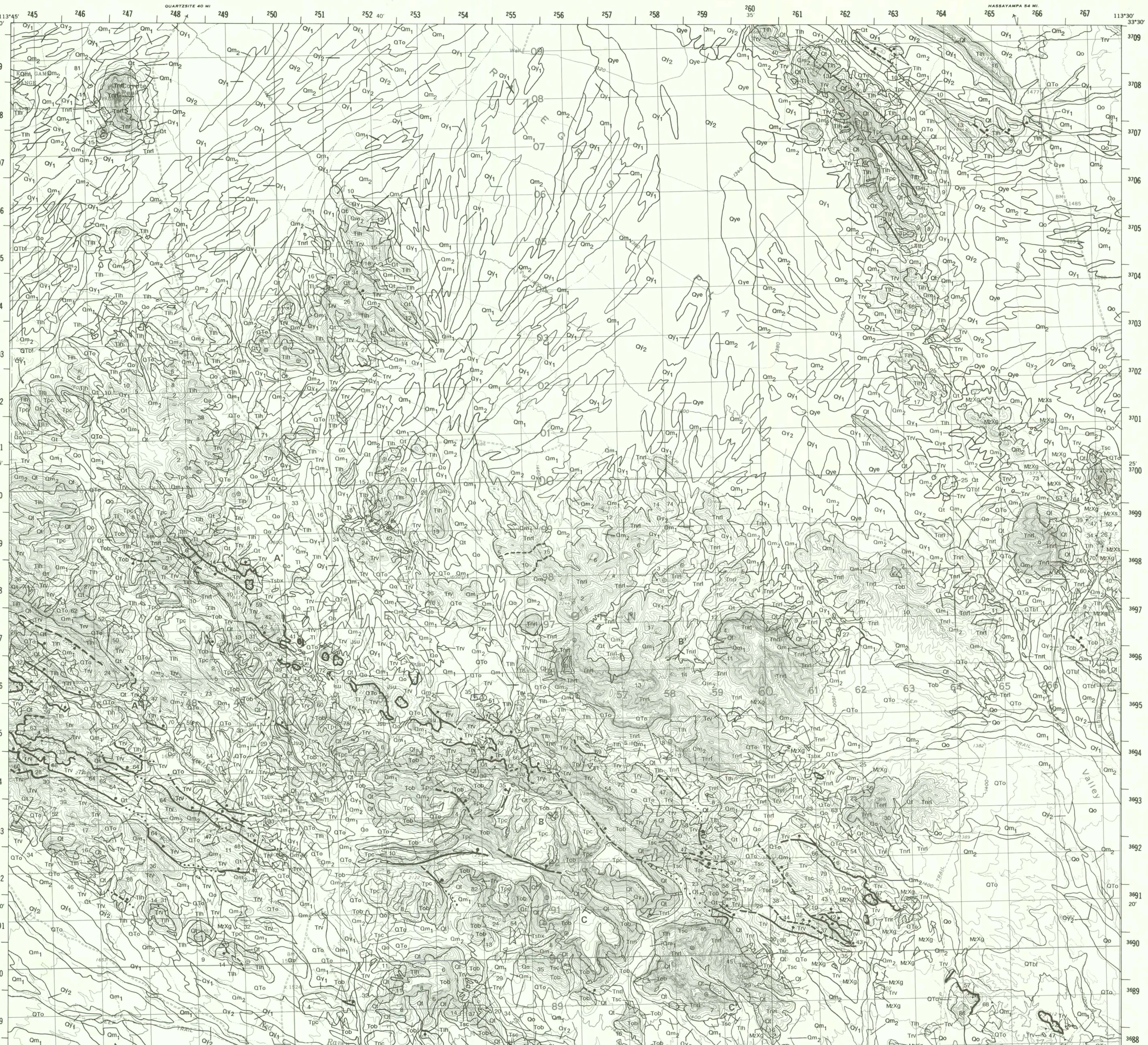
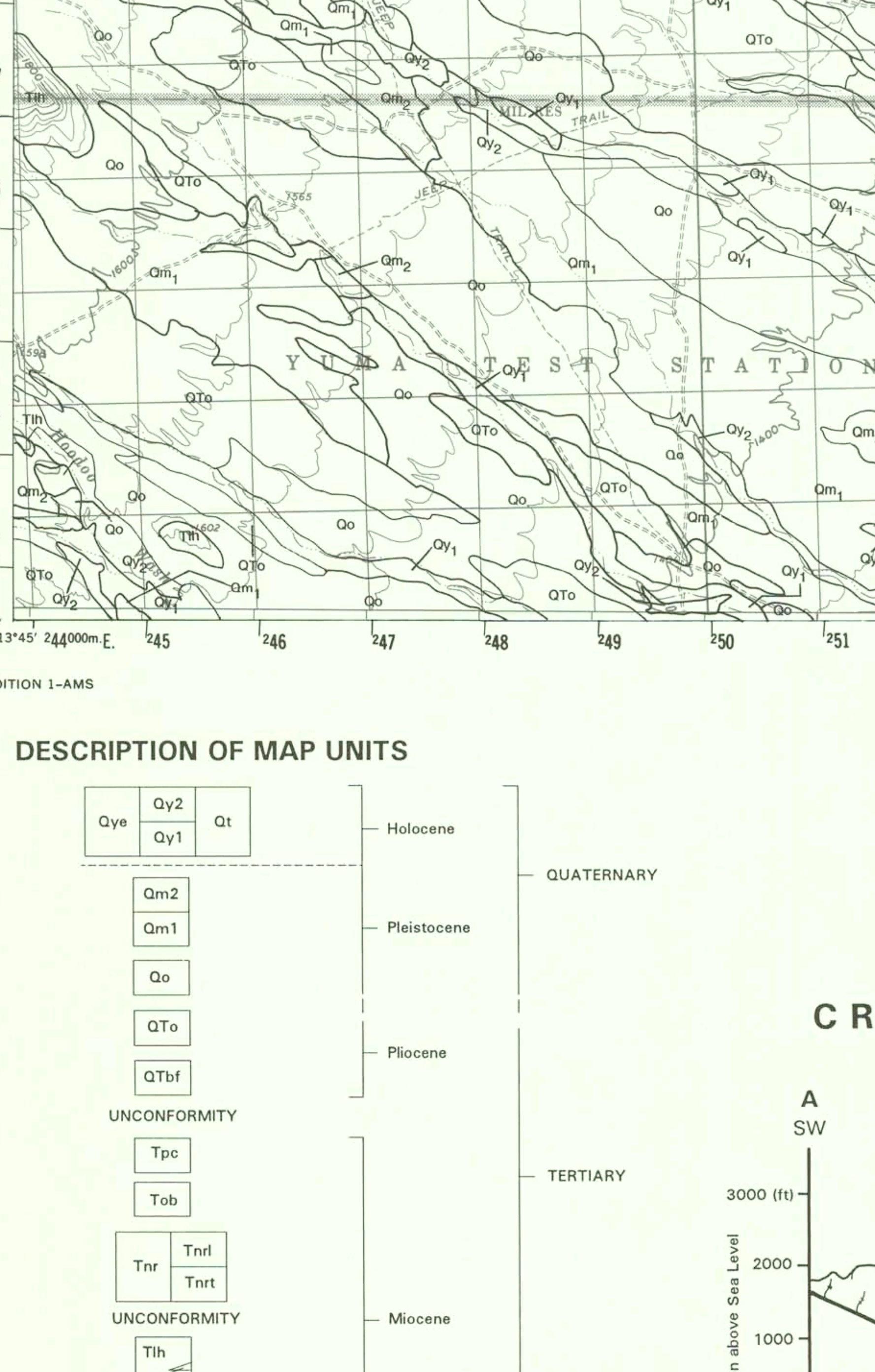
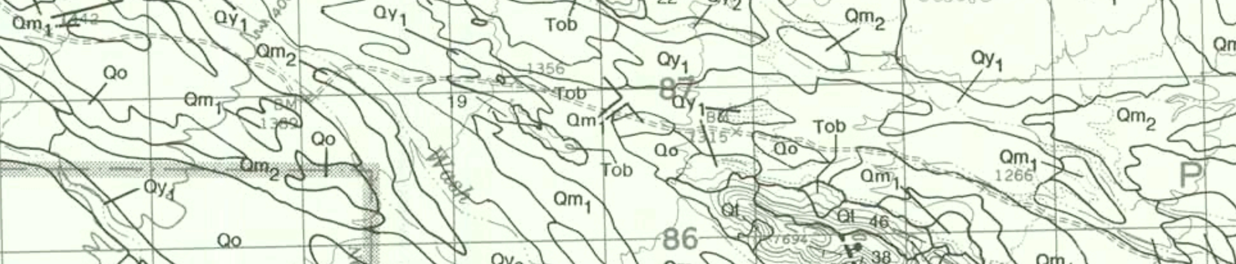
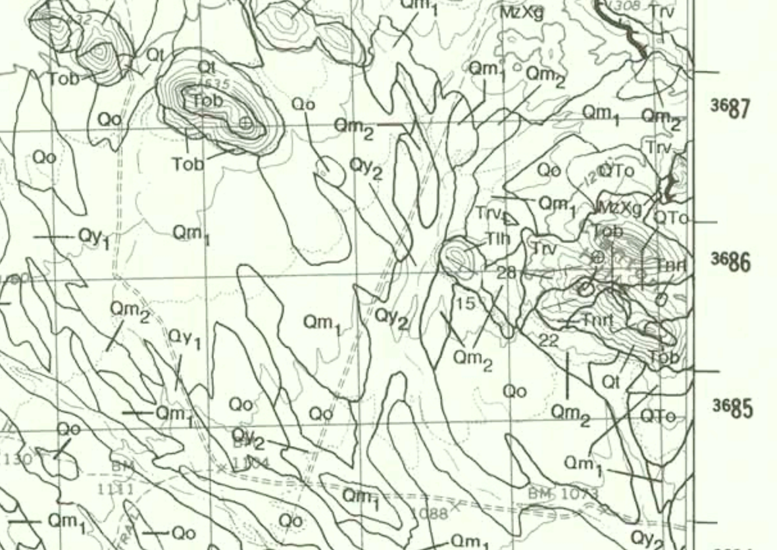


DESCRIPTION OF MAP UNITS

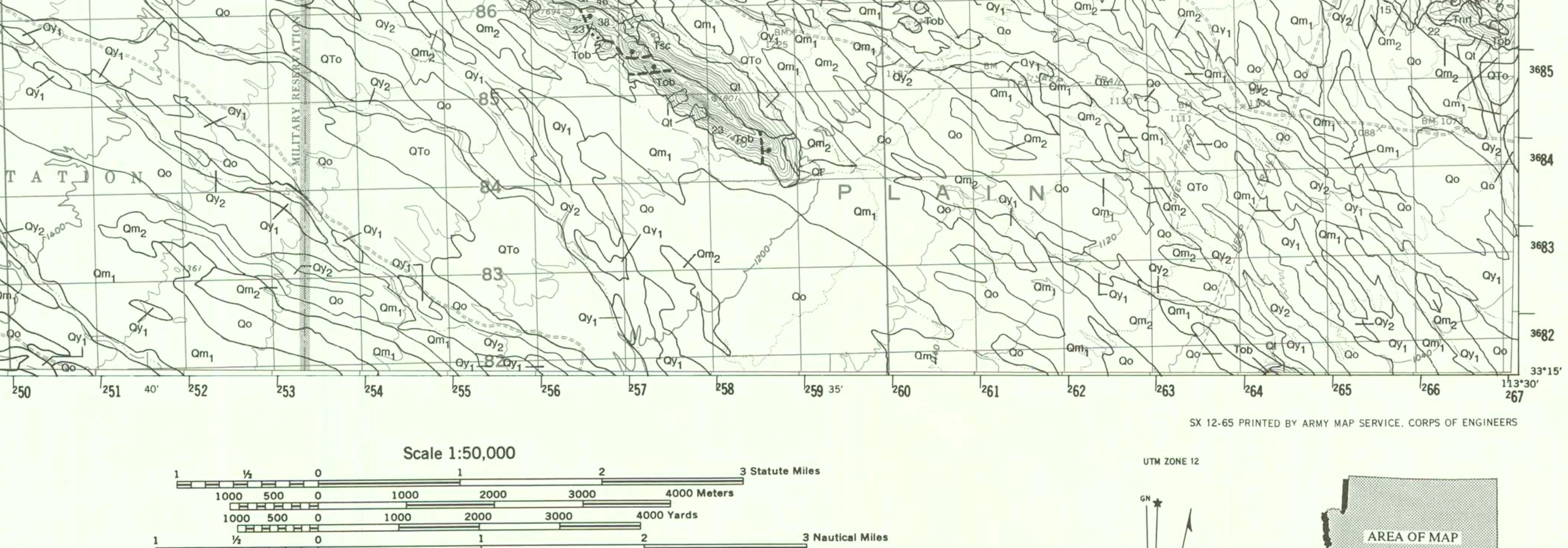




CONTOUR INTERVAL 40 FEET
WITH SUPPLEMENTARY CONTOURS AT 20 FOOT INTERVALS



CROSS SECTIONS



Horizontal Scale 1:50,000
Vertical Scale 1:25,000
Vertical Exaggeration 2:1

GEOLOGIC MAP OF THE LITTLE HORN MOUNTAINS 15' QUADRANGLE, SOUTHWESTERN ARIZONA

by Michael J. Grubensky and Karen A. Demsey

Arizona Geological Survey

Map 29

1991

MAP UNITS

Qye Eolian deposits (Holocene) -- Eolian sand and silt deposits, typified by small sand dunes and hummocky or corrugated overall surface textures; predominantly in central part of Ranegras Plain. Generally overlie units Qy_1 and Qy_2 and locally overlie Qm_2. Unit age is Holocene ($\leq$ 10 ka).

Qy_2 Young alluvium, unit 2 (Holocene) -- Active to very recently active channel and alluvial-fan deposits (primarily distal-fan deposits; local minor amounts of proximal-fan deposits). Deposits grade from cobbly sand (clast size less than about 30 cm) in channels near mountains and on Palomas Plain (south side of mountains) to silt and sand on Ranegras Plain (north side of mountains). Surfaces are characterized by bar-and-swale topography on coarser deposits, but on silty deposits are relatively smooth and planar with dense drainage networks; clasts are not varnished. Depth of dissection is generally < 1 m. Soils developed on these deposits are 7.5 YR in hue and exhibit no zones of reddening (cambic horizons) or marked clay accumulation (argillic horizons); maximum zones of carbonate accumulation (calcic horizons) achieve Stage I morphologic development (see Machette, 1985, for description of morphologic stages of calcic-horizon development). Unit age is late Holocene (0-2 ka*).

Qy_1 Young alluvium, unit 1 (Holocene) -- Relatively young channel terraces and slightly entrenched distal-fan deposits similar in grain size and distribution to unit Qy_2. Surfaces are characterized by bar-and-swale topography on coarser deposits, but are relatively smooth and planar on silty deposits; surface clasts are commonly lightly varnished. Depth of dissection is generally less than 1 m. Maximum soil development is exhibited by a 3- to 5-cm surficial cap of vesicular eolian silt and clay, incipient reddening (typically 7.5 YR hue; locally 5 YR), and Stage II calcic horizon. Unit age is middle to early Holocene (2-10 ka).

Qt Talus (Holocene to Pleistocene) -- Loose and unconsolidated debris on steep slopes and beneath bedrock cliffs. Unit typically forms cone-shaped deposits along flanks of hillsides capped by lavas of basalt of Oakland mine; includes active and dissected debris cones.

Qm_2 Intermediate alluvium, unit 2 (Pleistocene) -- Terraces and alluvial-fan deposits; typically gravelly (locally extremely gravelly) sand and silty sand; generally finer grained on Ranegras Plain. Surfaces are characterized by relatively smooth and planar, fine-gravelly to coarse-cobbly pavement. Bar-and-swale topography is preserved in coarser deposits. Surface clasts are lightly to very darkly varnished and commonly slightly reddened on undersides. Depth of dissection is approximately 0.3 m (Ranegras Plain) to 2 m (on southern and eastern sides of mountains). Soils typically consist of an uppermost 3 to 5 cm of vesicular eolian silt and clay, incipient to weak argillic horizons, weak to moderate reddening (5 YR hue), and Stage II-III calcic horizons. Unit age is late Pleistocene (10-250 ka).

Qm_1 Intermediate alluvium, unit 1 (Pleistocene) -- Terraces and alluvial-fan deposits; typically gravelly to extremely gravelly sand and silty sand (clast size less than 50 cm); generally finer grained on Ranegras Plain. Surfaces are characterized by gravelly and cobbly pavements. Bar-and-swale topography is locally preserved where deposits are extremely coarse (e.g., on cobbly and bouldery fan remnants emanating from southern side of mountains). Surface clasts are very darkly varnished and have well-reddened undersides; overall surface appearance is very dark. Margins of interfluves are typically erosionally rounded adjacent to dissecting channels and gullies. Depth of dissection is approximately 0.3 m (Ranegras Plain) to 3 m (southern and eastern sides of mountains). Soils are characteristically very strongly developed, exhibiting well-developed argillic horizons, strong reddening (5 YR hue), and Stage III calcic (locally petrocalcic) horizons. Unit age is middle Pleistocene (250-790 ka).

Qo Old alluvium (Pleistocene) -- Axial-valley terraces and alluvial-fan deposits; generally gravelly to extremely gravelly material; primarily on Palomas Plain, near mountain fronts, and in northeastern part of map area. Surfaces are characterized by abundant, pedogenic carbonate fragments (less than about 3 cm thick) and abundant, very darkly varnished clasts; pavement is moderately to poorly preserved. Surface remnants are typically somewhat degraded; interfluves are moderately erosionally rounded (extremely degraded members of unit are locally present on northeastern side of small bedrock ridge in southeastern quarter of map area). Overall surface appearance is intermediate between very dark Qm_1 and very light QTo surfaces. Depth of dissection is generally about 2 to 4 m. Soils are typically degraded; locally, well-reddened (5 YR hue), well-developed argillic horizons are preserved; fragments of underlying petrocalcic horizons litter these surfaces. Unit age is middle to early Pleistocene (500-1,000 ka[?]).

QTo Old alluvium (Pleistocene to Tertiary) -- Axial-valley terraces and alluvial-fan deposits (inferred to be predominantly Quaternary in age); typically very coarse gravelly to bouldery material; primarily on Palomas Plain and near mountain fronts. Remnants of depositional surfaces are generally confined to broad, erosionally rounded ridges between intervening gullies and deeply incised channels. Surface remnants are highly degraded and abundantly covered by pedogenic carbonate fragments (less than about 7 cm thick) that impart an overall whiteness to these surfaces. Depth of dissection is generally about 2 to 6 m and locally (in Nottbusch Valley) up to about 15 m. Soils are highly degraded above remnants of petrocalcic horizons that dominate surfaces. Unit age is early Pleistocene to late Tertiary (790-3,000 ka).

QTbf Basin-fill alluvium (Pleistocene to Tertiary) -- Alluvial-fan deposits (inferred to be predominantly late Tertiary in age); typically very coarse gravelly to bouldery material; most extensive in Nottbusch Valley (eastern side of map area). Deposits are characterized by a high degree of dissection and erosional degradation and lack remnants of original depositional surfaces. Depth of dissection is generally about 2 to 6 m and locally up to about 15 m. Unit age is earliest Pleistocene to late Tertiary ($\geq$ 1,800 ka).

Tpc Pedogenic(?) carbonate (Pliocene[?]) -- White to gray, extremely resistant carbonate inferred to be remnant of soil profile. Unit overlies horizontal and subhorizontal lavas of basalt of Oakland mine and basalt of Little Horn Mountains. Exposures in southwestern part of map area are up to 2 m thick. Unit age is inferred to be Pliocene, based on positioning at elevations of as much as 670 m (2,200 ft) above modern basins.

Tob Basalt of Oakland mine (Miocene) -- Dark-gray to black, very resistant, vesicular basalt and basaltic andesite lavas that contain phenocrysts of plagioclase, clinopyroxene, and olivine. Olivine is only partially altered to iddingsite along fractures and rims of phenocrysts; groundmass is only slightly altered and vitric in appearance and fracture. Layering is slightly tilted (6° or less) to horizontal. Unit reaches thickness of 300 m (900 ft) in south-central part of map area north of Palomas Plain. Unit is named for Oakland mine, located near junction of Cementosa Wash and Hovatter Road and is correlated with basalt of Black Mesa (Miller, 1970), based on description in literature (Shafiqullah and others, 1980). Unit age is inferred to be middle to early Miocene.

Tnr Rhyolite of Nottbusch Valley (Miocene) -- Unit consists of lavas and minor amounts of interbedded pyroclastic rocks, is locally glassy, and exhibits a low-degree of secondary alteration or oxidation; exposed as precipitous, steep-sided circular hills in central and eastern part of map area adjacent to Nottbusch Valley. Layers defined by zones of primary devitrification are horizontal, except where lava flows were confined in valleys and where flows cooled against channel walls and formed local, vertical chilled margins. Primary devitrification zones are preserved and typically consist of a basal vitrophyre and a flow-foliated center, separated by either a lithophysal or spherulitic zone of variable thickness. Pyroclastic rocks lack zeolite or pervasive clay alteration. Average unit thickness is approximately 300 m (1,000 ft). Lava flows are typically tens of meters thick and locally up to 65 m (200 ft) thick. Unit age is inferred to be middle to early Miocene, based on stratigraphic position beneath basalt of Oakland mine and on unconformable contact with underlying tilted basalt of Little Horn Mountains.

Tnrl -- Lava member.
Tnrt -- Tuff member.

Tl Limestone (Miocene) -- Gray, thinly bedded to laminated limestone, including minor beds and laminations of chert. Strata-bound deformation in unit is probably due to slumping during burial beneath overlying basalt lavas (unit Tlh). Unit thickness is approximately 12 m (40 ft). Unit age is inferred to be middle to early Miocene.

Tlh Basalt of Little Horn Mountains (Miocene) -- Blue-gray, variably resistant basalt and basaltic andesite lavas that are amygdaloidal and contain fine-grained phenocrysts of plagioclase, clinopyroxene, and olivine (altered to iddingsite). Groundmass is composed of variable amounts of microcrystalline plagioclase and tachylite, but is typically nonvitric and altered to an assemblage probably dominated by low-temperature clay. Thickest exposures, in northwestern part of map area, reach 130 m (400 ft). Strata are horizontal in north-central part of map area and moderately tilted in northwestern part. Rare interbeds of limestone, lithic lapilli tuff, and sandstone and conglomerate are present; locally may include basalt of Oakland mine. Unit correlates with basalt in northern Kofa Mountains, dated at 20.1 $\pm$ 0.6 Ma (whole-rock age; Sherrod and others, 1987). Unit age is inferred to be middle to early Miocene.

Tsc Sandstone, conglomerate, and sedimentary breccia (Miocene) -- Unit includes several discrete, potentially unrelated outcrops of clastic rocks that underlie basalt of Little Horn Mountains in central part of map area; unit is inferred to be interbedded with these basalt flows; exposures limited to southern half of map area. Near Red Raven Wash, unit predominantly consists of thickly bedded sedimentary breccia and conglomerate derived from porphyritic granitoid of unit MzXg. Extensive exposures north of Palomas Plain include lapilli-bearing arkosic sandstone, tuffaceous sandstone, pebbly arkosic sandstone with clasts of Tertiary basaltic rocks, and possibly flows of basalt lava (unit Tlh[?]). Cobble conglomerates contain clasts of granitoid and limestone. Unit also includes beds of unwelded lithic lapilli tuff. Thickness of unit varies and may reach 100 m (300 ft). Unit is exposed in fault blocks that dip approximately 50° west. Unit age is inferred to be middle to early Miocene.

Trv Volcanic rocks of Royal Arch (Miocene) -- Heterogeneous package of vent and near-vent lavas of rhyolite and rhyodacite composition. Dominated by massive, unlayered, flow-foliated lava, intrusions related to lava, and flow-breccia; includes subordinate lithic lapilli tuff that is well-bedded and basal andesite lavas. Exposed in moderately to steeply west-tilted fault blocks. Pervasive mild to moderate oxidation suggests potassic alteration has affected unit, particularly in exposures east of Hovatter Road near Royal Arch. Lavas exposed south of Cementosa Tanks are texturally diverse, have a broad range (10% to 25%) in phenocryst mode (1 to 2 mm phenocrysts of clinopyroxene, quartz, biotite, and sanidine), and are less altered; these lavas exhibit primary devitrification zones near their interiors and some have well-preserved vitrophyric margins. Lithic lapilli tuff consists of pyroclastic fall- and surge-related deposits; locally contains thick accumulations of stony welded tuff (phenocrysts of biotite, quartz, and sanidine). Unit is named for exposures at Royal Arch east of Hovatter Road in north-central part of Little Horn Mountains 15' quadrangle. Unit age is uncertain, though probably early Miocene, based on extensive structural dissection, degree of tilting (40° to 90°), and similarity to dated rocks in Kofa Mountains west of map area (Bagby and others, 1987).

Tsbx Sedimentary breccia derived from crystalline rocks (Miocene or Oligocene[?]) -- Nonresistant exposures of heterolithologic breccia composed of angular to subrounded clasts of crystalline and metamorphic rocks (units Jsu and MzXg) in a poorly sorted arkosic matrix. Medium bedded; locally includes coarse-grained, poorly sorted sandstone beds; clast dimensions reach 40 cm. Unit age is inferred to be early Miocene to Oligocene(?), based on lithologic similarities to deposits in southern Castle Dome Mountains (Grubensky and others, in press).

Jsu Sedimentary and volcanic rocks of Slumgullion, undivided (Jurassic[?]) -- Greenish-gray, nonresistant, low-grade metamorphic rocks that include arkosic sandstone, andesitic lava, quartzite, quartz-pebble conglomerate, and purple phyllite; unit also includes intrusive porphyry west of Oakland mine. Unit age is Middle and Early Jurassic([?]; Haxel and others, 1985; Grubensky and others, in press).

MzXg Granitoid (Mesozoic or Proterozoic X) -- Light-green to gray, nonresistant, leucocratic feldspar-porphyritic granodiorite, highly leucocratic equigranular biotite-granite, and medium-grained granite porphyry exposed in eastern half of map area. Unit age is uncertain because of similarity to both Jurassic and Early Proterozoic porphyritic granitoids in southwestern Arizona (Tosdal and others, 1989).

MzXs Schist (Mesozoic or Proterozoic X) -- Green or gray, monotonous, medium-grained biotite-schist. Intruded by northwest-trending dike swarm of unfoliated granitoid rocks (unit MzXg[?]), composed of muscovite aplite, leucocratic granite porphyry, and fine-grained granite.

* Mapping of the Quaternary and upper Tertiary alluvium is based on a detailed reconnaissance study. Units were mapped from 1:24,000-scale aerial photographs and field checked in many places. Ages of alluvial units are constrained by the inferred time since abandonment of the corresponding depositional surfaces. Relative topographic positions of the surfaces, extent of surface preservation, and degree of soil development are the principal criteria used to assess age of surface abandonment. No independent local age constraints were obtained in this study; the estimated numerical ages of the surfaces are largely inferred from radiometric dates and previous geologic studies in southern Arizona (especially Menges and McFadden, 1981; Morrison and Menges, 1982; Bull, in press).

MAP SYMBOLS

- Fault, showing dip; bar and ball on downthrown block; dashed where inferred, dotted where concealed
- Contact, showing dip; dashed where inferred, dotted where concealed
- Low-angle normal fault, showing dip; ticks on upper plate; dashed where inferred, dotted where concealed
- Strike and dip of bedding
  - inclined
  - vertical
  - horizontal
- Strike and dip of flow foliation
  - inclined
  - vertical
- Strike and dip of metamorphic mineral foliation
  - inclined
  - vertical
- Line of cross section
- Prospect
- Adit
- Shaft

PREPARED IN COOPERATION WITH THE U.S. GEOLOGICAL SURVEY AS PART OF THE COOPERATIVE GEOLOGICAL MAPPING (COGEOMAP) PROGRAM