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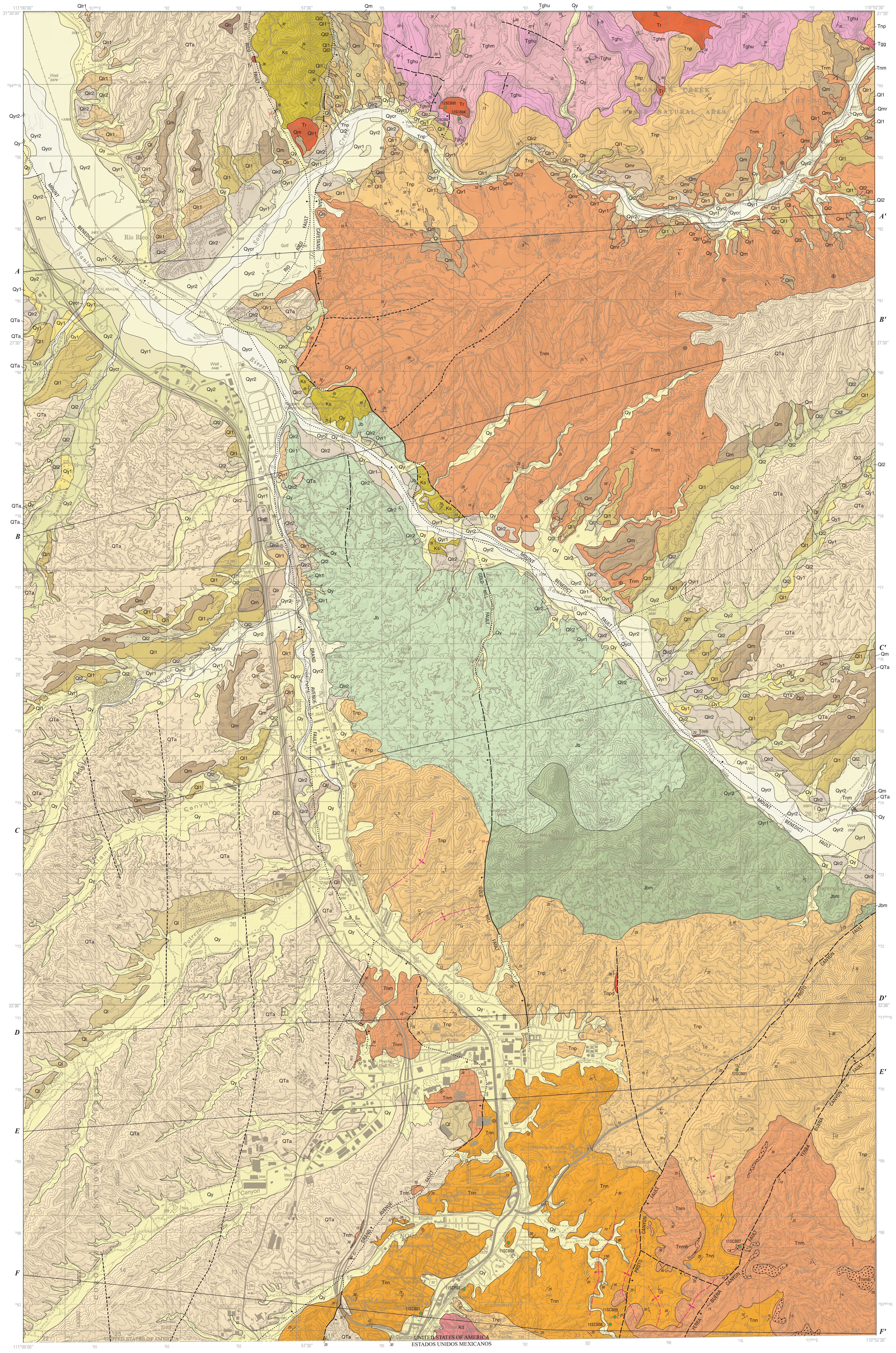
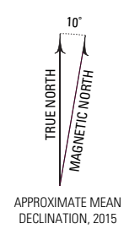
U.S. Geological Survey

Scientific Investigations Map 3354
Sheet 1 of 2
Pamphlet accompanies map


111°00′00″
31°30′00″
57′30″
55′
110°52′30″
31°30′
27′30″
22′30″
A
A′
B
B′
C
C′
D
D′
E
E′
F
F′
Rio Rico
MOUNT BENEDICT FAULT
RIO RICO FAULT
SAN CAYETANO FAULT
GRAND AVENUE FAULT
GOLD HILL FAULT
PROTO CANYON FAULT
YERBA BUENA CANYON FAULT
Santa Cruz River
Sonoita Creek
SONOITA CREEK STATE NATURAL AREA
LUIS MARIA BACA
NOGALES
UNITED STATES OF AMERICA
ESTADOS UNIDOS MEXICANOS


TRUE NORTH
MAGNETIC NORTH
10°
APPROXIMATE MEAN DECLINATION, 2015

Base from U.S. Geological Survey 1:24,000-scale maps: Rio Rico, Arizona, 1996; Nogales, Arizona–Sonora, 2004 and revised by the U.S. Forest Service January 18, 2013
North American Datum 83 (NAD 83)
Universal Transverse Mercator, zone 12
Shaded-relief base from U.S. Geological Survey National Elevation Dataset (NED) (accessed in 2015 at http://ned.usgs.gov/), 10-meter resolution elevation data
UTM grid in Nogales quadrangle created in 2016 from USGS sources

SCALE 1:24 000
1 MILE 1/2 0 1 MILE
1000 0 1000 2000 3000 4000 5000 6000 7000 FEET
1 .5 0 1 KILOMETER

CONTOUR INTERVAL OF 40 FEET
SUPPLEMENTARY CONTOUR INTERVAL OF 20 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929

ARIZONA
QUADRANGLE LOCATION

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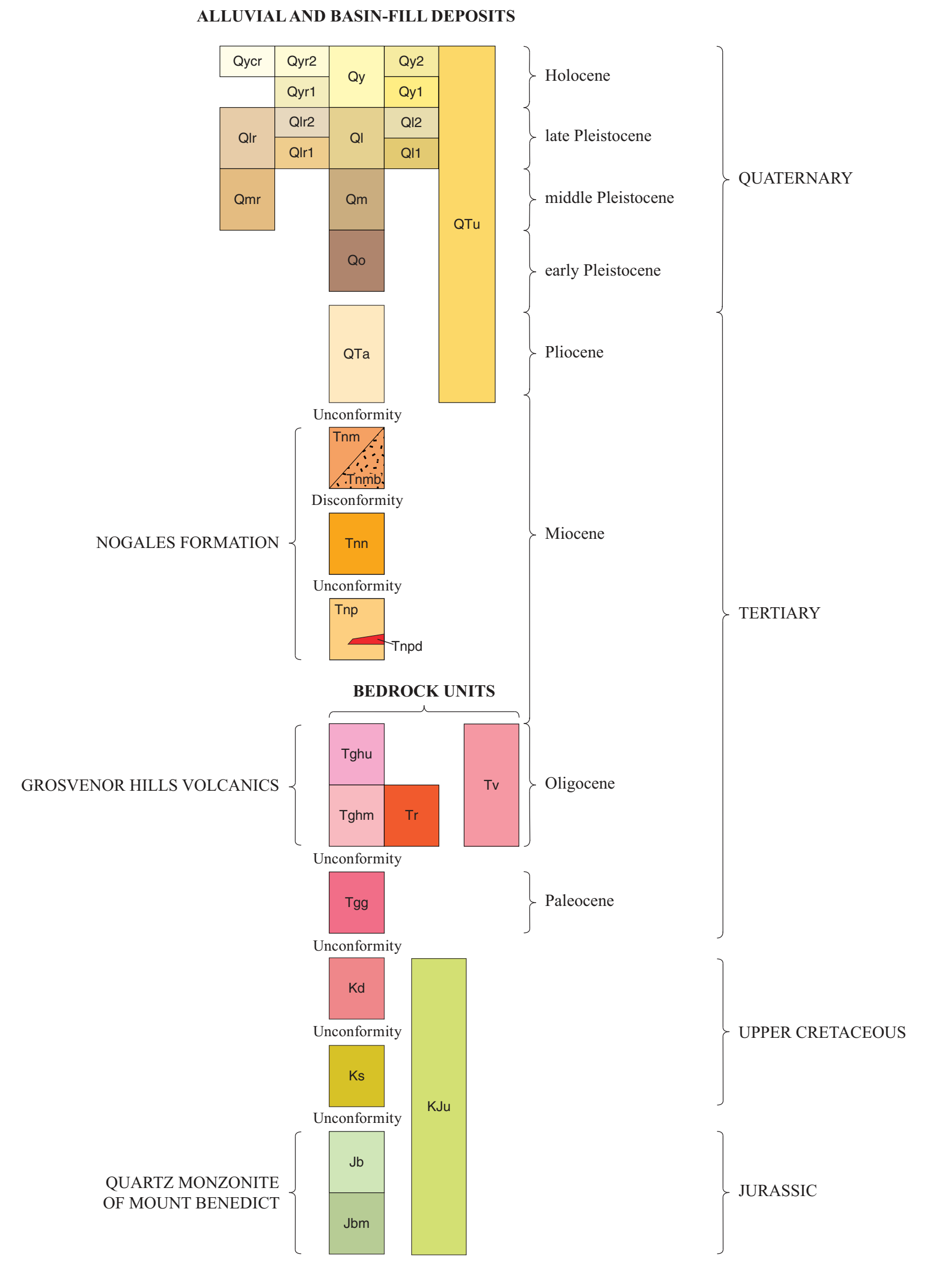
Mapping of the Miocene Nogales Formation was completed from 2011 to 2014 by William R. Page, Christopher M. Menges, Floyd Gray, and Margaret E. Berry. Late Miocene to Holocene alluvial and basin-fill deposits were mapped from 2011 to 2014 by Christopher M. Menges and Margaret E. Berry. Mesozoic bedrock units and the Oligocene Grosvenor Hills Volcanics were compiled from existing published geologic maps in the area, including those of Simons (1974) and Drewes (1972, 1980). Mark W. Bultman completed geophysical modeling, which defined the geometry of concealed faults and basin and bedrock geology and constrained the subsurface geology shown in the cross sections. Michael A. Cosca completed $^{40}Ar/^{39}Ar$ geochronology studies resulting in stratigraphic revision of the Oligocene Grosvenor Hills Volcanics and Miocene Nogales Formation. D. Paco VanSistine created cross section profiles and assisted authors in creating, editing, and finalizing the geologic map database and metadata. T.R. Brandt produced the digital topographic base map.

CORRELATION OF MAP UNITS


ALLUVIAL AND BASIN-FILL DEPOSITS
Qycr
Qyr2
Qyr1
Qy
Qy2
Qy1
Qlr
Qlr2
Qlr1
Ql
Ql2
Ql1
Qmr
Qm
Qo
QTa
QTu
Holocene
late Pleistocene
middle Pleistocene
early Pleistocene
Pliocene
QUATERNARY
Unconformity
Tnm
Tnmb
Disconformity
Tnn
Unconformity
Tnp
Tnpd
NOGALES FORMATION
Miocene
TERTIARY
BEDROCK UNITS
Tghu
Tghm
Tr
Tv
GROSVENOR HILLS VOLCANICS
Oligocene
Unconformity
Tgg
Paleocene
Unconformity
Kd
Unconformity
Ks
Unconformity
KJu
UPPER CRETACEOUS
Jb
Jbm
QUARTZ MONZONITE OF MOUNT BENEDICT
JURASSIC

LIST OF MAP UNITS

[Colors on the map may appear darker due to the hillshade transparancy]

ALLUVIAL AND BASIN-FILL DEPOSITS

Qycr	**Active river-channel deposits (latest Holocene)**
Qyr2	**Young river floodplain and terrace deposits (late Holocene)**
Qyr1	**Young river terrace deposits (Holocene)**
Qy	**Young alluvial deposits, undivided (Holocene)**
Qy2	**Younger of the young alluvial deposits (late Holocene)**
Qy1	**Older of the young alluvial deposits (Holocene)**
Qlr	**Young intermediate river-terrace deposits, undivided (late Pleistocene)**
Qlr2	**Younger of the young intermediate river-terrace deposits (late Pleistocene)**
Qlr1	**Older of the young intermediate river-terrace deposits (late Pleistocene)**
Ql	**Young intermediate alluvial deposits, undivided (late Pleistocene)**
Ql2	**Younger of the young intermediate alluvial deposits (late Pleistocene)**
Ql1	**Older of the young intermediate alluvial deposits (late Pleistocene)**
Qmr	**Older intermediate river-terrace deposits (middle Pleistocene)**
Qm	**Older intermediate alluvial deposits (middle Pleistocene)**
Qo	**Old alluvial deposits (early Pleistocene)**
QTa	**Alluvial basin fill (early Pleistocene? to Miocene)**
QTu	**Alluvium and basin-fill deposits, undivided (Holocene to Miocene)**—On cross sections only
	Nogales Formation (Miocene)
Tnm Tnmb	**Mariposa member**—Stipple pattern indicates basalt flows
Tnn	**Nogales Wash member**
Tnp Tnpd	**Proto Canyon member**—Red area indicates location of dacite dikes
	BEDROCK UNITS
	Grosvenor Hills Volcanics (Oligocene)
Tghu	**Upper rhyodacite member**
Tr	**Rhyodacite and rhyolite intrusive rocks**
Tghm	**Middle rhyolite member**
Tv	**Tertiary volcanic rocks, undivided (Oligocene)**—On cross sections only
Tgg	**Gringo Gulch Volcanics (Paleocene)**
Kd	**Diorite (Upper Cretaceous)**
Ks	**Salero Formation (Upper Cretaceous)**
	Quartz Monzonite of Mount Benedict (Jurassic)
Jb	**Biotite-hornblende quartz monzonite**
Jbm	**Quartz monzonite**
KJu	**Cretaceous and Jurassic rocks, undivided**—On cross sections only

EXPLANATION

Contact

Normal fault—Long-dashed where approximately located, short dashed where geophysically inferred, dotted where concealed; small red arrow shows direction and angle of dip; ball and bar on apparent downthrown side

Anticline—Long-dashed where location approximate

Syncline—Long-dashed where location approximate

Horizontal bedding

Overturned bedding—Showing strike and dip

Inclined bedding—Showing strike and dip

Inclined flow layering—Showing strike and dip

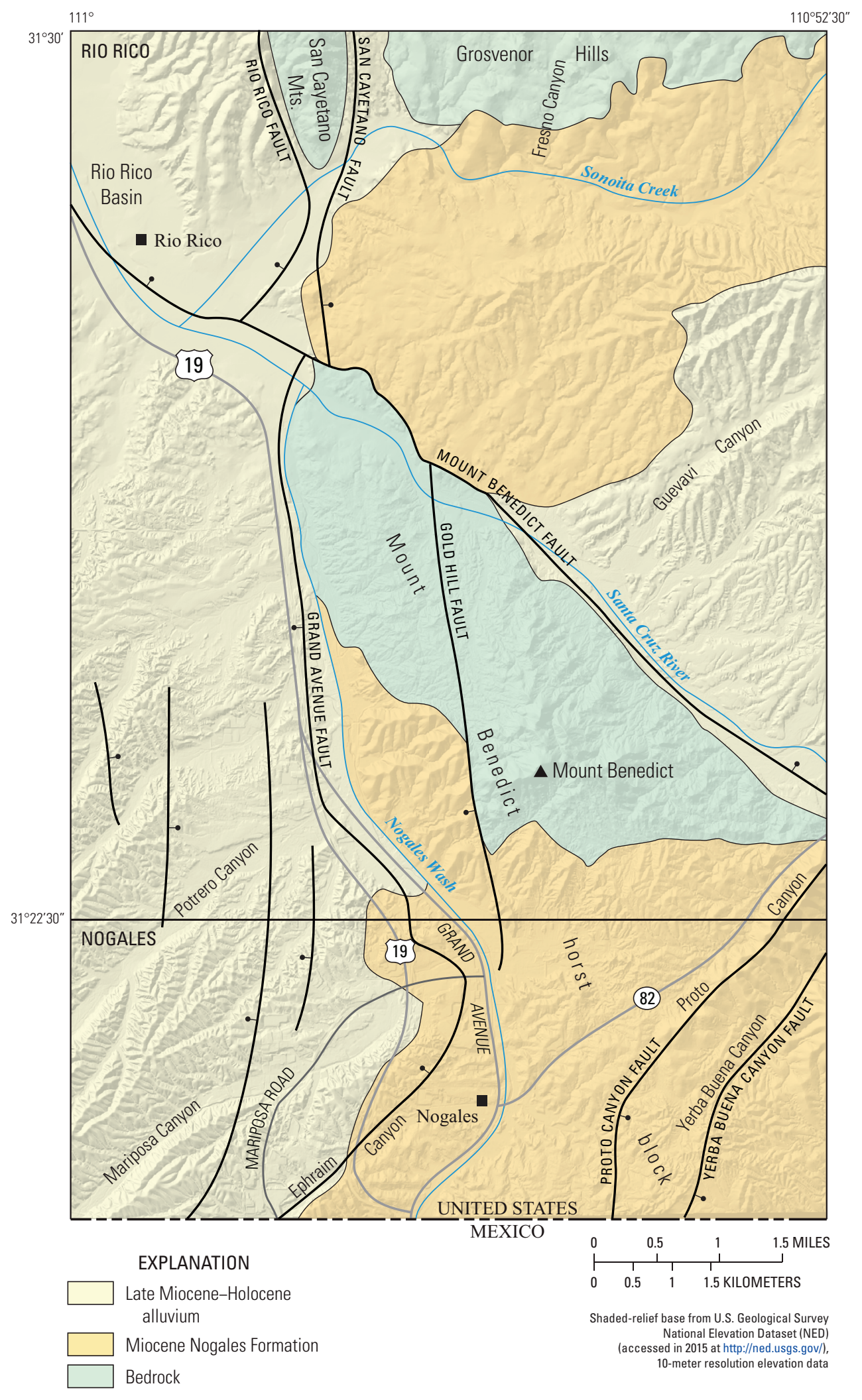
Vertical flow layering—Showing strike

Geochronological sample—Showing sample locations with sample number

11SCB01

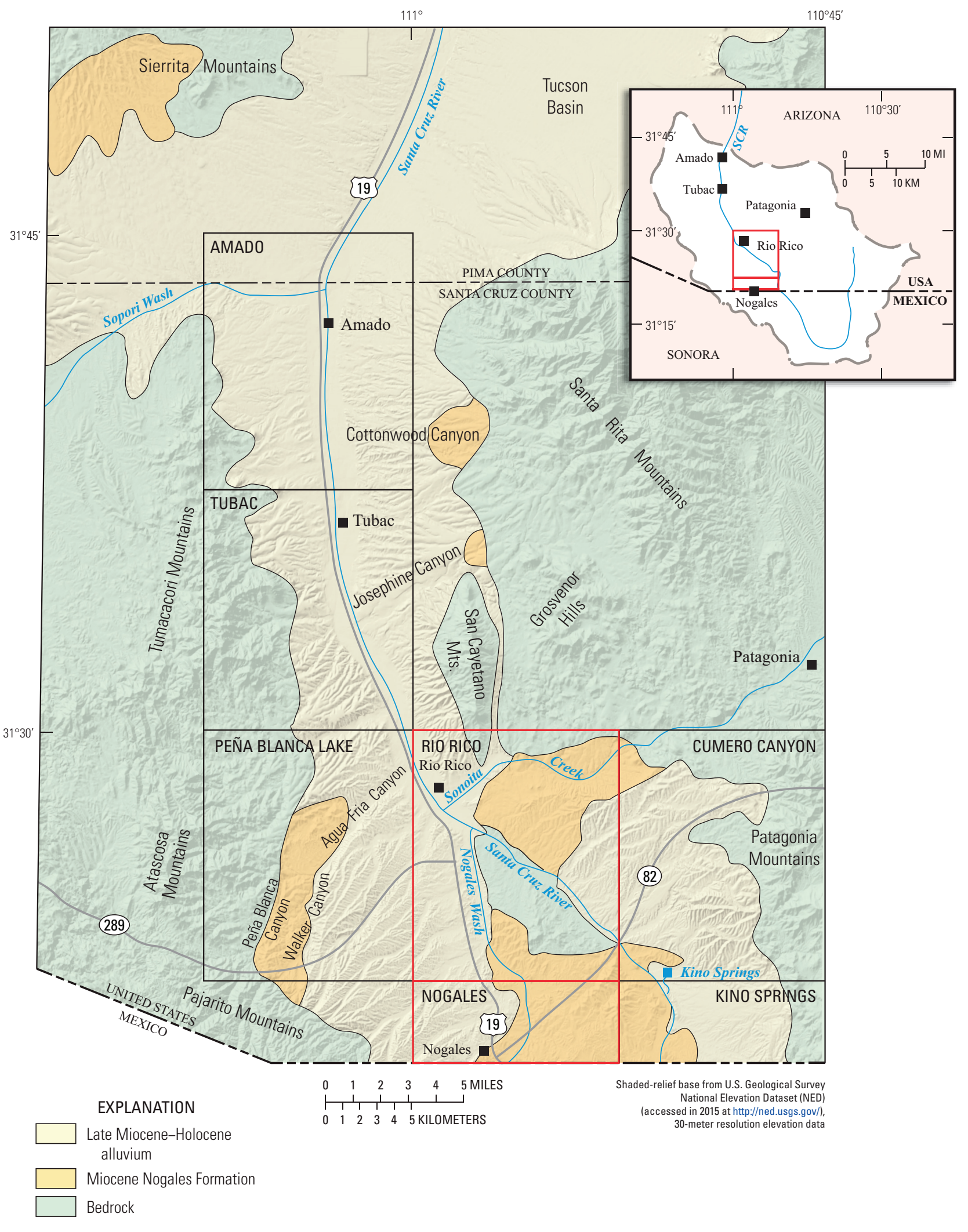
Period	Epoch	Units	Description
QUATERNARY	Holocene Pleistocene	Quaternary alluvium	Alluvium—Poorly to moderately bedded, unconsolidated to weakly consolidated, poorly sorted, interstratified sandy gravel and gravelly sand, deposited in major and tributary drainages and in piedmont alluvial fans; generally 3 to 4 m thick
TERTIARY	Pliocene Miocene	Basin-fill deposits	Basin-fill deposits—Moderately to poorly bedded, weakly consolidated, interstratified gravelly sand to sandy gravel; generally ≤100 m thick
	Miocene	Nogales Formation: Mariposa member	Mariposa member—Moderately to weakly consolidated calcareous, volcaniclastic sandstone and conglomerate, siltstone, claystone, basalt flows dated at 11.67 Ma; 300–350 m thick
		Nogales Formation: Nogales Wash member	Nogales Wash member—Moderately consolidated volcaniclastic sandstone and conglomerate, abundant pumice fragments, pervasively fractured; basal 20–30 m of member forms massive cliffs; 50–150 m thick
		Nogales Formation: Proto Canyon member	Proto Canyon member—Moderately to weakly consolidated volcaniclastic conglomerate and sandstone, arkosic sandy and clayey conglomerate, and gravelly claystone; includes basal debris-flow conglomerate which grades upward into arkose conglomerate and sandstone; maximum thickness about 450 m
	Oligocene	Grosvenor Hills Volcanics	Upper rhyodacite member—Rhyodacite and rhyolite tuff, agglomerate, flow breccia, and latite; rhyolite tuff samples dated at 24.8–23.5 Ma, and another at 26.9–26.3 Ma; 75 m thick Middle rhyolite member–Vitric-lithic tuff, rhyolite lava, tuffaceous sandstone and conglomerate; rhyodacite plugs dated at 27.8 Ma; 100 m thick
	Paleocene	Gringo Gulch Volcanics	Andesite lava and flow breccia, latitic to rhyolitic tuff and lava, tuffaceous conglomerate; 10–20 m thick
CRETACEOUS	Upper	Diorite	Diorite stock—Augite, hypersthene, and biotite, altered
		Salero Formation	Arkosic conglomerate and conglomeratic sandstone, argillite, and conglomeratic quartzite; 50–400 m thick
JURASSIC	Middle	Quartz Monzonite of Mount Benedict	Porphyritic biotite-hornblende quartz monzonite; lamprophyre, microdiorite, or diabase dikes

Figure 3. Stratigraphic chart of sediments and rocks in map area. Unconformities and disconformities are indicated by the wavy line.


111°
110°52′30″
31°30′
31°22′30″
RIO RICO
San Cayetano Mts.
RIO RICO FAULT
SAN CAYETANO FAULT
Grosvenor Hills
Fresno Canyon
Sonoita Creek
Rio Rico Basin
Rio Rico
19
MOUNT BENEDICT FAULT
Guevavi Canyon
Mount Benedict
GOLD HILL FAULT
GRAND AVENUE FAULT
Santa Cruz River
Mount Benedict
Nogales Wash
Potrero Canyon
Canyon
NOGALES
19
GRAND AVENUE
horst
82
Proto
Mariposa Canyon
MARIPOSA ROAD
Ephraim Canyon
Nogales
PROTO CANYON FAULT
block
Yerba Buena Canyon
YERBA BUENA CANYON FAULT
UNITED STATES
MEXICO
0 0.5 1 1.5 MILES
0 0.5 1 1.5 KILOMETERS
EXPLANATION
Late Miocene–Holocene alluvium
Miocene Nogales Formation
Bedrock

Shaded-relief base from U.S. Geological Survey National Elevation Dataset (NED) (accessed in 2015 at http://ned.usgs.gov/), 10-meter resolution elevation data

Figure 1. Location map of Rio Rico and Nogales (Arizona) 7.5′ quadrangles, showing major physiographic, geologic, and hydrologic features in the map area. Black squares are town locations and black ball and bar symbols indicate the downthrown side of normal faults. Fault dashing has been simplified from main map.


111°
110°45′
31°45′
31°30′
Sierrita Mountains
Tucson Basin
Santa Cruz River
19
AMADO
Amado
PIMA COUNTY
SANTA CRUZ COUNTY
Sopori Wash
Cottonwood Canyon
TUBAC
Tubac
Tumacacori Mountains
Josephine Canyon
San Cayetano Mts.
Grosvenor Hills
Santa Rita Mountains
Patagonia
PEÑA BLANCA LAKE
RIO RICO
Rio Rico
CUMERO CANYON
Sonoita Creek
Agua Fria Canyon
Atascosa Mountains
Peña Blanca Canyon
Walker Canyon
Nogales Wash
Santa Cruz River
82
Patagonia Mountains
289
Kino Springs
KINO SPRINGS
NOGALES
Nogales
19
Pajarito Mountains
UNITED STATES
MEXICO
111°
110°30′
31°45′
31°30′
31°15′
ARIZONA
SCR
Amado
Tubac
Patagonia
Rio Rico
Nogales
USA
MEXICO
SONORA
0 5 10 MI
0 5 10 KM
0 1 2 3 4 5 MILES
0 1 2 3 4 5 KILOMETERS
EXPLANATION
Late Miocene–Holocene alluvium
Miocene Nogales Formation
Bedrock

Shaded-relief base from U.S. Geological Survey National Elevation Dataset (NED) (accessed in 2015 at http://ned.usgs.gov/), 30-meter resolution elevation data

Figure 2. Location map of upper Santa Cruz basin area, showing major physiographic, geologic, and hydrologic features in the region. Black squares are town locations. Inset map in upper right shows location of upper Santa Cruz River basin with boundary in gray, Santa Cruz River (SCR) in blue, and boundaries of Rio Rico and Nogales quadrangles in red.

DIVISION OF QUATERNARY TIME USED IN THIS REPORT[1]

Period	Epoch		Age
Quaternary	Holocene		0–11.7 ka
	Pleistocene	late	11.7–126 ka
		middle	126–781 ka
		early	781 ka–2.58 Ma

[1] Ages for time divisions are from Cohen and others (2013; updated). Ma, million years; ka, thousand years.

CONVERSION FACTORS

Multiply	By	To obtain
millimeter (mm)	0.03937	inch (in.)
centimeter (cm)	0.3937	inch (in.)
meter (m)	3.281	foot (ft)
kilometer (km)	0.6214	mile (mi)

Geologic map of the Rio Rico and Nogales 7.5′ quadrangles, Santa Cruz County, Arizona

By

William R. Page, Christopher M. Menges, Floyd Gray, Margaret E. Berry, Mark W. Bultman, Michael A. Cosca, and D. Paco VanSistine

2016

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