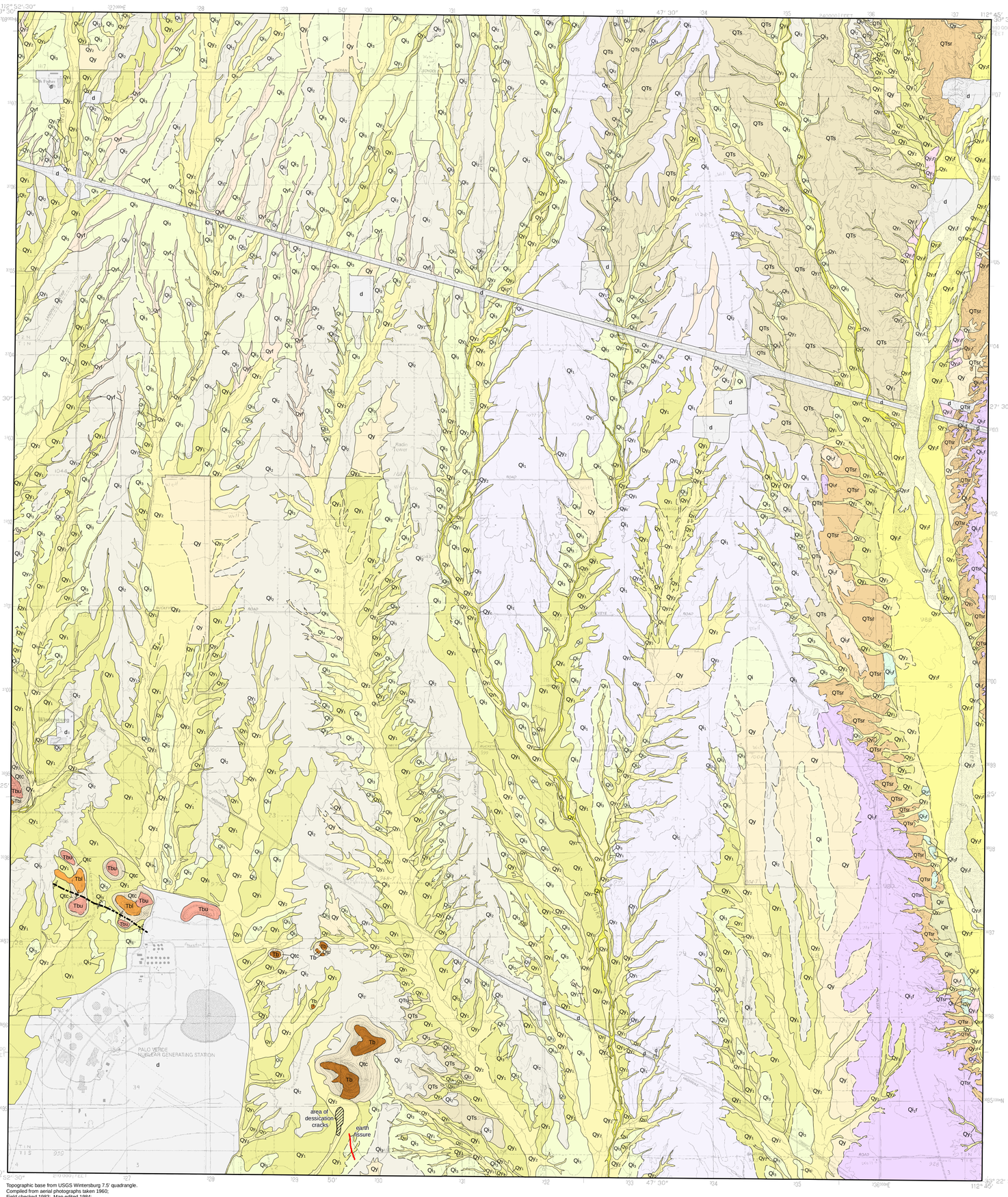


Topographic base from USGS Wintersburg 7.5' quadrangle.
Compiled from aerial photographs taken 1960;
Field checked 1983. Map edited 1984;
Projection: Transverse Mercator, datum: NAD 27, UTM zone 12.
Contour interval 10 feet.
Magnetic declination 11½° east of true north.

SCALE 1:24,000

1 ½ 0 1 Miles

1,000 500 0 1,000 2,000 3,000 4,000 5,000 6,000 7,000 Feet

1 ½ 0 1 Kilometers

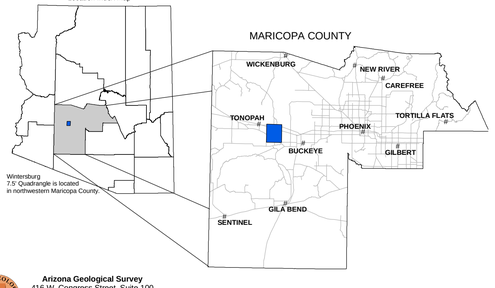
contour interval 10 feet

MN

11½°

2006 MAGNETIC NORTH DECLINATION

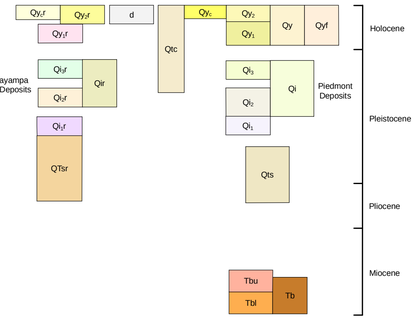
Location Index Map



Map Symbols

- contact, accurately located
- contact, approximately located
- fault; concealed, hypothetical
- earth fissure
- area of desiccation cracks

Stratigraphic Correlation



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Geologic Map of the Wintersburg 7.5' Quadrangle, Maricopa County, Arizona

by Philip A. Pearthree and Charles A. Ferguson and Raymond C. Harris

Arizona Geological Survey Digital Geologic Map 47 (DGM-47), version 1.0

March 2006

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Acknowledgments

The Flood Control District of Maricopa County provided high -resolution digital orthophotos that were used to accurately locate surficial geologic unit boundaries. Stevan Gyetvai was the cartographer for version 1.0 of DGM-47.

Introduction

The Wintersburg 7½' quadrangle is located 40 to 50 miles (70-80 km) west of downtown Phoenix. The map area covers much of the piedmont between the Palo Verde Hills and the Hassayampa River and a 7 mile (11 km) reach of the Hassayampa River. The quadrangle includes a portion of the Palo Verde Nuclear Generating Station (PVNGS) and Interstate Highway 10. It has experienced some suburban development associated with the PVNGS and is currently on the outer fringe of the greater Phoenix metropolitan area, so more development is likely in the near future. The small bedrock hills in the southwestern quarter of the quadrangle were mapped by Charles Ferguson in the spring of 2005. Surficial deposits that cover most of the quadrangle were mapped by Philip Pearthree using color aerial photos from 1979, high-resolution digital color orthophotos provided by the Flood Control District of Maricopa County (FCDMC), and topographic information. Field checking was done in the spring, summer and fall of 2005. This mapping was done in conjunction with geologic mapping of the Flatiron Mountain 7½' quadrangle (Spencer et al, 2005) to the north, and this quadrangle map is one of eight 1:24,000 scale geologic maps covering most of the Hassayampa Valley that have been produced in 2004 - 2006. This mapping was completed under the joint State-Federal STATEMAP program, as specified in the National Geologic Mapping Act of 1992.

Surficial Geology

The Wintersburg quadrangle is almost entirely covered with surficial deposits laid down by the Hassayampa River or numerous smaller tributary stream systems. These surficial deposits were mapped primarily using stereo pairs of color aerial photos taken in 1979 for the Bureau of Land Management, high-resolution digital orthophotos provided by the FCDMC, and topographic information obtained from the 7½' United States Geological Survey quadrangle map. Mapping interpretations were verified by field observations during the spring, summer and fall of 2005; unit characteristics were described and unit boundaries were spot-checked in the field. The physical characteristics of Quaternary alluvial surfaces (channels, alluvial fans, floodplains, stream terraces) evident on aerial photographs and in the field were used to differentiate their associated deposits by age and source. This mapping was compiled over a digital orthophoto base from 2003 provided by the FCDMC. Mapping was done in a GIS format and the final linework was generated from the digital data.

Several characteristics evident on aerial photographs and on the ground were used to differentiate various alluvial surfaces and deposits associated with them by age and source. The color of alluvial surfaces is primarily controlled by soil color, desert pavement development and rock varnish, and vegetation type and density. Significant soil development begins beneath an alluvial surface after it becomes isolated from active flooding and deposition (Gile et al., 1981, Birkeland, 1999). Holocene soils typically have relatively subtle horizons and generally are brown or gray in the field and on aerial photographs. More distinct, relatively obvious soil horizons develop over thousands to tens of thousands of years. Typical soil horizons in Pleistocene alluvial sediments of Arizona are reddish brown argillic horizons (zones of clay accumulation) and white calcic horizons (zones of calcium carbonate and silica accumulation). In arid areas such as the lower Hassayampa Valley, clay accumulation and reddening associated with argillic horizon development tend to be relatively weak even on old alluvial surfaces. On color aerial photographs and on the ground, older alluvial surfaces characteristically appear slightly redder or distinctly whiter (on more eroded surfaces) than younger surfaces. Dark rock varnish and gravel pavements also develop with time on stable alluvial surfaces, so well-preserved older surfaces typically have a dark brown color. Differences in the drainage patterns between surfaces also provide clues to surface age. Young alluvial surfaces commonly display distributary (branching downstream) or anastomosing (branching and rejoining) channel patterns. Areas adjacent to active channels commonly have little channel development because unconfined shallow flooding predominates. Dendritic tributary (joining downstream) drainage patterns are characteristic where modern drainages are incised into older surfaces. Topographic relief between adjacent alluvial surfaces and the depth of entrenchment of channels can be determined using stereo-paired aerial photographs and topographic maps. Young surfaces are minimally dissected and are less than 1 m above channel bottoms. Active channels are entrenched 1 to 5 m below Pleistocene alluvial surfaces, and the older surfaces typically have been moderately to severely rounded by erosion. Ages of various surficial deposits of the map area were roughly estimated based on regional correlations to similar surficial deposits in southern Arizona.

Variations in the distribution of surfaces of different ages and sources and concomitant variations in dissection across the quadrangle provide evidence regarding the recent geologic evolution of this area. Generally, areas along the Hassayampa River are moderately to deeply dissected. The highest terrace remnants of the Hassayampa River (unit $Q_{ly}f$) record the level of the river bed in the early to middle Quaternary. $Q_{ly}f$ terraces cap a several hundred meter thick aggradational sequence that was deposited during late Tertiary to early Quaternary (units QTs and QTsr) (Shoustra et al., 1976). Adjacent piedmont areas to the west and north were aggrading in the late Pliocene and early Quaternary as well (unit QTs). At that time the river was probably was depositing sediment across a fairly broad floodplain in the eastern part of the quadrangle, and distal alluvial fans on both sides of the river were interfingering with the river floodplain. Since then the Hassayampa River has downcut 10 to 15 m, with incision increasing slightly to the north. Preservation of Pleistocene river terraces recording intermediate levels of the Hassayampa River is poor. The valley bottom along the Hassayampa River consists almost entirely of modern channel deposits (unit Qy_cf) and late Holocene floodplain deposits (Qy_2f). Tributary washes immediately west and east of the Hassayampa River have downcut in response to incision of the river, and late Quaternary deposits are quite limited in extent along these drainages.

In the western 2/3 of the quadrangle, piedmont washes drain to the south to the Gila River or Centennial Wash, a sizable tributary of the Gila River. Much of this piedmont is mantled by Pleistocene tributary deposits (units Ql_1, Ql_2, or Ql_3). Older Pleistocene deposits (Ql_1 and Ql_2) have been eroded into broadly rounded ridges. The relatively small tributary washes that drain this area are incised less than a few meters below adjacent Pleistocene alluvial surfaces. Even though the amount of net incision is modest, there is enough topographic confinement of active fluvial systems that late Pleistocene deposits typically are found on the fringes of the eroded middle Pleistocene ridges, and Holocene deposits are found on valley bottoms. Agricultural activity, more recent residential development, aggregate pits and the PVNGS have modified the landscape to greater or lesser degrees. Areas are mapped as "disturbed" where the surficial deposits are profoundly altered (gravel pits, nuclear plant, interstate highway); surficial deposits other areas with less profound disturbance are depicted with concealed (dotted) contacts.

Bedrock Geology

Basalt lava flows cap several hills in the southwest corner of the map area. The basalt is part of an extensive lava field known as the Palo Verde Hills lava field. The flows were sampled extensively in and around the PVNGS prior to its construction. The lavas range in age from 16.9 to 20.7 Ma (Shoustra et al., 1976; Shafiqullah et al., 1980). In general, the lavas are gently dipping, but locally, dips of up to 70 degrees have been reported for lavas to the west of this map area (Shafiqullah et al., 1980).

The westernmost hills, which lie directly north of the PVNGS, are divided into two map units. A gently northeast-dipping contact between the units, concealed by colluvium, is interpreted to be present on the westernmost hill. The upper lava contains abundant mafic (pyroxene and/or olivine), and plagioclase phenocrysts (Tbu). The lower lava contains only mafic phenocrysts (Tbl). Similar units are found in the low hills just to the east. Two interpretations are possible for the volcanic stratigraphy and structure of this area. The simplest interpretation, which is depicted on the map, shows the sequence of upper and lower lavas repeated by a southwest-side-down normal fault with modest (50-100 m) displacement. An alternative interpretation is that there is no fault, but that the volcanic stratigraphy is more complex, with intertonguing flows of different composition.

The pair of hills lying to the east of the PVNGS are composed of amalgamated flows of mafic phenocryst-porphyritic basaltic lava (Tb) that appear to dip moderately to the southwest. These lavas were interpreted by Shafiqullah et al. (1980) to represent the oldest in the area. This sequence may correlate with the Tbl map unit, but since there are no other types of lava in the area, and since the flows dip in the opposite direction these rocks are mapped as undifferentiated basalt lava (Tb). The difference in dip between the eastern and western hills implies that an intervening structure may exist.

Geologic Hazards and Aggregate Resources

The geomorphology and surficial geology of the quadrangle provide clues to the extent and character of flood hazards and the availability of aggregate resources. Geologically young fluvial deposits (units Qy_c, Qy_2, and locally Qy_1 along tributary washes and units Qy_cf, Qy_2f along the Hassayampa River) record recent fluvial activity. The Hassayampa River is incised and flooding is restricted to the valley bottom. The fact that the valley bottom is covered almost entirely by late Holocene deposits strongly suggests that the valley bottom is the floodplain, and all portions of it have been subjected to recent inundation and deposition. Flooding is restricted to relatively narrow corridors along the incised tributary washes that drain directly to the Hassayampa. Flood-prone areas are somewhat more extensive in the western 2/3 of the quadrangle where incision is modest. Valley bottoms covered with young deposits but channels are quite small, implying that shallow sheet flooding and bank erosion along channels are the principal flood hazards. Although valley bottoms are fairly wide, there are no major distributary channel networks or active alluvial fans on the piedmont.

Aggregate resources were extracted from several small pits in piedmont surficial deposits near Interstate Highway 10, probably for construction of the highway. Two larger aggregate operations are currently active along the Hassayampa River north of Interstate 10. These operations are apparently mining aggregate primarily from Holocene river deposits, but they may be drawing upon older river deposits as well. The potential for useful aggregate resources in older river deposits that flank the modern floodplain is not known because the thickness of these deposits is uncertain.

Both earth fissures (Harris, 2001) and giant desiccation cracks (Harris, 2003) have been recognized in the southwestern portion of the quadrangle. A new earth fissure opened in the summer of 2000 about 3 miles (5 km) southeast of Wintersburg. The fissure trends nearly north-south and is about 1,150 ft (350 m) long. The fissure is very young, with narrow, steep sides and a highly irregular apparent depth ranging from <1 foot to >8 feet over short distances. In two locations the fissure is en echelon, with NW-SE steps. There is no discernable vertical offset across the fissure. The location of the fissure, at the edge of the Palo Verde basin and somewhat in line with the trend of a small hill, suggests that a shallow buried bedrock ridge may extend south of the hill beneath the trace of the fissure. If this scenario is correct, the crack may represent fissuring due to compaction and subsidence on either or both sides of the buried ridge. Adjacent to the new earth fissure is an area of giant desiccation cracks that opened at the same time as the earth fissure. Alignments of established vegetation in some portions of the polygonal desiccation crack network demonstrate that cracking has occurred periodically in the past. Additional areas of giant desiccation cracks were mapped by Harris (2003) immediately west and south of the Wintersburg quadrangle.

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Surficial Units

Piedmont Alluvium

Quaternary and late Tertiary piedmont deposits from the Belmont Mountains to the north cover the western 2/3 of the Wintersburg quadrangle. This alluvium was deposited primarily by larger tributary streams that head to the north of the quadrangle; these larger streams and smaller streams that in this quadrangle have eroded and reworked some of these deposits. Clast lithologies include basalt and felsic volcanic rocks with lesser amounts of granite. Deposits range in age from modern to Pliocene. Abbreviations used are ka, thousands of years before present, and Ma, millions of years before present.

Qy_c — **Modern stream channel deposits –** Active channel deposits composed of very poorly-sorted sand, pebbles, and cobbles with some boulders to moderately-sorted sand and pebbles. Channels are generally incised 0.5 to 2 m below adjacent Holocene terraces and alluvial fans, but may be incised as much as 4 m below adjacent Pleistocene deposits. Channel morphologies generally consist of a single thread, relatively deep channel or multi-threaded smaller, shallower channels with gravel bars. Channels are extremely flood prone and are subject to deep, high velocity flow in moderate to large flow events. Areas adjacent to Qy_c deposits may be prone to lateral bank erosion.

Qy_2 — **Late Holocene alluvium –** Young, typically fine-grained deposits in floodplains, low terraces and small channels. Along the larger drainages, unit Qy_2 sediment is generally poorly to very poorly sorted silt, sand, pebbles, and small cobbles; floodplain and terrace surfaces typically are mantled with sand and finer sediment. On lower piedmont areas and in smaller tributary washes young deposits consist predominantly of moderately sorted sand and silt, with some pebbles and cobbles in channels. Soils are pale brown in color (10 YR), and soil development is very weak, consisting of slight carbonate accumulation. Channels generally are incised less than 1 m below adjacent young surfaces, but locally incision may be as much as 2 m. Channel morphologies generally consist of a single- or multi-threaded channels with gravel bars adjacent to low flow channels. Channels are flood prone and may be subject to deep, high velocity flows in large flow events. Substantial lateral bank erosion may occur in these deposits, and flood flows may significantly change channel morphology and flow paths. Local relief varies from fairly smooth channel bottoms to undulating bar-and-swale topography that is characteristic of coarser deposits. Terraces have planar surfaces, but small channels are common.

Qy_1 — **Holocene alluvium –** Older Holocene terrace deposits found mostly along the margins of incised drainages throughout the map area. Qy_1 surfaces are higher and less subject to inundation than adjacent Qy_2 surfaces. Qy_1 terraces are generally planar but local surface relief may be up to 1 m where gravel bars are present. Qy_1 surfaces are <2 m above adjacent active channels. Surfaces typically are sandy but locally have unvarnished open fine gravel lags or pebble and cobble deposits. Qy_1 soils typically are brown in color (7.5 to 10 YR) with weakly developed stage I calcium carbonate accumulation (see Machette, 1985, for description of stages of calcium carbonate accumulation in soils).

Qyf — **Fine-grained Holocene alluvium –** Thin, fine-grain Holocene alluvial deposits formed in swales on ridges of mid-Pleistocene fan deposits. These deposits are very thin, typically less than 0.5 m thick, but locally may be 1 m or more thick. Sediment typically is brown (7.5 YR) mainly silt and sand, with occasional deposits of open, unvarnished, fine gravel lag. Soil development is minimal, with substantial disseminated carbonate but little visible carbonate accumulation.

Qy — **Holocene alluvial deposits, undifferentiated.**

Ql_3 — **Late Pleistocene alluvium –** Unit Ql_3 is composed of slightly dissected relict alluvial fans and terraces. Active channels are incised up to about 2 m below Ql_3 surfaces, and Ql_3 fans and terraces generally are lower in elevation than adjacent older surfaces. Ql_3 deposits consist of pebbles, cobbles, and finer-grained sediment. Ql_3 surfaces commonly are fairly smooth with weak bar and swale topography and loose to moderately packed pebble and cobble pavements. Surface gravel clasts typically exhibit weak to moderate brown rock varnish but some surfaces in the northern part of the quadrangle that are mainly composed of fine-grained volcanics are more darkly varnished. Ql_3 soils are moderately developed, with brown loamy (7.5 YR) near-surface horizons and stage II calcium carbonate accumulation.

Ql_2 — **Middle to late Pleistocene alluvium –** Unit Ql_2 is composed of moderately dissected relict alluvial fans and terraces with moderate soil development. Ql_2 surfaces are drained by broad swales and well-developed, moderately incised tributary channel networks; channels are typically 1-2 meters below adjacent Ql_2 surfaces. Well-preserved, planar Ql_2 surfaces are smooth with pebble and cobble pavements; surface color is reddish brown; surface gravel clasts are moderately to strongly varnished. More eroded, rounded Ql_2 surfaces are characterized by strongly varnished, scattered, cobble to pebble lags. Soils associated with planar surface remnants typically contain reddened (5 to 7.5 YR), clay loam argillic horizons, with clay coatings and subangular blocky structure. Underlying soil carbonate development is typically stage III with areas to stage IV, and abundant carbonate through at least 1 m of the soil profile. In more eroded locations, argillic horizons have been removed and soils are calcic throughout.

Ql_1 — **Middle Pleistocene alluvium –** Unit Ql_2 is composed of moderately dissected relict alluvial fans and terraces with moderate soil development. Ql_2 surfaces are drained by broad swales and well-developed, moderately incised tributary channel networks; channels are typically 1-2 meters below adjacent Ql_3 surfaces. Well-preserved, planar Ql_3 surfaces are smooth with pebble and cobble pavements; surface color is reddish brown; surface gravel clasts are moderately to strongly varnished. More eroded, rounded Ql_2 surfaces are characterized by strongly varnished, scattered, cobble to pebble lags. Soils associated with planar surface remnants typically contain reddened (5 to 7.5 YR), clay loam argillic horizons, with clay coatings and subangular blocky structure. Underlying soil carbonate development is typically stage III with areas to stage IV, and abundant carbonate through at least 1 m of the soil profile. In more eroded locations, argillic horizons have been removed and soils are calcic throughout.

Ql — **Middle and late Pleistocene alluvial deposits, undifferentiated.**

QTs — **Early Pleistocene to Pliocene alluvium –** Unit QTs is composed of eroded alluvial fan deposits, locally overlain by younger Quaternary units. QTs deposits typically are poorly exposed on ridge slopes, in wash banks, and in channels as strath terraces. The thickness of QTs deposits is variable, but certainly is at least tens of meters (Shoustra et al., 1976). In the shallow subsurface, unit QTs includes an extensive clay-rich unit (the Palo Verde clay) that is older than 2 Ma (Shoustra et al., 1976). Surface exposures of QTs include poorly sorted, subangular to subrounded, carbonate cemented, tan, pebble to cobble conglomerates, moderately to well sorted, subangular to subrounded, moderately indurated, cross-bedded, red, pebbly sandstones, and buried paleosols.

Hassayampa River Alluvium

Quaternary and late Tertiary piedmont deposits associated with the Hassayampa cover the eastern margin of the Wintersburg quadrangle. Clast lithologies are quite diverse, but are principally mixed fine-grained volcanic rocks and granite. Clasts range from well-rounded to subangular in shape. Deposits range in age from modern to Pliocene.

Qy_cf — **Active river channel deposits –** Moderately to poorly sorted sand, gravel and minor silt in recently active channels and lightly vegetated bars of the Hassayampa River. Gravel consists mainly of pebbles with some cobbles; clasts range from subangular to well-rounded.

Qy_2f — **Late Holocene floodplain deposits –** Sand, silt, and gravel deposits associated with the floodplain and low terraces along the Hassayampa River. Qy_2f surfaces typically are smooth and are less than 2 m above the active channel. Terrace surfaces typically are covered with fine-grained floodplain deposits, but relict gravel bars and lenses are common.

Qy_1f — **Older Holocene river terrace deposits –** Sand, silt, and gravel deposits associated with slightly higher terraces along the Hassayampa River. Terrace surfaces typically are flat but rounded around their margins and are less than 3 m above the active channel. Terrace surfaces typically are covered with a fine gravel lag where well-preserved but are quite fine-grained where eroded.

Ql_3f — **Late Pleistocene river terrace deposits –** Deposits associated with low intermediate terraces inset about 3 m above the Holocene floodplain of the Hassayampa River. Deposits consist of sand, silt, and gravel, with weak to moderate soil carbonate (Stage I-II) accumulation. Terrace surfaces typically are smooth and are covered with fine-grained floodplain deposits, but relict gravel bars and lenses are found locally.

Ql_2f — **Middle Pleistocene river terrace deposits –** High intermediate terraces about 5 m above the Holocene floodplain of the Hassayampa River. Terrace surfaces typically are dissected by small tributary drainages but are smooth away from the drainages. Terrace deposits are a mix of river sand, gravel, and silt and clay, but surfaces typically are covered with relict gravel deposits. Soil development is moderately strong, consisting primarily of stage II to III calcic horizons.

Ql_1f — **Early to middle Pleistocene river deposits –** Deposits associated with the highest terraces along the Hassayampa River that record the maximum aggradation of the river. Terrace surfaces are broadly rounded, and the deposits are moderately to deeply dissected by tributary drainages and the river and have been substantially modified by erosion. Exposures are poor, but subangular to well-rounded gravel is evident at the surface. Terrace surfaces are also typically covered with litter from underlying indurated stage IV petrocalcic soil horizons. Ql_1f terrace surfaces are more extensive than any of the younger Pleistocene terraces. Terrace surfaces range from about 10 to 15 m above the active river channel, and rise slightly to the north across the quadrangle.

Qlr — **Pleistocene river deposits, undifferentiated.**

QTsr — **Pliocene to early Pleistocene river deposits –** A sequence of old river deposits of unknown thickness that underlies the Ql_1f terrace deposits. These deposits consist of river sand, gravel and silt with a substantial component of tributary sand and gravel. Local zones of substantial carbonate accumulation may represent moderately to strongly developed buried soils.

Other Units

d — **Disturbed areas –** Much of the quadrangle has been disturbed by human activities, particularly agricultural activities. This unit designation is used only in areas of substantial excavation or anthropogenic deposition, for example, major flood-control levees.

Qtc — **Quaternary hillslope talus and colluvium –** Thin, steeply to moderately sloping, weakly bedded hillslope deposits mantling the middle and lower slopes of basalt hills. Deposits are locally derived and very poorly sorted, consisting of angular to subangular basalt cobbles and boulders with a matrix of sand, silt and clay. Older hillslope deposits have darkly varnished cobble and boulder mantles and relatively clay-rich soils.

Bedrock Units

Tbu — **Upper basalt –** Basalt lava containing 3-7% 1-2 mm mafic phenocrysts (pyroxene and/or iddingsite altered olivine), and 5-10% 1-4 mm plagioclase phenocrysts (samples: CAF-2-10637, 10638, 10639, 10643, 10649, 10650, 11343, 11344, 11345, 11346, and 11348)

Tbl — **Lower basalt –** Basalt lava containing 3-7%, 1-3 mm mafic phenocrysts (pyroxene and/or iddingsite altered olivine), and sparse 1-2 mm plagioclase phenocrysts (samples: CAF-2-10640, 10644, 10646, 10648)

Tb — **Basalt lava, undifferentiated –** Basalt lava containing 2-7%, 0.5-3 mm mafic phenocrysts (pyroxene and/or iddingsite altered olivine) with sparse plagioclase phenocrysts <2 mm (samples: CAF-2-10622, 10626, 10631, and 10635). Shafiqullah et al., (1980) report a whole rock, K/Ar age of 20.7 + 0.6 Ma for this unit, making it the oldest known lava from the Palo Verde lava field.