block is characterized by a predominantly mafic volcanic-plutonic complex overlain by graywacke turbidites and fine-grained clastic rocks, that are in turn overlain by various intermediate to felsic igneous complexes. The uppermost Early Proterozoic assemblages are dominated by quartz-rich clastic units. Tectonism of the Mazatzal Block is reflected initially by the voluminous clastic sedimentary and intermediate and felsic igneous activity from 1.72 to 1.69 Ga. Continued compressive deformation and very low grade metamorphism within the Mazatzal Block continued from 1.66 to 1.60 Ga. Regional, postorogenic granitic magmatism at apporoximately 1.4 Ga also affected the Mazatzal Block (Wilson, 1939; Anderson, 1989a; Karlstrom and Bowring, 1993).

Numerous workers have described the Proterozoic stratigraphic succession of central Arizona, resulting in a confusing collection of rock unit and stratigraphic names (eg. Anderson, 1989b; Conway and Silver, 1989; and Karlstrom and Bowring, 1993). This report will not attempt to resolve nomenclature problems, and as much as possible will identify rock units solely on the basis of lithologic criteria.

The oldest rocks in the Humboldt Mountain Quadrangle are the felsic volcanic (Xfv) and coarse clastic units (Xcg) that crop out in the core of a regional antiform in the northwest part of the quadrangle (Sheet I; A-A', Sheet III). These units are overlain by an extensive succession of mafic and intermediate volcanic rocks (Xm, Xma), together with interbedded units of felsic volcanic rocks (Xf) and siliceous pelitic rocks, chert, and limestone (Xsc, Xc, Xl). In the southern part of the quadrangle the volcanic succession is overlain by an assemblage of turbiditic clastic rocks (Xs) (Figure 1).

In the supracrustal Early Proterozoic rocks of the map area, a prominent cleavage or schistosity (S_1) is commonly developed that is axial planar, and presumably syn-kinematic with respect to the megascopic fold structure. The intensity of the fabric varies considerably over short distances, from very strong and obliterating all evidence of primary structures to very weak, but is generally weak to moderate. Rarely, a post-metamorphic, mm- to cm-scale spaced crenulation cleavage (S_2) is developed in the pelitic rocks, which suggests a later phase of deformation.

An intersection lineation of bedding and the prominent cleavage (S_1) consistently trends NE-SW. In general, the lineation plunges moderately towards the northeast. A younger crenulation lineation is produced by the intersection of the S_1 and S_2 cleavages.

The Early Proterozoic supracrustal units are intruded by the Early Proterozoic (1700 Ma?) Verde River granite (Xg) (Anderson, 1989a) in the east-central and northeastern part of the map area, and by dacitic rocks (Xd) (possibly hypabyssal equivalents of the Verde River granite) in the northwest part of the quadrangle (Sheet 1; Figure 1).

Along the east-central edge of the map area, a screen of variably foliated (S_1) metabasite and diorite separates the Early Proterozoic Verde River granite from the Middle Proterozoic K-feldspar megacrystic granite to the south. East of the map area a well-developed mylonite shear zone occurs within the Verde River granite in the west-central Horseshoe Dam quadrangle along strike from the screen of Early Proterozoic supracrustal rocks (Ferguson and others, in preparation).

In the southern part of the Humboldt Mountain Quadrangle small stocks of Middle Proterozoic (?) diorite (Yd) locally intrude Early Proterozoic units. Moreover, the south-central and southeastern part of the quadrangle is generally underlain by Middle Proterzoic granite (Yg) that is intrusive into Early Proterozoic turbitites and mafic volcanic units along its northern margin (Sheet 1; Figure 1).

A cross-cutting relationship between the Early and Middle Proterozoic granitic bodies is well exposed near St. Clair Spring in the easterly adjacent Horseshoe Dam quadrangle (Ferguson and others, in preparation). No evidence of tectonic fabric development was observed in the southerly, Middle Proterozoic granite even though well-developed mylonites and shear zones can be found nearby within the Early Proterozoic Verde River granite. Further evidence of the post-kinematic emplacement age of the Middle Proterozoic megacrystic granite is the post-kinematic growth of 3-5 mm black porphyroblasts within a contact metamorphic aureole in the turbidite unit (Xs).

Tertiary

The Proterozoic rocks of the Humboldt Mountain Quadrangle are unconformably overlain by a gently dipping Neogene sedimentary and volcanic complex. The quadrangle lies within the Transition Zone between the Colorado Plateau to the north and the Basin and Range Province to the south. This zone remained tectonically stable during the period of mid-Tertiary extension to the south, but did participate in the Middle and Late Tertiary block faulting (Leighty, 1997).

The oldest Tertiary sedimentary rock unit in the Humboldt Mountain Quadrangle is a generally prevolcanic, weakly to non-stratified conglomerate (Tc), with clasts predominantly derived from nearby Proterozoic rocks. Rare paleocurrent data suggest that this unit originated from sediment filling a north-flowing fluvial basin. This unit is likely correlative with the extensive Middle Tertiary prevolcanic fluvial units, such as in the eastern Gila Bend Mountains (Gilbert, 1991), the Whitetail Conglomerate (Pederson, 1969), the Bloody Basin Fanglomerate of Elston, 1984, and the Cave Creek Fanglomerate (Gomez, 1979, Jagiello, 1987; and Leighty, 1997) found throughout central and southern Arizona (Eberly and Stanly, 1978; Scarbourough and Wilt, 1979). The unit unconformably overlies the Proterozoic basement rocks, unconformably underlies the younger basaltic lavas, and represents the oldest post-Laramide rock unit in the Transititon Zone (Gomez, 1979, Elston, 1984; Jagiello, 1987; Leighty, 1997).

Late Oligocene to Early Miocene trachyandesite, latite and andesite units are scattered throughout central Arizona, including in immediately adjacent quadrangles (McKee and Anderson, 1971; Esperanca, 1984; Esperanca and Holloway, 1986; Gomez, 1979; Jagiello, 1987; Leighty and others, 1997; and Skotniki and others, 1997). These rocks tend to form domes, with thick flows, and may have tuff associated with them. The latite rocks in the southeast part of the Humboldt Mountain Quadrangle may be related to the Camp Creek latite in the adjacent Wildcat Hill Quadrangle (Skotnicki and others, 1997), and may be the oldest Tertiary volcanic rocks in the quadrangle.

Overlying and locally intruding the prevolcanic conglomerate, and capping the highest parts of the map area, is a series of latitic to basaltic lavas (Tvi, Tbl, Tbb, Tb) that are interbedded with subordinate amounts of volcaniclastic sedimentary rocks (Tvs, Tsa, Tbs) and tuff (Tt) (Figure 1). North and southwest of Kentuck Mountain an unconformity separates a lower basaltic assemblage (Tbl, Tvs, Tsa) from overlying basaltic units. The lower basalt sequence is the equivalent of the Early and Middle Miocene Chalk Canyon formation to the east (Gomez, 1979; Leighty, 1997). Some of the lower basaltic and sedimentary units in the Bronco Creek and upper Rackensack Creek areas may also be equivalent to the Chalk Canyon Formation. The overlying basalt is correlative with the Middle Miocene Hickey Formation basaltic lavas that cap mesas in the New River Mesa Quadrangle and was produced by the same Middle Miocene (14-16 Ma) eruptive event that formed other Hickey Formation sheet lavas (e.g., at New River Mesa, Skull Mesa, etc.) across the Transition Zone and Basin and Range (Gomez, 1979; Leighty and Glascock, 1994; Leighty and others, 1985; Leighty, 1997).

Conglomerate (Tcyl, Tcyu) derived from both Proterozoic and Tertiary units overlies Miocene and Proterozoic units in the central part of the Humboldt Mountain Quadrangle. The older conglomerates (Tcyl) were syntectonically deposited during formation of the Seven Springs Wash half-graben.

STRUCTURE

Folds

The structure of Early Proterozoic supracrustal rocks in the Humboldt Mountain Quadrangle is characterized by a series of tight, northeast-trending folds (Sheet 1; Figure 2). The folds range from regional- to outcrop-scale. The study area is dominated by a regional anticline trending 055. The axis of this structure crosses the southwest part of the New River Mesa Quadrangle and the northwest part of the Humboldt Mountain Quadrangle (Sheet 1; A-A', Sheet 3; Figure 2). The hinge region of the regional anticline is never completely exposed and for the most part is buried by Tertiary rocks or is intruded by Early Proterozoic granitic rocks (Xgm of Ferguson and others, 1998). An important exception is in the Seven Springs area where northeast-dipping, upright, turbiditic conglomerate and sandstone (Xcg, Xcm) are only weakly foliated, but possesses consistent northeast-plunging intersection lineations. This area represents the best preserved evidence of the northeast plunging hinge area of the major anticline. Strata on either limb of the anticline give every indication that they are part of the same folded sequence, even if the two sections are significantly different. All of the lithologies, both volcanic and sedimentary, are common to either limb, as is the overall metamorphic grade and degree of cleavage development. Granite boulder conglomerate, volcaniclastic units, and interbedded mafic subaqueous lava flows and hyaloclastites are more abundant in the northwest limb. We speculate that this difference reflects normal facies changes along a continental volcanic arc, with the northwest limb being more proximal to the shoreline.

The Early Proterozoic supracrustal assemblage is exposed in two thick sections on either side of a major northeast-trending regional anticline (Sheet 1, Figure 2,3), but any connection between the two sections is obscured by Tertiary cover. The section on the northeast limb is approximately 6 km thick and on the southeast limb 3-4 km thick. Even though the sequence appears different on each limb (Figure 3), there are many similarities. All lithologies are present in both sections and all at approximately the same metamorphic grade and cut by similar styles of slaty cleavage and schistosity. In both limbs, upward transitions from mafic volcanics to turbidites are fairly rapid and characterized by intervals of ribbon chert and mudstone (Xsc) and in some areas, thick individual chert beds (Xc). This facies association occurs only once in the southeast limb, but in at least three places in the northwest limb. It is not known which one, if any, of the northwestern chert marker units correlates with the only chert marker of the southeast limb. It is possible that the southeast-limb chert marker, which pinches out to the northeast, does not correlate with any of the northwestern limb cherts, and that instead the thick turbidite sequence of the southeast limb correlates as a whole with the entire interbedded turbidite and volcanic succession of the northwest limb (see correlations of Figure 3).

The axis of a northeast-trending syncline ($\lambda/2=3.0$ mi) can be traced from Continental Mountain in the southeast corner of the New River Mesa Quadrangle across Rackensack Canyon in the Humboldt Mountain Quadrangle. The axial surface of this syncline dips steeply to the northwest, and turbidite beds in the northwest limb are generally overturned. Similar folds are mapped in turbidites between Sears Kay Ranch and Gold Hill (Sheet 1; B-B', Sheet 3).

Sub-parallelism between the regional northeast-trending folds and cleavage in Early Proterozoic rocks suggests that the folding was synchronous with Early Proterozoic orogeny. Evidence that this deformation occurred during Early Proterozoic time (Yavapai Orogeny ?) is that the Early Proterozoic Verde River granite (1700 Ma?) apparently cuts the regional fold structures and exhibits little to no tectonic fabric.

Weak, variably north-south-trending folding during Late Tertiary/Quaternary time is suggested by the gentle syncline outlined by Late Tertiary conglomerate in the Humboldt Mountain Quadrangle, and by varying gentle attitudes in Middle to Late Tertiary units (Sheet 1).

Faults

Several northwest-striking, high-angle faults cut Pre-Holocene rocks units in the Humboldt Mountain Quadrangle. In the northeast corner of the quadrangle the west-northwest-striking, high-angle, Lime Creek fault (Leighty, 1997) juxtaposes Miocene basalt (Chalk Canyon Formation ?) on the northeast against Early Proterozoic Verde River granite on the southwest. A high-angle fault, also with apparent northeast side down, mapped by Skotnicki and others (1997) continues into the southwest corner of the Humboldt Mountain Quadrangle. North of Kentuck Mountain west-northwest-striking high angle faults have up to 600 feet of northeast side down separation of Tertiary rocks (Sheet 1).

The overall pattern of Tertiary normal faulting in the region is north-striking, and east-side-down, resulting in gentle (5°-15°) dips of the Miocene strata. The main faults are the Horseshoe Lake fault, with at least 2500 feet of displacement, which barely cuts through the northeast corner of the Humboldt Mountain Quadrangle (Sheet 1; Ferguson and Gilbert, 1998; Wrucke and Conway, 1987), and a fault which parallels the south-flowing segment of Cave Creek in the westerly adjacent New River Mesa quadrangle, with between 200 and 1000 feet of displacement (Gomez, 1979; Ferguson and others, 1998). Another zone of east-side-down normal faulting is expressed in the south-central part of the quadrangle near the mouth of Rackensack Canyon. Here, an east-side down fault with 400 feet of displacement of the base of the Tertiary volcanic units apparently dies upward into and is buried by the younger conglomerates (Tcyl). Along strike to the north, the buried fault appears to step to the left along a steeply east-dipping buttress unconformity between basalt lava and the conglomerate (Sheet 1; D-D', Sheet 3). This fault forms the Seven Springs Wash half-graben into which the Tcyl unit was deposited. The fault must die out completely farther north because there is no evidence of displacement of the basal Tertiary contact in the Seven Springs area (Sheet 1). Likewise, a steep, east-dipping buttress unconformity mantled by basalt lava in lower Bronco Creek may have been localized along a north-striking fault, but if present any fault here must predate the oldest Tertiary strata along the confluence of Bronco Creek and Cave Creek. North-south faulting correlates with Late Miocene east-west extension of the Basin and Range disturbance (Leighty and Reynolds, 1996).

REFERENCES

Anderson, Phillip, 1989a, Stratigraphic framework, volcanic-plutonic evolution, and vertical deformation of the Proterozoic volcanic belts of central Arizona, in Jenney, J.P., and Reynolds, S.J., eds., Geologic evolution of Arizona: Arizona Geological Society Digest 17, p. 57-147.

Anderson, Phillip, 1989b, Proterozoic plate tectonic evolution of Arizona, in Jenney, J.P., and Reynolds, S.J., eds., Geologic evolution of Arizona: Arizona Geological Society Digest 17, p. 17-55.

Conway, C.M., and Silver, L.T., 1989, Early Proterozoic rocks (1710-1615 Ma) in central to southeastern Arizona, in Jenney, J.P., and Reynolds, S.J., eds., Geologic evolution of Arizona: Arizona Geological Society Digest 17, p. 165-186.

Eberly, L.D., and Stanley, T.B., 1978, Cenozoic stratigraphy and geologic history of southwestern Arizona: Geological Society of America Bulletin, v. 89, no. 6, p. 921-940.

Elston, D.P., 1984, Rocks, landforms, and landscape development in central Arizona, in Smiley, T.L., Nations, J.D., Pewe, T.L., and Schafer, J.P., eds., Landscapes of Arizona--The geological story: Lanham, Md., University Press of America, p. 151-173.

Esperanca, S., 1984, An experimental and geochemical study of the high-K latites and associated nodules from Camp Creek, Arizona: Tempe, Arizona State University, Ph.D. dissertation, 204 p.

Esperanca, S., and Holloway, J.R., 1986, The originof the high-K latites from Camp Creek, Arizona; constraints from experiments with variable fO2 and aH20: Contributions to Mineralogy and Petrology, v. 93, p. 504-512.

Ferguson, C.A, Gilbert, W.G., and Leighty, R.S., 1998, Geologic map of the New River Mesa 7.5 Minute Quadrangle, Maricopa County, Arizona: Arizona Geological Survey Open-File Report 98-12, p., 3 sheets, scale 1:24,000.

Gilbert, W. G., 1991, Bedrock geology of the eastern Gila Bend Mountains, Maricopa County, Arizona: Arizona Geological Survey Open-file Report 91-5, 13 pp., 1:24,000 sheet.

Gomez, Ernest, 1979, Geology of the south-central part of the New River Mesa Quadrangle, Cave Creek area, Maricopa County, Arizona: U.S. Geological Survey Open-File Report 79-1312, 144 p., 1 sheet, scale 1:12,000.

Heindl, L.A., and Armstrong, C.A., 1963, Geology and ground-water conditions in the Gila Bend Indian Reservation, Maricopa County, Arizona: U.S. Geological Survey Water-Supply Paper 1647-A, p. A1-A48.

Jagiello, K.J., 1987, Structural evolution of the Phoenix basin, Arizona: Tempe, Arizona State University, M.S. thesis, 156 p.

Leighty, R.S., and Glascock, M.D., 1994, A Middle Miocene magmatic transition in central Arizona: Geological Society of America Abstracts withPrograms, v. 26, no. 7, p. A354.

Leighty, R.S., and Reynolds, S.J., 1996, Dynamics of Neogene faulting across the Basin and Range-Colorado Plateau transitioin in central Arizona: Geological Society of America Abstracts with Programs, v. 28, no. 7, p. A451.

Leighty, R.S., Reynolds, S.J., Farmer, G.L., and Glascock, M.D., 1995, Early Miocene mafic magmatism in central Arizona: American Geophysical Union Abstracts with Programs, v. 76, p. F656.

Leighty, R.S., Skotnicki, S.J., and Pearthree, P.A., 1997, Geologic map of the Cave Creek Quadrangle, Maricopa County, Arizona: Arizona Geological Survey Oper-File Report 97-1, 38 p., 2 sheets, scale 1:24,000 and 1:12,000.

Karlstrom, K.E., and Bowring, S.A., 1993, Proterozoic orogenic history of Arizona, in Reed, J.C., Jr., Bickford, M.E., Houston, R.S., Link, P.K., Rankin, D.W., Sims, P.K., and Van Schmus, W.R., eds., Precambrian: conterminous U.S.: Geological Society of America, the geology of North America, v. C-2., p. 188-211.

Kayler, K.L., 1978, Geology of the Humboldt Mountain area, Arizona: Tempe, Arizona State University, M.S. thesis, 101 p., 1 sheet, scale 1:9,600.

Leighty, R.S., 1997, Evolution of tectonism and magmatism across the Basin and Range-Colorado Plateau boundary, central Arizona: Tempe, Arizona State University, unpublished Ph.D dissertation, 1019 p.

Lewis, A.S., 1920, Ore deposits of Cave Creek district in Arizona: Engineering and Mining Journal, v. 110, no. 15, p. 713-716.

McKee, H.H., and Anderson, C.A., 1971, Age and chemistry of Tertiary volcanic rocks in north-central Arizona and relation of the rocks to the Colorado Plateaus: Geological Society of America Bulletin, v. 82, no. 10, p. 2767-2782.

Pearthree, P.A., and Demsey, K.A., 1996, Surficial geologic map of the southern parts of the New River Mesa and Humboldt Mountain quadrangles, Maricopa County, Arizona: Arizona Geological Survey Open-File Report 96-26, 13 p., 1 sheet, scale 1:24,000.

Pedersen, E.P., 1969, Sedimentology and stratigraphy of basin-fill sediments of the Payson Basin, Gila County, Arizona: Tempe, Arizona State University, M.S. thesis, 136 p., 1 sheet, scale 1:32,000.

Scarborough, R.B., and Wilt, J.C., 1979, A study of the uranium favorability of Cenozoic sedimentary rocks, Basin and Range Province, Arizona; Part 1, General geology and chronology of pre-late Miocene Cenozoic sedimentary rocks: Arizona Bureau of Geology and Mineral Technology Open-File Report 79-1, 101 p.

Skotnicki, S.J., 1996a, Geologic map of portions of the Fort McDowell and McDowell Peak quadrangles, Maricopa County, Arizona: Arizona Geological Survey Open-File Report 96-11, 20 p., scale 1:24,000.

Skotnicki, S.J., 1996b, Geologic map of the Bartlett Dam Quadrangle and southern part of the Horseshoe Dam Quadrangle, Maricopa County, Arizona: Arizona Geological Survey Open-File Report 96-22, 21 p., scale 1:24,000.

Skotnicki, S.J., Leighty, R.S., and Pearthree, P.A., 1997, Geologic Map of the Wildcat Hill Quadrangle, Maricopa County, Arizona: Arizona Geological Survey Open-File Report 97-2, 17 p., scale 1:24,000.

Wilson, E.D., Moore, R.T., and Peirce, H.W., 1957, Geologic map of Maricopa County, Arizona: Arizona Bureau of Mines, 1 sheet, scale 1:375,000 (now available as Arizona Geological Survey Map M-3-5).

Wilson, E.D., 1939, Pre-cambrian Mazatzal revolution in central Arizona: Geological Society of America Bulletin, v. 50, p. 1113-1164.

Wrucke, C.T., and Conway, C.M., 1987, Geologic map of the Mazatzal Wilderness and contiguous roadless area, Gila, Maricopa, and Yavapai counties, Arizona: U.S. Geological Survey Open-File Report 87-0664, 22 p., 1 sheet, scale 1:48,000.

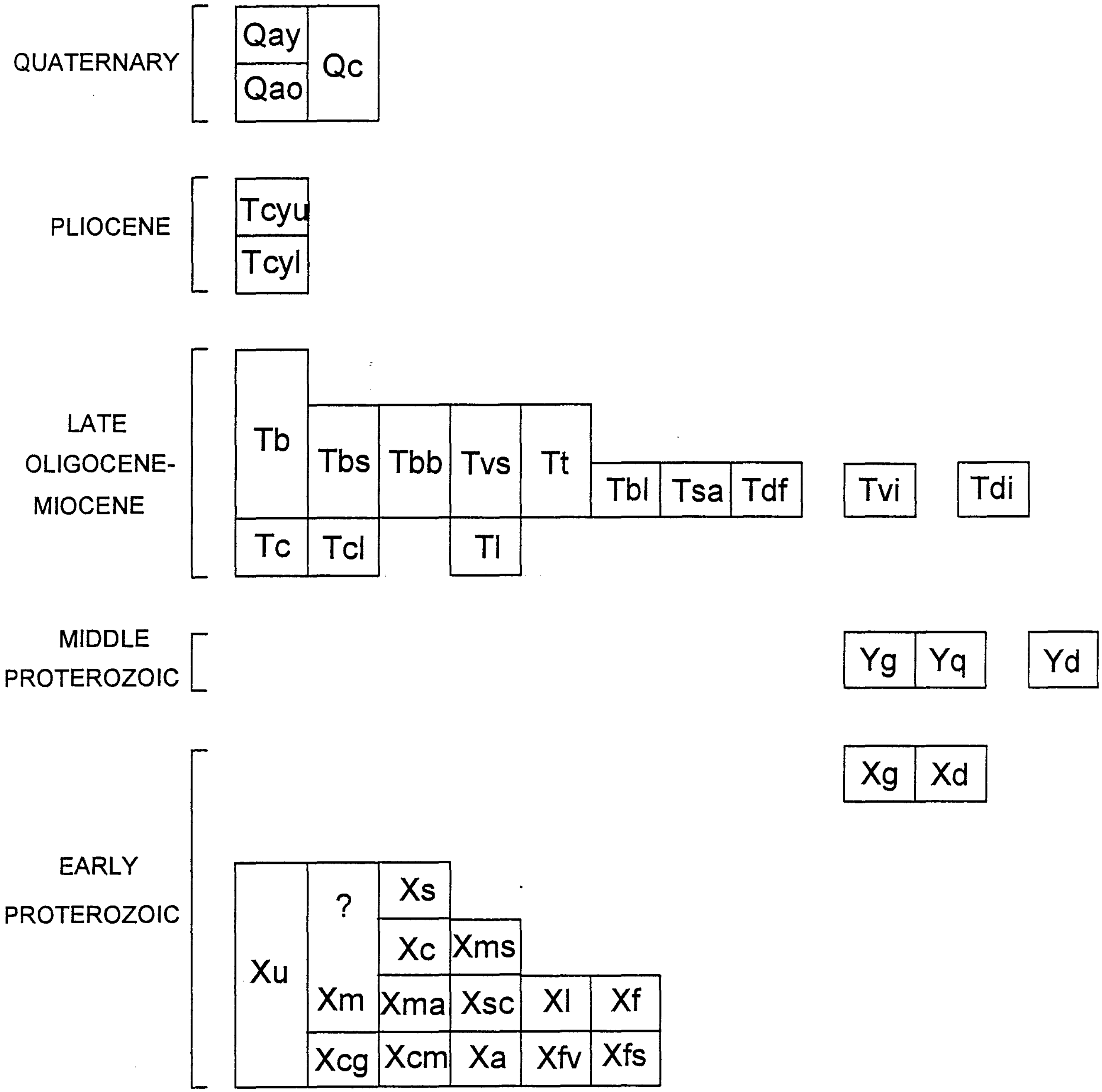

Figure 1 Correlation diagram for map units of the Humboldt Mountain 7.5' quadrangle.

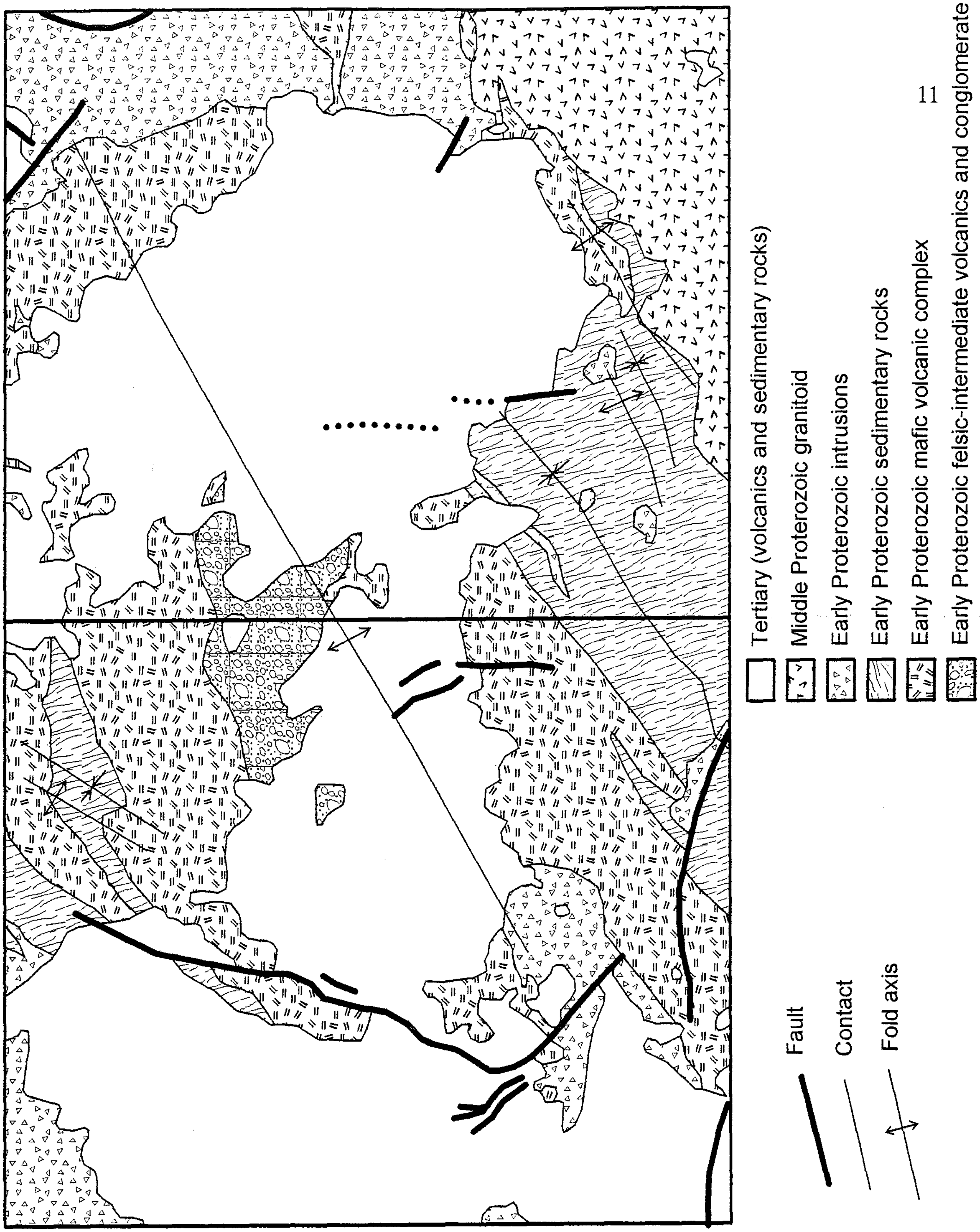

Figure 2 Generalized geology of the New River Mesa (left) and Humboldt Mountain (right) 7.5' quadrangles.

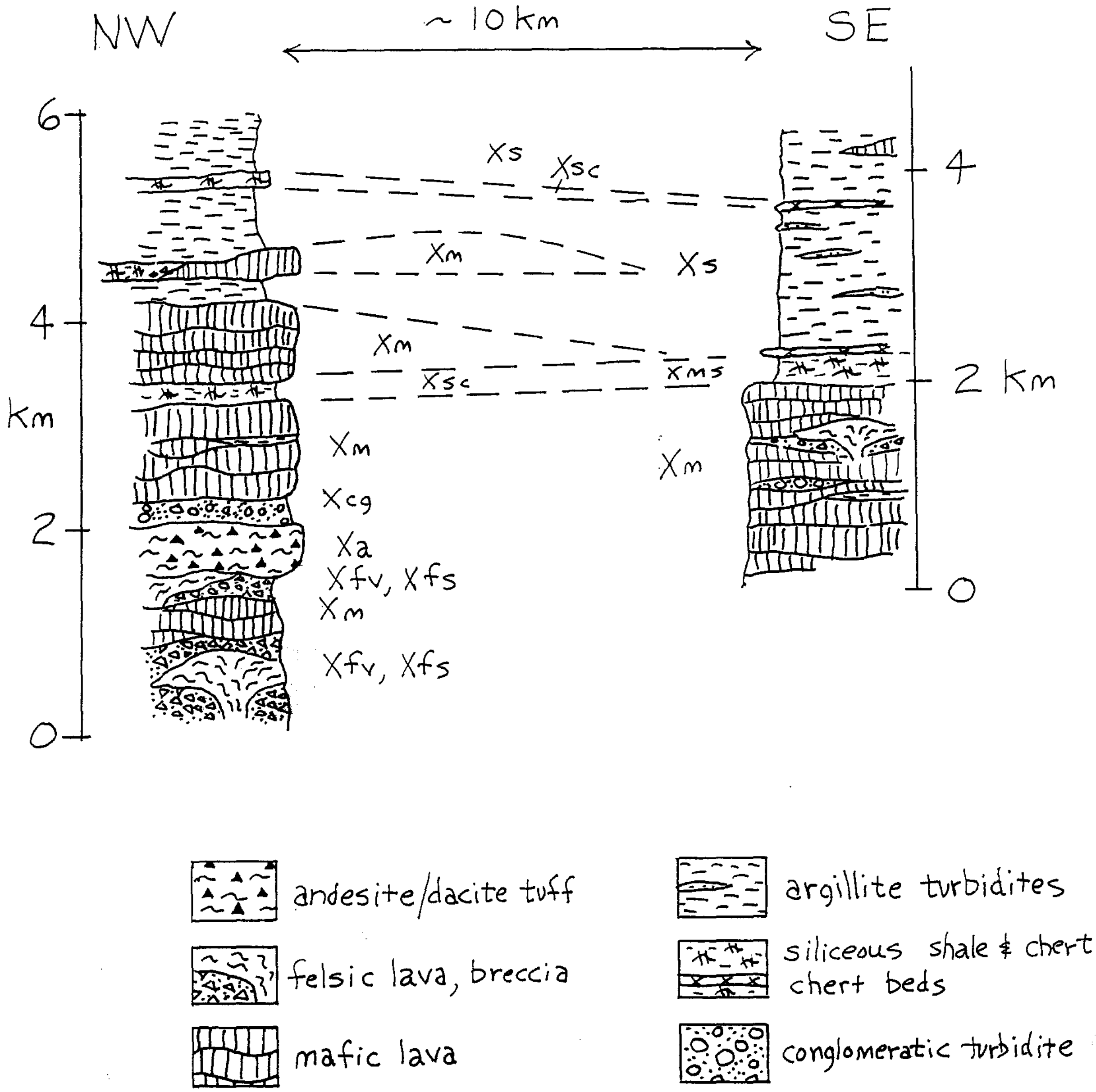

Figure 3 Stratigraphic correlation diagram for Early Proterozoic supracrustal rocks exposed on the northwest (NW) and southeast (SE) limbs of the major anticline which transects the Humboldt Mt. and New River Mesa map areas. Unit symbols correspond to units described in the unit descriptions section and on the geologic map (Sheet 1).

UNIT DESCRIPTIONS
HUMBOLT MOUNTAIN QUADRANGLE,
MARICOPA COUNTY, ARIZONA

QUATERNARY

Qay--Younger alluvium--Unconsolidated, poorly sorted, sand, gravel and boulder deposits confined to modern drainages. Characterized by stratified, poorly to moderately sorted, sand, gravel, and cobbles. Single channels commonly diverge into braided channels, which converge again downstream. Alluvial surfaces exhibit bar-and-swale topography, with the ridges typically being more vegetated.

Qao--Older alluvium--Unconsolidated, moderately to poorly sorted, subrounded to rounded sand- and gravel-sized clasts in a sandy to silty matrix. Landforms typically are low terraces, but also include minor channels.

Qc--Talus and colluvium--Unconsolidated to moderately consolidated colluvial deposits on hillslopes. Typically fairly coarse, subangular to angular, very poorly sorted, weakly bedded deposits. Commonly present along the scarps of larger mesa escarpments.

TERTIARY

Tcyu--Younger conglomerate (upper)--Tcyl grades upward over 10-30 meters into a crudely stratified, basaltic conglomerate (Tcyu) with 90% subangular to subrounded granules, pebbles, cobbles and rare boulders of basalt and 10% finer-grained (pebble-granule) granitic clasts. Tcyu overlies Tcyl along the axis of the Camp Creek-Seven Springs Wash lowland, and overlaps Tb along the margins of the valley. The unit forms rubbly slopes of basalt cobbles and boulders. Between Juans Canyon and upper Cave Creek in the northwest part of the quadrangle Tcyu consists of cobbles of porphyritic YXd (85%), purple slate (10%), and metabasite (5%).

Tcyl--Younger conglomerate (lower)--The valley of upper Camp Creek and upper Seven Springs Creek is underlain by moderately indurated, buff-colored conglomerate. The lower part of the unit (Tcyl) is composed of crudely stratified pebble-cobble conglomerate with a poorly sorted, coarse-grained, sandy to granule arkosic sandstone matrix. This part of the unit weathers to arkosic gruss. Clasts are subrounded and compositions variable, but are approximately 30% basalt, 30% granite, and 20% felsite.

Tdt--Dacite tuff--Welded to nonwelded dacite tuff, typically thin- to medium-bedded. Phenocrysts of plagioclase and biotite $\pm$ quartz make up 10-15% of the tuffs which occur as one and locally two units interleaved with basalt flows in upper Bronco Creek and areas north of Rackensack Canyon. Associated with a single dacite lava plug (Tdi).

Tdi--Dacite intrusion--Plagioclase, biotite-bearing dacite lava plug. Phenocryst mineralogy matches the dacite tuff (Tdt).

Tb--Basalt lava--A thick succession of basaltic andesite (?) and basalt flows with associated flow breccia and minor amounts of interbedded mafic and felsic tuff, bedded basaltic scoria, and volcaniclastic sedimentary rocks. The basaltic lava flows are generally correlative with the Middle and Late Miocene Hickey Formation, that unconformably overlie the Chalk Canyon Formation sequence, but may include undifferentiated Tbl lavas in the northwest part of the map. The lavas typically weather as brown, cliff-forming basaltic units. These rocks are characteristicly intergranular to porphyritic in overall texture, with clinopyroxene and altered olivine phenocrysts present within a framework of plagioclase crystals. Columnar jointing and zones of vesicles are common in outcrop. The vesicles are typically open, 2cm in dimeter, and may be rimmed with calcite. Hornblende pseudormophs are locally present (e.g., in lavas in the Humboldt Mountain and Kentuck Mountain areas), and possibly represent a more andesitic composition. The lavas are largely subalkaline (olivine-subalkali basalt and basaltic andesite).

Tbs--Basaltic scoria and sandstone--Basaltic scoria and agglomerate, locally interbedded with basaltic volcaniclastic sandstone. Occurs chiefly in thick sequences that are probably associated with vents.

Tbb--Basalt breccia--In upper Cave Creek in the northwest part of the map a crudely stratified, basaltic andesite breccia (Tbb) can be mapped separately.

Tbl--Lower basalt--Along the southeast margin of the Tb volcanic pile a lower basalt unit (Tbl) can be differentiated that unconformably underlies Tb. In Buck Basin, these lavas overlie and interfinger with lavas and tuffs derived from two massive plugs of latitic composition (Leighty, 1997). Tbl lavas probably represent the lower member of the Chalk Canyon Formation, which ranges in age from Latest Oligocene to Earliest Miocene (23 to 17 Ma). The lavas are typically porphyritic, with olivine + clinopyroxene phenocrysts in a fine-grained groundmass. Intergranular biotite is commonly present. Lower flows are typically altered and amygdaloidal. These basaltic lavas are largely alkaline to transitional in composition. Exposures along Bronco Creek and the East Fork of Bronco Creek contain subporphyritic, biotite-bearing olivine basalt that probably flowed into topographic low areas. Southwest of Kentuck Mountain, several porphyritic olivine+ clinopyroxene basalt flows bracket a tuffaceous sedimentary sequence.

Tvi--Intermediate volcanic intrusion--Resistant, light-gray, andesitic dome, flows, and hypabyssal dikes and plugs. Forms steep cliffs below the Miocene basalt-tuff sequence east of Maverick Butte. Parts of the dome exhibit steeply-dipping, radial internal foliation. Locally includes scoria and agglomerate deposits. Porphyritic overall texture with a microtrachytic groundmass. Chemical compositon is latite. Typically slightly vesicular and variably altered. No xenoliths were observed in this unit.

Tsa--Arkosic sandstone--Akosic sandstone that is locally interbedded with Tb and Tbl. The sandstone is locally volcaniclastic, and in some areas (lower Bronco Creek) contain distinctive clasts of the Proterozoic dacite unit (Xd).

Tvs--Volcaniclastic sandstone--Pumiceous sandstone, pebbly sandstone, and rare conglomerate. Generally contains abundant pumice and Tertiary volcanic lithic clasts. Locally includes thin, nonwelded bedded tuff and units of undifferentiated volcaniclastic sandstone and tuff. East of Maverick Butte a west-dipping sequence of tan to pale-orange, tuffaceous pebbly sandstone overlies thickly bedded tuff and reworked tuff. A sequence of massive, tuffaceous, pebbly sandstone (30 m thick) is exposed southwest of Kentuck Mountain. The lower 10 meters consists of massive tuffaceous sandstone with pebble-sized pumice and basalt clasts. The middle 10 meters consists of matrix-suported pumice- and basalt-rich tuffaceous sandstone, and the upper 10 meters is a tan, medium- to fine-grained tuffaceous sandstone with basalt and minor Proterozoic clasts.

Tt--Nonwelded tuff--Medium- to thin-bedded tuff ranging from basaltic to rhyolitic in compostion. Basaltic tuff typicallly grades laterally into bedded scoria deposits (Tbs). Locally interbedded with thin sequences of pumiceous volcaniclastic rocks.

Tcl--Conglomerate and limestone--Conglomerate and sandstone, mostly of granitic origin, interbedded with thin- to medium-bedded white, lacustrine limestone. The limestone is typically recrystallized, but locally preserves ooid-pisoid grainstone/packstone textures and stromatolites. The unit is interbedded with subaqueous basalt lava flows.

Tc--Conglomerate--Buff- to orange-weathering, weakly indurated, poorly sorted, pebble-cobble-boulder conglomerate with a granule sandy matrix. The unit is generally crudely to poorly stratified, and forms slopes and cliffs. Subrounded clasts are predominantly from underlying Proterozoic units. Clasts in Buck Basin are composed of quartz porphyry and granite (60%), Xm mafic rocks (30%), and chert and quartz (10%), and are set in a poorly sorted, coarse-grained arkosic sandstone matrix. South of Kentuck Mountain, however, the unit is an arkosic granule conglomerate, with scattered pebbles and cobbles of basalt and rare clasts of the megacrystic granite (Yg). South of lower Lime Creek at the east edge of the map an arkosic conglomerate is composed of granules, pebbles, cobbles, and boulders of granite (80%) and Tertiary basalt (20%). In the northwest part of the map along upper Walnut Creek the conglomerate is composed of Proterozoic clasts, including porphyritic rhyolite (50%), porphyritic dacite (25%), red jasper (10%), and felsic schist (5%). Near the mouth of Walnut Creek the upper part of the unit contains subequal amounts of subangular Xm and Tb pebbles and cobbles set in a lithic sandstone matrix. The conglomerate along the west-central edge of the map area consists largely of metabasite (Xm) and metaturbidite (Xs) clasts, but also rare clasts of the megacrystic granite (Yg). The abundance of tabular-shaped meta-argillite (Xs) clasts accentuates the pebble-cobble imbrication texture of the conglomerate in this area.

Tl--Latite--Hornblende latite intrusions, dikes and plugs in the southeast corner of the quadrangle.

MIDDLE PROTEROZOIC

Yg--Quartz vein--Massive, white to orange quartz veins.

Yg--Megacrystic granite--Light tan- to orange-weathering, porphyritic granite with megacrysts of K-feldspar up to 5.0 cm across set in a coarse-grained granitic groundmass. Border phase textures and dikes of Yg in Xm in southeast part of quadrangle are commonly fine- to medium-grained and equigranular.

Yd--Diorite--Small stocks of medium- to fine-grained diorite and, rarely, gabbro that have intruded Xm and Xs in the sourthern part of the quadrangle.

EARLY PROTEROZOIC

Xg--Equigranular granite--Pink- to orange-weathering, coarse-grained, equigranular granite. Underlies extensive terrane in eastern part of the quadrangle and forms small stocks in southwest part of the quadrangle. Correlates with the Verde Valley Granite of Anderson (1989).

Xd--Dacite--Pink- to lavender-weathering, lavender to medium gray dacite in northern part of quadrangle. Commonly porphyritic with coarse-grained phenocrysts of quartz and plagioclase (20-50% of rock) set in a fine-grained to aphanitic groundmass, but locally fine-grained.

Xs--Turbidites--Dark-colored mudstone and siltstone interbedded with between 5 and 25 percent resistant, medium gray- to buff-weathering, dark gray, fine- to medium-grained and rare granule sandstone. The sandstone is thin- to medium-bedded with argillaceous matrix and commonly displays classic Bouma sequence sedimentary structures. Massive, graded beds are commonly capped by parallel to ripple cross-laminated, fine-grained sandstone or siltstone. Flame structures, ball and pillow structures, and sharp erosive bases are common. Locally, mud-chip intraformational cobble-pebble conglomerate is present. Northeast of Sears-Kay Ranch the unit is commonly brown-weathering, medium- to coarse-grained, calcarous sandstone, locally interbedded with black, sandy limestone.

Xu--Undivided supracrustal rocks--Areas of undivided volcanic and/or sedimentary rock along eastcentral boundary of quadrangle. Mapped from areal photographs.

Xc--Chert--Individual chert beds.

Xms--Green argillite--Medium to dark green argillite, probably derived from fine-grained mafic tuffaceous or volcaniclastic rocks.

Xsc--Siliceous pelite and chert--Brown- to yellow- to orange-weathering, purple to black, medium- to thin-bedded, siliceous siltstone, interbedded with white, dark gray, green, and red chert. Locally includes interbeds of basaltic sandstone or greenstone (mafic flows?).

Xl--Limestone--Northwest of Humbolt Mountain the Xsc unit is interbedded with beds of lavender to white limestone (Xl).

Xma--Mafic and andesitic rocks--Brown- to light green-weathering, medium to dark gray basaltic andesite or andesite that characteristically display coarse-grained plagioclase phenocrysts. Locally displays pillow structures and hyaloclastites. Differs from Xm in that Xma is generally lighter-colored and lacks pyroxene phenocrysts.

Xf--Felsite--White- to light gray-weathering, medium to dark gray, fine- to coarse-grained felsite. Locally granophryic, with phenocrysts of plagioclase, K-feldspar, and quartz. In some areas this unit is hypabyssal. A single, thin sill of crystal-poor rhyolite occurs in the southeast corner, near Bronco Butte.

Xm--Mafic volcanic rocks--Dark brown- to light green-weathering, dark green to black basalt and basaltic andesite. Commonly massive or composed of volcanic breccia. Locally displays pillow structures and hyaloclastites. The unit is rarely amygdaloidal, and locally porphyritic, with coarse-grained plagioclase or pyroxene phenocrysts. Generally displays greenschist-grade metamorphic recrystallization, and is locally interbedded with volcaniclastic sandstone and mudstone. May locally include intervals of Xma.

Xcm--Mudstone--Interbeds of olive-green mudstone within Xcg.

Xcg--Conglomerate--Granite cobble-boulder conglomerate in northwest part of map. Rounded granitic and volcanic cobbles and boulders are set in a dark green argillaceous sandstone matrix. Thick beds of conglomerate are interbedded with subequal amounts of massive, dark green argillaceous sandstone and siltstone.

Xa--Andesite--Massive, light gray- to brown-weathering porphyritic andesite with abundant plagioclase phenocrysts. The unit also contains abundant lithic fragments and possible pumice fragments and is interpreted as a subaqueous ash-flow tuff.

Xfv--Felsic lava--Light gray- to light pink-weathering, dark gray, crystal poor (quartz and feldspar) felsite. Flow-banding and autoclastic primary textures are commonly preserved, indicating origin as lava flows.

Xfs--Felsic volcaniclastic and pyroclastic rocks--Felsic to intermediate composition clastic rocks displaying a wide variety of textures, ranging from pyroclastic to volcaniclastic conglomerate. The more pyroclastic and volcaniclastic varieties contain mostly angular to subangular volcanic clasts, and abundant crystal clasts that could be phenocrysts. The unit also includes minor mudstone and rounded plutonic boulder-cobble clast conglomerate with variable amounts of volcanic detritus.