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Surficial and Environmental Geology of the Sierra Vista Area Cochise County, Arizona

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Map Explanation

Map Unit **Estimated age**
(ka = thousand years before present; Ma = million years before present)

Y2 **Modern (< 100 years)**

Active and very recently active channel deposits of silt and sand to extremely gravelly sand; abundant cobbles and boulders in canyons and near the mountains; clast size generally decreases with distance from mountains; abundant well-rounded cobbles in the San Pedro River channel. Surfaces are characterized by well-defined depositional morphology (e.g., channels and gravel bars); gravel clasts are unvarnished. Deposits are typically 7.5 YR (dull orange to brown) in color. Primary sedimentary layering predominates, with no discernible soil-profile development. Soils are Torrifluvents and Torriorthents.

Y1 **Upper to Lower Holocene (0.1 to 11 ka)**

Young terrace and fan deposits; slightly removed from the most active areas of flow and deposition. Y1 deposits occur as terraces along active channels or as broader zones of alluvial-fan deposition. Primarily silt and sand to extremely gravelly sand, with abundant cobbles in terraces of larger streams and in distributary flow areas near mountains; deposits are generally finer-grained toward distal portions of the piedmont. Surfaces exhibit original bar-and-swale depositional morphology in areas of distributary flow; surface clasts are not varnished or reddened. Depths of dissection are generally < 1 m; however, in lower parts of piedmont affected by historical arroyo cutting, active channels may be entrenched 4 to 5 m below Y1 deposits. Soils typically are 7.5 YR (brown) throughout, but exhibit incipient soil structure (cambic horizons); older soils of this map unit have horizons with slight increases in clay content; maximum carbonate accumulation (carbonate morphology) is weak Stage I (see Machette, 1985, for description of morphologic stages of carbonate accumulation in soils of increasing age). Soils associated with Y1 deposits are Torriorthents and Camborthids. Y1 deposits have similar soil-profile development as the Organ deposits of the Desert Project of the Las Cruces area in southern New Mexico, which are about 100 to 7,000 years old (Gile et al, 1981). Y1 deposits are correlative with the Lehner Ranch (11 to 6.5 ka), Escapule Ranch (6.5 to 0.2 ka), and Teviston (<0.2 ka) formations defined in Curry Draw in the Lewis Springs quadrangle (Haynes, 1987; Lindsay and others, 1990)

Y **Holocene (0 to 11 ka)**

Areas of Holocene channel and fan deposits. This unit is composed of both very young (Y2) deposits and somewhat older (Y1) deposits. This broader designation is used for areas in which the scale of mapping or lack of dissection made it unfeasible to map the Holocene deposits in more detail.

M2b **Uppermost Pleistocene (11 to 30 ka)**

Stream terraces and abandoned fan remnants that are generally restricted in extent and inset somewhat below older M2a surfaces. They are composed primarily of silt and sand to extremely gravelly sand, with abundant cobbles in deposits near mountains and in terrace deposits along larger channels; M2b deposits are very fine grained (including clay loam and clay) in lower portions of the piedmont. M2b surfaces have a light orange cast, but surface clasts are not visibly reddened. Channels are typically entrenched 1 to 2 m below these surfaces. Soils are characterized by increases in redness up to 5 YR (orange and reddish brown) and zones of slight clay accumulation (cambic or weak argillic horizons); carbonate morphology is Stage I-II. Soils associated with M2b deposits are Camborthids and Haplargids. M2b deposits have similar soil development as the Isaac's Ranch unit of the Desert Project, which is estimated to be about 8 to 15 ka (Gile and others, 1981). M2b deposits are probably correlative with the Murray Springs formation of Curry Draw, which was deposited between about 11 and 30 ka (Haynes, 1987; Lindsay and others, 1990).

M2a **Upper Pleistocene (30 to 125 ka)**

M2a deposits are stream terraces and extensive abandoned fan remnants. These deposits share many characteristics with the younger M2b deposits. M2a deposits are distinguished primarily on the basis of deeper dissection and greater soil-profile development. Deposits are mostly silty sand to extremely gravelly sand, with abundant cobbles in deposits near mountains and along larger channels; they are very fine grained (including clay loam and clay) in lower portions of piedmont. Surfaces appear reddish but surface clasts typically are not reddened. Original depositional topography is generally not obvious. Larger surface remnants are characterized by broadly rounded interfluves between relatively shallow swales and somewhat deeper dissecting channels. Depths of dissection are typically 2 to 5 m. Soils exhibit moderate increases in redness up to 5 YR (reddish brown) and moderate clay accumulation in argillic horizons; carbonate morphology is Stage I-III; soils are chiefly Haplargids. M2a deposits have similar soil-profile development as the Jornada II unit of the Desert Project, which is about 25 to 125 ka (Gile et al, 1981; Machette, 1985). M2a deposits are probably correlative with the late Pleistocene Millville formation of Curry Draw (Waters and Haynes, 1987).

M2 **Upper Pleistocene (11 to 125 ka)**

Areas of terrace and abandoned fan deposits of latest Pleistocene (M2b) to late Pleistocene (M2a) age. This broader designation is used where scale of mapping or lack of definitive evidence (e.g., inset relationships) prohibits more specific age assignments.

M1 **Middle Pleistocene (125 to 700 ka)**

M1 deposits are predominantly abandoned fan remnants; locally, they are stream terraces. M1 deposits typically are composed of gravelly to extremely gravelly sand and silt; deposits are generally coarser and more gravelly in middle and lower portions of the piedmont than are any younger deposits. M1 surfaces red and clayey, under a concentration of well-reddened pebbles and cobbles. Remnants of M1 fan surfaces are characterized by relatively narrow, curvilinear, discontinuous interfluves dissected by a system of intervening swales and gullies; depths of dissection are commonly 5 to 8 m. Soils are characterized by moderate to strong reddening (5 YR to 2.5 YR; reddish brown) and very well developed argillic horizons; locally in canyon areas, zones of intense leaching (albic horizons) are found above the argillic horizons; carbonate morphology is Stage II-IV; soils are Haplargids and Paleargids. M1 deposits have similar soil-profile development as the Jornada I unit of the Desert Project, which is about 250 to 400 ka (Gile et al, 1981). The middle Pleistocene Nexpa formation of Curry Draw (Waters and Haynes, 1987) is probably correlative with M1 deposits.

M1t **Middle Pleistocene (125 to 700 ka)**

Old terrace gravels of the San Pedro River. Deposits of well-rounded, red-stained gravels which occur as terrace remnants paralleling the modern San Pedro River. Terrace remnants are preserved as small, flat-topped hills that record former altitudes of the channel about 15 to 30 m above the present channel. M1t cannot be directly traced to any of the piedmont surfaces. However, M1t surfaces stand at least 15 m below the projected gradient of the early Pleistocene erosion surface capped by unit Ogr, and generally correlate in altitude with the distal portions of M1 fan and terrace deposits found higher on the piedmont. M1t deposits are correlative with the Nexpa formation of Curry Draw.

Ogr **Middle to Lower Pleistocene (500 ka to 2 Ma)**

Coarse, carbonate-cemented alluvial gravels of the lower and middle piedmont. They are generally < 1 m thick, capping basin fill (QTbf) over a widespread erosional surface (Waters and Haynes, 1987; Lindsay and others, 1990). Remnants of this surface occur primarily in the middle and lower portions of the piedmont as broad, planar mesas that stand above other surrounding Quaternary surfaces; depths of dissection are commonly 20 to 30 m. These deposits are gray in overall appearance due to strong carbonate accumulation (Stage IV) and lack of overlying reddened, clay-rich soil horizons. Soils are Paleorthids. Portions of this unit near Curry Draw have been grouped in the Nexpa Formation, which is less than 700 ka (Waters and Haynes, 1987; Lindsay and others, 1990). Ogr may be substantially older than 700 ka in some places, however, based on its high topographic position, pervasive cementation, and the fact that some middle Pleistocene M1 surfaces are substantially lower than Ogr surfaces. The highest remnants of this unit may be carbonate-rich, downslope equivalents of the early Pleistocene alluvial fan deposits on the upper piedmont (Unit O).

O **Lower Pleistocene (700 ka to 2 Ma)**

Abandoned coarse alluvial fan remnants of the upper and middle piedmont. Deposits are composed of extremely gravelly sand and silt. This unit occurs primarily in the upper portions of the piedmont, and O deposits are generally coarser than younger deposits in those areas. Surfaces are strongly reddened, with overlying concentrations of extremely darkly red-stained cobbles. Remnants of O surfaces are characterized by relatively narrow, curvilinear ridges, deeply dissected by intervening gullies or ravines; depths of dissection are commonly 10 to 25 m. Soils are reddish brown (2.5 YR) and have extremely well developed argillic horizons; in general, minimal carbonate accumulation is associated with this unit; soils are Haplargids. Deposition of this unit may have begun in the earliest Pleistocene (~ 1.5 to 2 Ma), corresponding to an interval of widespread progradation of coarse alluvial fan gravels represented by the upper member of the St. David Formation (Lindsay et al, 1990). Unit O is probably correlative with other early Pleistocene fan remnants in southeastern Arizona that have similar morphologic and sedimentologic characteristics (Menges and McFadden, 1981; Morrison, 1985)

TQbf **Lower Pleistocene to Upper Pliocene (1 to 3.4 Ma)**

Generally red-colored clay and fine-grained sandstone, with local exposures of buried paleosols. Where not capped by younger, cemented gravels (Ogr), this unit is exposed as gently rounded, eroded hills, rising up to about 15 m above active channels. This unit probably corresponds to the middle member of the Pliocene-early Pleistocene St. David formation, which dates between 3.4 and 1.6 Ma and is dominated by red and green mudstone with superimposed paleosols near the top (Lindsay and others, 1990). Some exposures in the map area may represent the upper member of the St. David formation (1.6 to 0.6 Ma), described as red sandy gravel, minor red mud, and calcareous paleosols (Lindsay and others, 1990).

Generalized Bedrock Lithologies
(from Ken Hon, U.S. Geological Survey, unpubl. mapping, and Hayes and Raup, 1968)

Km **Cretaceous Morita Formation**

Red to gray sandstone, siltstone, mudstone, and minor conglomerate.

Jc **Jurassic Glance Conglomerate**

Cemented volcaniclastic cobble and boulder conglomerate. Cobbles and boulders are set in a gray to grayish-red matrix.

Jg **Jurassic intrusive rocks**

Medium-grained granitic rock. Includes homogranular biotite granite and porphyritic biotite-amphibole granite, and rhyolite dikes.

Jv **Jurassic volcanic rocks**

Primarily dacitic volcanic rocks associated with the Montezuma Caldera. Collapse breccia associated with this caldera includes small exotic blocks of Paleozoic sedimentary rock. Larger exotic blocks are mapped separately and included in the following map units.

ss **Clastic rocks, age uncertain**

Blocks and megablocks of sandstone, siltstone, shale, and phyllite incorporated into caldera-collapse breccia. Age of source lithologies uncertain.

Pl **Paleozoic limestone and dolomite**

Intact limestone and dolomite and large blocks in the caldera-collapse breccia. Unit is composed of rocks of the Naco Group, Escabrosa Limestone, Martin Limestone, and Abrigo Limestone. Includes large blocks and shattered masses of limestone incorporated into the collapse breccia associated with the Montezuma Caldera.

Cb **Cambrian Bolsa Quartzite**

Yellowish- to reddish-brown siliceous sandstone, with cemented conglomerate near base. Strongly resistant to weathering, it forms prominent cliffs.

pCg **Precambrian granite**

Yellowish- to pinkish-gray coarse-grained porphyritic granite. Commonly deeply weathered and not very resistant to erosion.

Symbols

- Bedrock-Alluvium Contact (line with hachure)
- Fault scarp (heavy line with bar and ball on downthrown side)
- 1988 debris flow (heavy line)
- Area of potential debris-flow hazard (pattern)

SCALE 1:24,000
1 .5 0 1 MILE
1000 0 1000 2000 3000 4000 5000 6000 7000 FEET
1 .5 0 1 KILOMETER

INDEX MAP OF ARIZONA
Showing Location of Cochise County
Map Area
NORTH

R. 20 E. R. 21 E. 110° 15' 12' 30" 10' R. 21 E. R. 22 E. 110° 07' 30"
35' 32° 30' 31' 30" 27' 30" 25' 31° 22' 30"
17' 30"
T. 23 S.
T. 24 S.