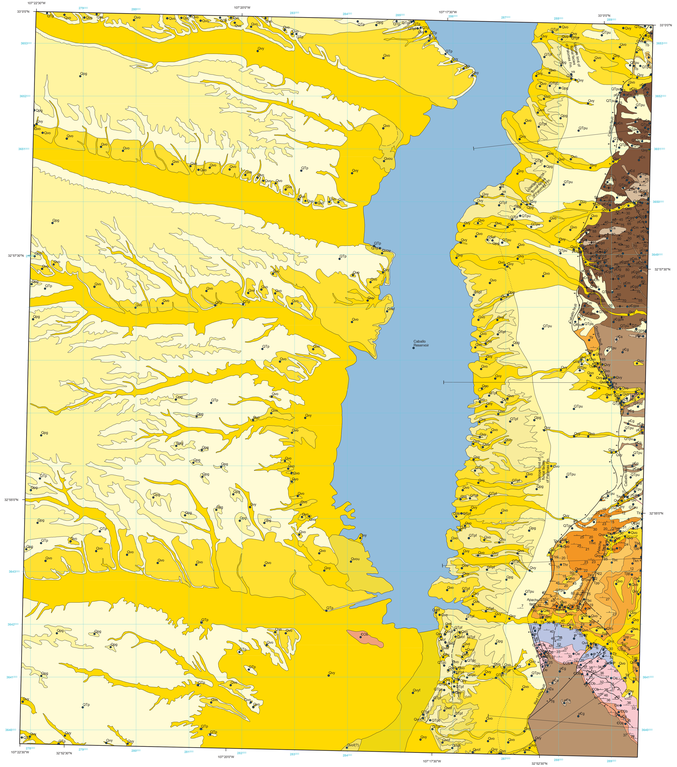
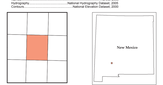
NMBGMR Open-File Geologic Map XXX
Last Modified June 2015



Base map from U.S. Geological Survey 2010
North American Datum of 1927 (NAD27) World Geodetic System of 1984 (WGS84).
Projection and 1000-meter grid: Universal Transverse Mercator, Zone 13N
10,000-meter ticks: New Mexico Coordinate System of 1927 (Central Zone)

Equipment:	ArcGIS and Trig Judy
Topography:	USGS 2009
Hydrology:	National Hydrography Dataset 2009
Contours:	National Elevation Dataset 2010



Magnetic Declination
2015
10° 07' East
to True North

1:24,000

Contour Interval 40 Feet
North American Vertical Datum of 1988

This draft geologic map is preliminary and will undergo revision. It was produced from either scans of hand-drafted originals or from digitally drafted original maps and figures using a wide variety of software, and is currently in cartographic production. It is being distributed in this draft form as part of the bureau's Open-file map series (NMBGMR OF-GM series) to make the information shown on the STATEMAP quadrangles are located, and it is the bureau's policy to disseminate geologic data to the public as soon as possible.

After this map has undergone review, editing, and final cartographic production adhering to bureau map standards, it will be released in our Geologic Map (GM) series. This final version will receive a new GM number and will supercede this preliminary open-file geologic map.

DRAFT

Quadrangle Location

New Mexico Bureau of Geology and Mineral Resources
New Mexico Tech
801 Leroy Place
Socorro, New Mexico
87801-4796

[575) 835-5490

This and other STATEMAP quadrangles are available for free download in both PDF and ArcGIS formats at:

http://geoinfo.nmt.edu

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New Mexico Bureau of Geology and Mineral Resources
Geologic Map 74

Mapping of this quadrangle was funded by a matching-funds grant from the STATEMAP program of the National Cooperative Geologic Mapping Act (Fund Number _____), administered by the U. S. Geological Survey, and by the State of New Mexico through the New Mexico Bureau of Geology and Mineral Resources, Dr. Peter Scholle, Director and State Geologist; Dr. J. Michael Timmons, Assoc. Director for Mapping Programs.

Geology of Caballo and Apache Gap quadrangles, Sierra County, New Mexico: Caballo Quadrangle

2005

by
William R. Seager and Greg H. Mack

Department of Geological Sciences, New Mexico State University, Las Cruces, New Mexico 88003

Comments to Map Users

A geologic map displays information on the distribution, nature, orientation, and age relationships of rock and deposits and the occurrence of structural features. Geologic and fault contacts are irregular surfaces that form boundaries between different types or ages of units. Data depicted on this map come from many different sources. Primary data are from new fieldwork and reinterpretation of geologic mapping, compilation of published and unpublished work, and photogeologic interpretation. Locations of contacts are not surveyed, but are plotted by interpretation of the position of a given geologic unit or contact on the topographic base map. Many factors affect the interpretation of where to place a contact on the map, some of which may be critical to the safe use of the map for any application (for example, slope stability, excavation, or drilling). Some of the factors that affect the interpretation of where to place a contact on the map are the quality and quantity of the data, the nature of the contact (for example, some contacts between units of very different ages are easy to map because they are marked by major erosional surfaces or by the juxtaposition of very young against very old rocks, but other contacts may be very difficult to place because they are between units that are very similar), the scale at which the map was compiled, and the ability of the map user to see the ground surface while using the map. Such factors may be different than the ones you may have in mind for your use of the map, and you should be aware of them before using the map for any application. Also, the ease of recognition of a contact on the ground may be very different than it was for the person who mapped it, for the same reasons. Therefore, you may find that you will need to modify the location of contacts or even some units when you use the map for your own purposes.

The New Mexico Bureau of Geology and Mineral Resources created the Open-file Geologic Map Series to expedite dissemination of these geologic maps and may data to the public as rapidly as possible. Unpublished maps in this series may lack some elements that are found on our more refined maps, and they may contain errors. Most of these maps are released in the format they were delivered to us by the author. The date of publication of each map in the series is the date we put the map online, and the date of any subsequent revision is recorded in the map series index table. Some of the maps in the series are released in draft form without formal peer review if we judge that the map is timely and that its release will benefit the public. We release such maps in the interest of speeding the dissemination of new geologic information, with the understanding that the map may be revised soon after release as more information becomes available. Maps in this series may be revised and republished at any time in the future at the discretion of the author and the Bureau. Revised maps will supersede previous versions of the same map.

Cross sections are constructed based upon the interpretations of the author made from geologic mapping, and available geophysical, and subsurface (drillhole) data. Cross sections should be used with caution and with the understanding that they are interpretations of the geology that are the best fit to the available data. They are useful for broad-scale regional geologic understanding, but may be misleading if used for detailed site-specific purposes such as siting of water wells or other subsurface exploration.

Topographic and cultural changes may not be shown due to recent development.

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Symbol

<all other values>

01-01-00-00-00—Unit—Qvy—Younger valley-fill alluvium—Gravel, sand, silt, and clay deposits of arroyo floors, terraces, and alluvial fans that are graded to or within a few meters of the Rio Grande floodplain; as much as 15 m (49 ft) thick.

01-02-00-00-00—Unit—Qvyf—Younger valley-fill fluvial deposits—Gravel, sand, and clay deposits of the floodplain and river channels of the Rio Grande; as much as 21 m (69 ft) thick.

01-03-00-00-00—Unit—Qvo—Older valley-fill alluvium—Gravel, sand, silt, and clay that comprise at least three generations of terraces or alluvial fans and whose surfaces are graded to approximately 24 m (79 ft), 33 m (108 ft), and 50 m (164 ft) above the floodplain of the Rio Grande. Pedogenic carbonate (stage II to stage IV) cements uppermost parts of deposits, especially the higher deposits. THe unit interfingers with Qvof and is as much as 30 m (98 ft) thick.

01-04-00-00-00—Unit—Qvof—Older valley-fill alluvium —Sand the cobble gravel with lesser silt and clay deposited by the Rio Grande. Unit interfingers with at least two of the three Qvo units; upper parts of the deposits are cemented by pedogenic carbonate (stage II to stage IV) and crop out as high as 50 m (164 ft) above the modern floodplain; as much as 15 m (49 ft) thick.

01-05-00-00-00—Unit—Qvou—Intertonguing Qvo and Qvof —Intertonguing Qvo and Qvof

01-06-00-00-00—Unit—Qva—Undifferentiated by Qvy and Qvo—Undifferentiated by Qvy and Qvo

01-01-00-00-00—Unit—Qey—Younger piedmont-slope alluvium—Sand, Gravel, silt, and clay of modern shallowly raised drainageways alluvial flats near the center of the Jornada del Muerto; as much as 6 m (20 ft) thick

02-02-00-00-00—Unit—Qeo—Older piedmont-slope alluvium —Gravel and gravelly sand deposits of arroyos, alluvial fans, and pediment veneers that are intermediate in geomorphic position between higher Palomas (Qpg) deposits and lower (Qey) alluvium. At least two generations of Qpo deposits are locally present. Upper part of Qpo deposits is cemented by stage II to stage IV pedogenic carbonate; as much as 7 m (23 ft) thick.

02-03-00-00-00—Unit—Qpa—Undifferentiated Qey and Qpo—Undifferentiated Qey and Qpo

03-01-00-00-00—Unit—Qpg—Palomas Formation, upper proximal piedmont-slope facies—Boulder to pebble conglomerate, gravel, sandstone, sand, and mudstone derived from Cabello and Red Hills fault blocks; contains zones of stage III or stage IV pedogenic carbonate as mac has .08 m (2.6 ft), especially at the top; unit overlies Qtpf west of Caballo and Red Hills fault, but above the fault the unit forms a relatively thin (1-20-m-thick) pediment veneer on bedrock; unit is 20 m (66 ft) or more thick near mountain front faults, thinning basinward

03-02-00-00-00—Unit—QTpf—Palomas Formation, transitional facies —Massive, unbedded, fine-to-medium grained sandstone and mudstone, mapped only locally, that may represent mudflow deposits on distal piedmont slopes adjacent to the ancestral Rio Grande floodplain; as much as 15 m (49 ft) thick.

03-03-00-00-00—Unit—Qpr—Palomas Formation, fluvial and associated facies—Light-gray, yellow, and pink to tan sand, sandstone, gravel, conglomerate, conglomeratic sandstone, and mudstone representing fluvial-channel and overbank deposits of the ancestral Rio Grande; may include deposits of sand, silt, or loam sediments deposited on alluvial flats or in eolian environments' tongues of piedmont-slope conglomerate (QTpc) are interbedded locally within the unit; as much as 100 m (328 ft) thick.

03-04-00-00-00—Unit—QTpc—Palomas Formation, lower proximal piedmont-slope facies—Well to moderately cemented, tan to reddish-brown, boulder to cobble-pebble conglomerate and conglomeratic sandstone; derived from Red Hills and Caballo fault blocks; underlies and intertongues laterally with QTpf. Near mountain fronts, the unit is gradational upward into Qpg; at least 50 m (164 ft) thick.

03-05-00-00-00—Unit—Qpga—Palomas Formation, Qpg and QTpc undifferentiated—100m (328 ft) thick

03-06-00-00-00—Unit—QTp—Palomas Formation, distal piedmont-slope facies—Pink, tan, and gray sandstone, siltstone, and mudstone with thin soil-carbonate horizons and thin to thick (10 m (33 ft)) interbeds of pebble-cobble conglomerate that increase in number and coarseness westward of the Rio Grande and represents environments of deposition ranging from arroyo channel and overbank to alluvial flat; intertongues locally with QTpf; at least 90 m (295 ft) thick.

03-07-00-00-00—Unit—Tb—Alkali-olivine basalt—Flows and cinders that underlie and interfinger with the base of QTpa' while rock K-Ar age is 3.1 ± 0.1 Ma; as much as 10 m (33 ft) thick

03-08-00-00-00—Unit—Trvc—Rincon Valley Formation, conglomerate facies—Reddish-brown conglomerate and conglomeratic sandstone derivedlargely from Paleozoic strata; volcanic-clast and distal piedmont-slope deposits derived from an early stage of uplift of the Caballo Mountains; at least 335 m (1,100 ft) thick.

03-09-00-00-00—Unit—TRr—Hayner Ranch Formation—Light-gray to brown conglomerate, conglomeratic sandstone and mudstone derived largely from middle Tertiary volcanic rocks; content of Paleozoic clasts increases upward in section; formation represents alluvial-fan and distal piedmont-slope deposits derived from an early stage of uplift of the Caballo Mountains; at least 305 m (1,000 ft) thick

03-10-00-00-00—Unit—TT—Thurman Formation —White to light-tan to light-gray, tuffaceous, volcaniclastic sandstone and pink mudstone; bedding ranges from massive nonsorted to thin and parallel to channel from, the latter filled with trough crossbeds; as much as 508 m (1,666 ft) thick.

03-11-00-00-00—Unit—Tba—Dikes —Dark-gray andesite, andesite-porphyry, and basalto-andesite dikes, 1 - 5 m (3 - 16 ft) thick. 40 Ar/ 39 Ar age is 26.8 Ma.

03-12-00-00-00—Unit—Tr—Dikes —Gray to cream flow-banded rhyolite dikes 1 - m (3 - 10 ft) thick

03-13-00-00-00—Unit—TRd7—Bell Top Formation, ash-flow tuff 7—Gray to brownish-gray, fine-grained, vitric ash-flow tuff; approximately 3 m (10 ft) thick.

03-14-00-00-00—Unit—Trbt—Bell Top Formation, ash-flow tuff 6 —Gray to pinkish-gray, moderately welded, crystal-rich ash-flow tuff, approximately 15 m (49 ft) thick where separated from Kneeling Nun Tuff by channel-fill deposits of Trc; apparently merges with and is indistinguishable from Kneeling Nun Tuff in westernmost outcrops in Apache Valley.

03-15-00-00-00—Unit—Trc—Bell Top Formation, conglomerate member—Reddish-brown to tan conglomerate and conglomeratic sandstone, pink to tan mudstone, and white tuffaceous sandstone. Boulder and cobble clasts consist predominately of Kneeling Nun Tuff, intermediate-composition volcanic porphyries and lesser amounts of Paleozoic limestone, the latter two types probably reworked from Love Ranch Formation; Trbt is locally interbedded with the conglomerate member, dividing it into upper and lower units; approximately 50 ft (164 ft) thick

03-16-00-00-00—Unit—Trn—Kneeling Nun Tuff—Grayish-pink, crystal and pumice-rich ash-flow tuff; apparently merges with and is indistinguishable from Trbt in westernmost outcrops in Apache Valley; approximately 30 m (98 ft) thick.

Description of Map Units

03-17-00-00-00—Unit—Tpp—Palm Park Formation—Basal unit of cobble-boulder conglomerate contains a large proportion of porphyritic, intermediate-composition lava or hypabyssal intrusive clasts and lesser amounts of Paleozoic and Precambrian clasts; several such beds totalling 330 m (238 ft) or more are present in adjacent areas, but only the basal few meters are exposed in the Caballo or Apache Gap quadrangles.

03-18-00-00-00—Unit—Tppl—Palm Park Formation—The rest of the formation consists of tuffaceous, purple, gray, green, and red volcanic mudstone, sandstone, and lahar breccia, mostly intermediate in composition; fresh water algal limestone beds and travertine mounds (Tppl), as much as 30 m (98 ft) thick, are interbedded at the top of the formation; approximately 610 m (2,000 ft) thick.

03-19-00-00-00—Unit—Tls—Love Ranch Formation—Reddish-brown to reddish-gray cobble-boulder conglomerate, conglomeratic sandstone, arkosic sandstone, siltstone, and mudstone. Conglomerate includes Paleozoic carbonate, Precambrian granite, and intermediate-composition porphyritic rocks of Late Cretaceous age. Discontinuous fresh water limestone beds, as much as 15 m (50 ft) thickness in the map area is approximately 152 m (500 ft), except in the Red Hills area where the formation fills a deep Laramide paleocanyon and is approximately 550 m (1, 804 ft) thick.

03-20-00-00-00—Unit—K—Undifferentiated Kcl, Kg, Kdc, Kt, Km, Kd, —Undifferentiated Kcl, Kg, Kdc, Kt, Km, Kd,

03-21-00-00-00—Unit—Kcl—Crevasse Canyon Formation, lower member—Exposed only in adjacent quadrangles but is shown on cross sections; interbedded nonmarine, gray to tan fluvial sandstone, olive-brown crevasse splay sandstone, and brown to olive-brown overbank mudstone and fine sandstone; contains large (>1 m (>3 ft)) calcareous, iron-rich concretions; approximately 305 m (1,000 ft) thick.

03-22-00-00-00—Unit—Kdc—D Cross Tongue of Mancos Shale—Dark-gray, fissile marine shale with thin interbeds of fossiliferous sandstone and siltstone; 20 m (66 ft) thick.

03-23-00-00-00—Unit—Kg—Gallup Sanstone—Massive to crossbedded, cream to gray marine sandstone and minor marine shale, gradational downward into D-Cross Tongue of Mancos; approximately 33 m (109 ft) thick

03-23-00-00-00—Unit—Kt—Tres Hermanos Formation—Brown, fossiliferous, burrowed marine sandstone of the upper Fite Ranch Member overlies fluvial brown sandstone and olive-green mudstone of the Carthage Member and brown and greenish-brown, fossiliferous, burrowed marine sandstone of the lower Atarque Member. Total thickness is approximately 100-106 m (328-348 ft).

03-24-00-00-00—Unit—Km—Mancos Shale —Thin-bedded to fissile, fine siltstone and shale with at least 5 ash beds, each 6-12 cm (2.5 inches) thick; approximately 120 m (394 ft) thick.

03-25-00-00-00—Unit—Kd—Dakota Sandstone—Upper marine shale and marine, crossbedded quartzose sandstone overlies lower yellow-brown, crossbedded fluvial, quartzose sandstone. Upper unit grades into overlying Mancos Shale. Thickness ranges from 2 to 44 m (7 to 144 ft) because of relief on the unconformity at the base of the formation

03-26-00-00-00—Unit—Pzu—Upper Yeso Formation —Upper sandstone-dolomite member consists of approximately 100 m (328 ft) consists of interbedded gray limestone, dolomite, and yellow sandstone with local lenses of gypsum. Lower limestone member consists of approximately 26 m (85 ft) of medium-bedded, fossiliferous, gray limestone with minor interbeds of yellow sandstone or siltstone.

03-27-00-00-00—Unit —Pzl—Lower Yeso Formation—Upper red siltstone-dolomite member, approximately 195 m (640 ft) thick, includes three tin (<20 m (<65 ft)) limestone/dolomite units within a sequence of massive gypsum and red siltstone and sandstone beds. Basal Meseta Blanca Member consists of approximately 72 m (236 ft) of poorly exposed, brick-red sandstone and siltstone.

03-28-00-00-00—Unit—Pa—Abo Formation—Red fluvial sandstone and siltstone interbedded with grayish-red to red overbank shale; approximately 305 m (1,000 ft) thick.

03-29-00-00-00—Unit—Ᵽ—Undifferentiated IPh, IPv—Undifferentiated IPh, IPv

03-30-00-00-00—Unit—IPh—Magdalena Group, Bar B Formation—Upper 100 m (328 ft) is correlative with Burnum Formation and consists of interbedded red to maroon sandstone and shale, limestone beds. Interbedded gray- to brown-weathering, fossiliferous marine limestone, micrite, and prominent gray shale compose lower 180 m (590 ft). Bar B Formation thickens southward from approximately 281 m (920 ft) in Apache Gap quadrangle to 433 m (1,345 ft) in Alvino quadrangle.

03-31-00-00-00—Unit—IPv—Magdalena Group, Nakaye Formation—Thick-bedded, cliff- or ledge-forming, gray limestone including many cherty, fossiliferous, and burrowed beds. Green, red, and gray shale beds, generally <2 m (<6.3 ft) thick, are interbedded; approximately 200 m (656 ft) thick.

03-32-00-00-00—Unit—IPv—Magdalena Group, Red House Formation—Interbedded gray marine shale, discontinuous brown, channel-shaped sheets, and thin to medium beds of fossiliferous limestone, some of which contain abundant black chert; thickness ranges from 35 m (115 ft) to approximately 86 m (282 ft).

03-33-00-00-00—Unit—Dp—Percha Shale—Greenish-gray to black, micaceous shale containing a few thin limestone beds in middle part; generally approximately 46 m (150 ft) thick but was removed by pre-Pennsylvanian erosion across much of the Red hills area and from Burbank Canyon northward.

03-34-00-00-00—Unit—Sf—Fusselman Dolomite—Brown, cherty dolomite in thick to medium beds, sandy at base; generally 26 - 30 m (85 - 98 ft) thick in southern part but thins to zero northward as a result of pre-Percha and pre-Pennsylvanian erosion

03-35-00-00-00—Unit—Ꞓm—Montoya Dolomite—Formation is capped by 43 m (141 ft) of light- to medium-gray, medium-bedded Cutler Dolomite Member followed, in decending order, by 46 m (151 ft) of very cherty, light- to dark-gray, fine- to medium-grained Alamito Dolomite Member; 21 m (69 ft) of massive, dark-gray, coarse-grained Upham Dolomite Member; and approximately 8 m (26 ft) of basal tan to brown, coarse-grained Cable Canyon Sandstone Member. Total thickness is approximately 119 m (390 ft), but formation is locally thin or missing due to pre-Pennsylvanian

03-36-00-00-00—Unit—Ꞓe—El Paso Formation—Upper McKelligon Canyon Member is 54 m (177 ft) thick and is largely light colored, fine-grained dolomite. Medial Jose Member, approximately 91 m (298 ft) of medium-bedded, burrowed, mottled limestone, sandy at the base. Total thickness is approximately 152 m (498 ft) thins northward.

03-37-00-00-00—Unit—Ꞓb—Bliss Formation—Brown to nearly black, hematitic to glauconitic, arkosic sandstone avg gray orthoquartzite; dark-brown to greenish-brown siltstone, dolomite, limestone, and shale; and minor dark-maroon, oolitic, ironstone; approximately 35 m (115 ft) thick.

03-38-00-00-00—Unit—ᵽ—Caballo granite—Red, coarse- to fine-grained microcline granite containing widely scattered and small red syenite (pCs) plutons

03-39-00-00-00—Unit—ᵽga—Caballo granite, pegmatite facies—White to light-gray pegmatite at northern margin of Caballo granite; grades into main body of Caballo granite. Pegmatites are in from of semi-concordant sheets, as well as discordant, irregular bodies, both of which complexly intrude amphibolite and other metamorphic wall rock ofthe batholith.

03-40-00-00-00—Unit—ᵽ—Northern granite—Heterogeneous assemblage of 1) pink to gray, coarse-grained granite; 2) gray, coarse-grained, porphyritic granite or granodiorite that may be Longbottom granodiorite; 3) brown, massive, granite granite with thin lenticular schistose zones; 4) small (100-300 m [328 ft - 984 ft]) bodies of red granite; 5) numerous small (<1 m [<3 ft]) to large (>100 m [328 ft]) xenoliths and/or irregular septa (?) of amphibolite with lesser gneiss and schist. Unit is primarily granite and granite gneiss, apparently with mutually gradational contacts. Amphibolite, schist, and gneiss have sharp crosscutting contacts with enclosing granitic rocks. None of the units were mapped in detail.

03-41-00-00-00—Unit—ᵽd—Granite dikes—Pink to light-brown, medium-grained granite dikes as much as 15 m (50 ft) wide that trend north-northwest; cut metamorphic rocks as well as Longbottom granodiorite.

03-42-00-00-00—Unit—ᵽg—Longbottom granodiorite—Medium- to dark-gray, coarse-grained granodiorite containing plagioclase and conspicuous phenocrysts of microcline and plagioclase as much as 3 cm (1.5 inches) long. Contains many angular xenoliths of metamorphic rocks to locally flow foliated at the margins , and has complexly intruded metamorphic foliation in wall rock.

03-43-00-00-00—Unit—ᵽd—Diorite—Dark- to medium- grained diorite or gabbro in small bodies adjacent to Longbottom granodiorite and at the deepest levels of exposure of the "northern granite".

03-44-00-00-00—Unit—ᵽs—Syenite—Small bodies of red, coarse grained syenite mapped north of Longbottom Canyon. Other similar but unmapped plutons in the Caballo granite, especially in the Red Hills, may be of late Cambrian age.

03-45-00-00-00—Unit—ᵽs—Metamorphic rocks—Interlayered amphibolite schist and gneiss, biotite schist, quartz-feldspar-mica schist, and brown quartz-feldspar gneiss; strongly foliated and nechitally folded; complexly intruded by marginal pegmatites of Caballo granite, as well as by Longbottom granodiorite.

03-46-00-00-00—Unit—ᵽa—Amphibolite—Black amphibolite schist and gneiss, biotite schist; forms many conspicuous lenses at least some of which are boudins, as well as thick to thin, somewhat continuous layers within the metamorphic sequence between Burbank and Longbottom Canyons; weakly to strongly foliated; contains local lenses and pods of both concordant and discordant quartz.

03-47-00-00-00—Unit—ᵽgn—Brown gneiss—Brown- to tan- to reddish-brown-weathering quartz-feldspar-biotite containing minor amounts of interlayered pelitic schist and amphibolite; distinct coarse-grained, foliated texture.

03-48-00-00-00—Unit—ᵽgrd—Red felsic gneiss—Brick-red,fine-to medium-grained gneiss with indistinct, thin, laminae-like foliation.

03-49-00-00-00—Unit—pCagn—Amphibolite and browngneiss, undifferentiated—Amphibolite and browngneiss, undifferentiated

Explanation of Map Symbols

<all other values>

01.01.01 — —Contact—Identity and existence certain, location accurate

01.01.03 — —Contact—Identity and existence certain, location approximate

01.01.07 — —Contact—Identity and existence certain, location concealed

02.01.01 — —Fault—Identity and existence certain, location accurate

02.01.03 — —Fault—Identity and existence certain, location approximate

02.01.07 — —Fault—Identity and existence certain, location concealed

02.02.01 — —Normal fault—Identity and existence certain, location accurate

02.02.03 — —Normal fault—Identity and existence certain, location approximate

02.02.07 — —Normal fault—Identity and existence certain, location concealed

<all other values>

02.11.09 — —Inferred fault (2nd option)

06.02 — —Inclined bedding

06.33 — —Approximate orientation of inclined bedding

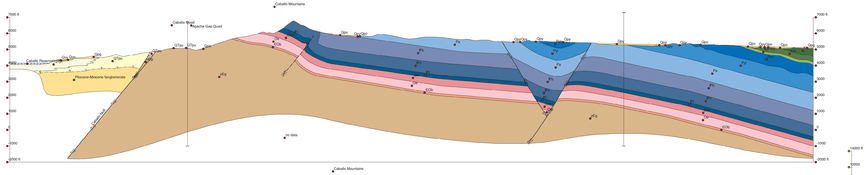
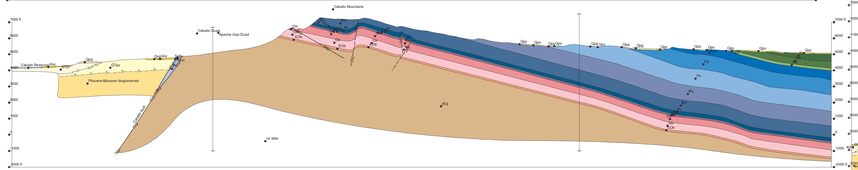
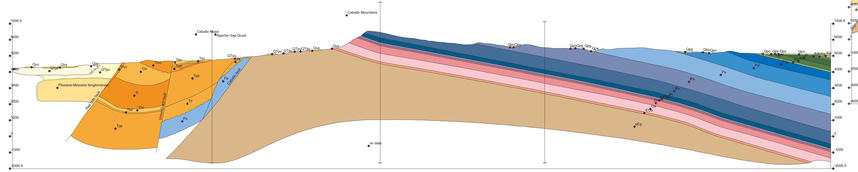
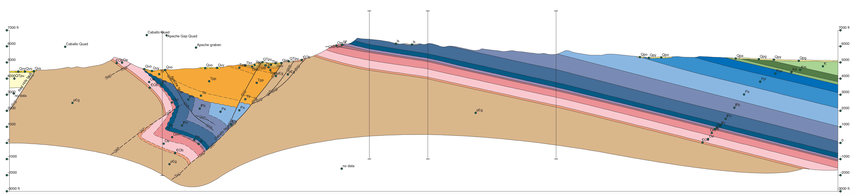
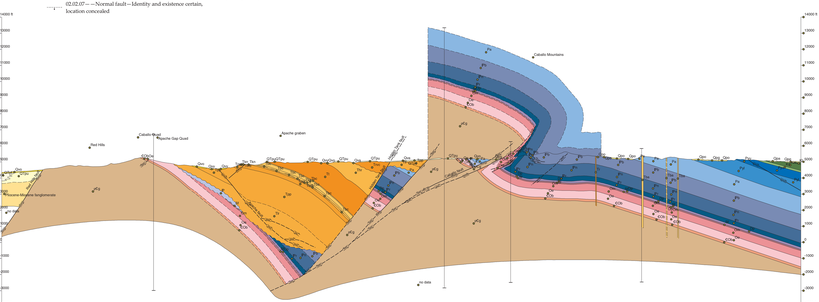
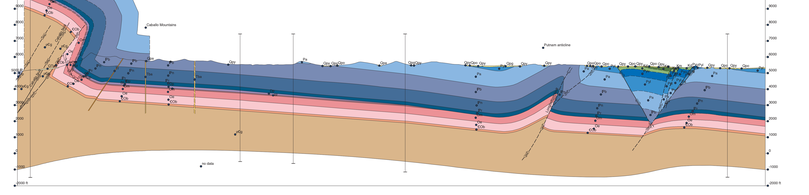
08.01.02 — —Inclined metamorphic foliation

08.03.03 — —Vertical metamorphic foliation

08.03.04 — —Inclined (dip direction to right) metamorphic foliation, for multiple observations at one locality

09.003 — —Inclined generic (origin or type not known or not specified) lineation or linear structure (1st option)

GeologicLines

<all other values>

31.10, Cross section line