



# **Geologic map of the Carrizozo East** quadrangle, Lincoln County, New Mexico

### June 2010

**Daniel Koning<sup>1</sup>** and Kirt Kempter <sup>1</sup> New Mexico Bureau of Geology and Mineral Resources, 801 Leroy Place, Socorro, NM 87801 <sup>2</sup> 2623 Via Caballero del Norte, Santa Fe, NM 87505

### 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 geologic quadrangle map may be based on any of the following: reconnaissance field geologic mapping, compilation of published and unpublished work, and photogeologic interpretation.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 contact onto a topographic base map; therefore, the accuracy of contact locations depends on the scale of mapping and the interpretation of the geologist(s). Any enlargement of this map could cause misunderstanding in the detail of mapping and may result in erroneous interpretations. Site-specific conditions should be verified by detailed surface mapping or subsurface exploration. Topographic and cultural changes associated with recent development may not be shown. 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 as an aid to understanding the general geologic framework of the map area, and not be the sole source of information for use in locating or designing wells, buildings, roads, or other man-made structures. The map has not been reviewed according to New Mexico Bureau of Geology and Mineral Resources standards. The contents of the report and map should not be considered final and complete until

reviewed and published by the New Mexico Bureau of Geology and Mineral Resources. The views and conclusions contained in this document are those of the authors and should not be interpreted as necessarily representing the official policies, either expressed or implied, of the State of New Mexico, or the U.S. Government.

<ul> <li>Grain size follow the Udder Wentworth scale for clastic sediments?</li> <li>The term 'clastic' infers to the Numeral 301 Color Charts Numeral 1(1991), additeding (1992). Stages of peoplemic calcium sented in the accompanying report. The report also presents at (1991) and bindening (1992). Stages of peoplemic calcium sented in the accompanying report. The report also presents with a scale work of the scale of the s</li></ul>		project only cover the western 50-65% of the quadrangle. Aer the map deadline. Consequently, Quaternary mapping of the tions prohibited field-checking in the extreme southeast corne
<ul> <li>SHEETELOOD AND EOLIAN DEPOSITS</li> <li>Note: These two deposits are grouped together because most colar up anted volume for fines). Color of light yellowish forown to ye Locally at dept, color changes to brownish yellow (107.66) able medium-upper to very coarse upper said and very fine Grains are submanued at evaluanguitar, moderalely to modera guitar. Upper 0.5-10.0 dn is loose below, sediment is harder a guitar. Upper 0.5-10.0 dn is loose below, sediment is harder a guitar. Upper 0.5-10.0 dn is loose below, sediment is harder a guitar. Upper 0.5-10.0 dn is loose below, sediment is harder a guitar. Upper 0.5-10.0 dn is loose below, sediment is harder a guitar. Upper 0.5-10.0 dn is loose below, sediment is harder a guitar. Untell Sand in due besits overlying Callup Sandstone thick.</li> <li>Caer (Ages Sheetflood and colina deposits overlying below (15.01.74) and the sediment of the sediment is pleased. Science of the sediment is pleased and science of the sediment is pleased. Science of the sediment is pleased and science of the sediment is pleased. Science of the sediment is placed and science of the sediment</li></ul>	Grain s	izes follow the Udden-Wentworth scale for clastic sediments (U The term "clast(s)" refers to the grain size fraction greater than parison of dry samples to the Munsell Soil Color Charts (Munse al. (1991), and Birkeland (1999). Stages of pedogenic calcium of sented in the accompanying report. The report also presents i
<ul> <li>Sheetflood and eolian deposits (uppermost Pleistocene to up mated volume for fines). Color of light yellowith brown to yellow class of the second of the second seco</li></ul>	SHEETF	LOOD AND EOLIAN DEPOSITS
<ul> <li>Qser/Kgs Sheetflood and eolian deposits overlying Gallup Sandstone thick.</li> <li>Qser/Gao Sheetflood and eolian deposits overlying older alluvium – Gser/Gsep Sheetflood and eolian deposits overlying Carrizo Peak lan erafly less than 1 m-thick.</li> <li>Qeer Coppice dunes on a sand ramp (upper Holocene) – Coppicit to brownish yellow (7.5-1078 &amp;/d) to very pale brown (1017 7 lar, well-sorted, and composed of quarz, –5% ledspar, and 5</li> <li>DEBRIS FLOW AND HILLSLOPE DEPOSITS</li> <li>Qdet Debris flow deposits, colluvium, and talus (upper Pleistocene dayew; bly and matrix, carvel are angular to subrounded, to subrounded, than carbale and/or Baster Mountain melatarchy to subrounded. Shale clasts are angular. Matrix is light yellow Medium. to very coarse-grained sand is comprised of angular, grains of Mancos Shale, and minor fledspar. 1-15(7) m-thick.</li> <li>Qlat Landslide deposits on slopes of Carrizo Peak (lower to middle in a sandy matrix. No intact bedding. No exposure. Up to 20 m grained matrix. No intact bedding. No exposure. Up to 20 m ALLUVIAL DEPOSITS</li> <li>Quit Lei andidice remants west of faxet Mountain (upper Pleistocene campoeab drolpeous syenite-trachyte fragments with – Swg OTIS Outler landidice remants west of faxet Mountain (upper Pleistocene sy endower low or (25 y 27.3). Sediment becomes r 10% fines (estimated volume) but ranging up to 40%. Typica dium- to very coarse-grained sand is generally lithic grains (ig posed of quart, fieldspar, and lithic grains. 1-16% wery thin to variable amounts of cobbles. Clasts are subrounded to subar Draw, grave clossit of fields ingenous clasts, sindstore, hourds they endower dower and lenticular. Deposit is comorphology. Minor gysum accurulation below a meter de taining minor pebbles (1-02%), this upper une shifts very into (106 fr 73 or or gle velow 25.7 v1-05% erg this and the accurate synophrophology. Jong grained matrix to an erdogegraft in the seriaboutid comorbid with series of the or syning or the syning or th</li></ul>	Note: ⊺ Qse	These two deposits are grouped together because most eolian s Sheetflood and eolian deposits (uppermost Pleistocene to upp mated volume for fines). Color of light yellowish brown to yell Locally at depth, color changes to brownish yellow (10YR 6/6). able medium-upper to very coarse-upper sand and very fine to Grains are subrounded to subangular, moderately to moderate gular. Upper 0.5-1.0 dm is loose; below, sediment is harder an base of tall slopes there may be Unit appears to have somewh erally < 1 m-tall. Sand in dunes is very pale brown (10YR 7/4), 1 feldsar, and 8% lithics and mafics. Unit grades laterally into un steep slopes.
<ul> <li>Gae/Qao Sheetflood and eolian deposits overlying Older alluvium – Gae/Olscp. Sheetflood and eolian deposits overlying Carrizo Peak lan erally less than 1 m-thick.</li> <li>Ger Cappice dures on a sand ramp (upper Holocene) – Coppic to brown fURF MC 6/01 very pale brown fURF 1017 to response of quartz, –5% feldspar, and 5</li> <li>DEBRIS FLOW AND HILLSLOPE DEPOSITS</li> <li>Qdct Debris flow deposits, colluvium, and talus (upper Pleistocene clayey-silty sand matrix, Gravel are angular to subrounded; to very coarse-grained sand that isports of adapting grains of Mancos Shale and/or Baxter Mountain melaratoly to subrounded. Shale clasts are uplar, Matrix is light yellow Medium to very coarse grained sand is compressed of angular grains of Mancos Shale and minor flexpar. 1-15(7) m-thick.</li> <li>Clast Landslide deposits on slopes of Garrizo Peak (lower to middle in a sand matrix. Clasts are well-graded sand storout (orgc response) of igneous syenite trachyte fragments with -5% composed of igneous syenite trachyte fragments with response to the pof adjoining. A opensure. Up to 20 m RLUUVIAL DEPOSITS</li> <li>Qutile landslide remnants west of Baxter Mountain (upper Pli) grained matrix. No intact bedding. No exposure. Up to 20 m runs below the pof adjoining. A opensure is a relatively with the pof adjoining. A opensure is a subrounded intest in a sind etarget in a sind in a sind etarget in a sind etarget in a sind</li></ul>	Qse/Kg	s Sheetflood and eolian deposits overlying Gallup Sandstone thick.
<ul> <li>Qsc/Olscp Sheetflood and eolian deposits overlying Carrizo Peak lan erally less than 1 m-thick.</li> <li>Qeer Coppice dunes on a sand ramp (upper Holocene) – Coppice to brownish yellow (7.5-10YR 6/6) to very pale brown (10YR 7 lar, well-sorted, and composed of quartz, ~5% feldspar, and 5</li> <li>DEBRIS FLOW AND HILLSLOPE DEPOSITS</li> <li>Qdct Debris flow deposits, colluvium, and talus (upper Pleistocene clayey-silly sand matrix. Gravel are angular to subroundet; jot to very coarse-grained sand that isporty sorted and subangul Qisbm Landslide deposit on slopes of Baxter Mountain (middle to la cobbles of Mancos Shale and/matrix Matrix is light yello. Medium- to very coarse-grained sand is comprised of angula grains of Mancos Shale and/matrix. Matrix is light yello. Medium- to very coarse-grained sand store mitted of magnating and into feldspar. 1-15(2) m-thick.</li> <li>Olst Landslide deposits on slopes of Carrizo Peak (lower to middle in a sandy matrix. Clasts are well-graded, subrounded (most yellow, dayey-silly very fine-grained sandstone (from Crews: composed of gineous symelite-trachyte fragments with -5% sc (2015)</li> <li>Outlier landslide remnants west of Baxter Mountain (upper Pligrained matrix. No intact bedding. No exposure. Up to 20 m distribution (12,15,15/2), Softman Discovers in brown, drave silly very fine-grained sand is greenably thic grains. 1-0%, wery thin to very coarse-grained sand is greenably thic grains. 10% wery thin to very coarse-grained sand is greenably thic grains. 1-0%, wery faint to yery faint day: the very faint day: the sandy sing yearde (valy, with in to medium and lenticular. Deposit is commonly gyptife reations, divis, and the sandy on a the very carse-grained sand is greenably thing transe to poly for the very faint day: the</li></ul>	Qse/Qa	to Sheetflood and eolian deposits overlying older alluvium $$ – S
<ul> <li>Vesti Copper University and Substantian S</li></ul>	Qse/Ql	scp Sheetflood and eolian deposits overlying Carrizo Peak land erally less than 1 m-thick.
<ul> <li>DEBRIS FLOW AND HILLSLOPE DEPOSITS</li> <li>Qdct Debris flow deposits, colluvium, and talus (upper Pleistocene clayey-sitty sand matrix. Gravel are angular to subrounded; git to very coarse-grained sand that tisporty sorted and subangul Qlsbm Landslide deposit on slopes of Baxter Mountain (middle to la subrounded. Shale and/or Baxter Mountain melatrachy to subrounded. Shale and minor feldspar. 1-15(7) m-thick.</li> <li>Qlst Landslides on slopes capped by trachyte sills (upper Pleistocene capped by fractured: transported trachyte sill. 2-10(7) m-thick.</li> <li>Qlst Landslides on slopes capped by trachyte sills (upper Pleistocene capped by fractured: transported trachyte sill. 2-10(7) m-thick.</li> <li>Qlst Landslide deposits on slopes of Carrizo Peak (lower to middle in a sandy matrix. Clasts are well-graded, subrounded (most y ellow, clayey-silly very fine-grained sandstone (from Crevas: composed of igneous syenite-trachyte fragments with -5% g</li> <li>Outlier landslide remnants west of Baxter Mountain (upper Plistocene) in grained matrix. No intact bedding. No exposure. Up to 20 m</li> <li>ALLUVIAL DEPOSITS</li> <li>Oay Younger alluvium (Holocene) - Very fine- to fine-grained sand below the top of adjoiningAa deposits and has a relatively brown to light olive brown (2.5% 5/2-3). Sediment becomes to 10% fines (estimated volume) but ranging up to 40%. Typica dium: to very coarse-grained sand is generally lithic grains (i toy state. Supported peubles. (Clast sare subrounded to subar Draw, gravel consist of felsic igneous clasts, sandstone, horn there is a sumulic solid evoloped throughout the sediment. J dry state. Jupported peubles (10-20%), this upper unit carbonate morphology) has that are slightly hard to very faint care yery faint cary with three indivium (middle to late Pleistocene) - opposit of variant grap and prince has angle and to 2007 72 (3 or light yellowidi to very lard. Except where removed by Stratigraphic relations 05-10, Pais with this toromoted in the</li></ul>	Qeci	to brownish yellow (7.5-10YR 6/6) to very pale brown (10YR 7/ lar, well-sorted, and composed of quartz, ~5% feldspar, and 5-
<ul> <li>Qdct Debris flow deposits, collwoium, and talus (upper Pleistocene cayey-vilus and matix. Grave) are angular to subrounded; to very coarse-grained sand in Batter Mountain (middle to la cobbies of Mancos Shale and/or Batter Mountain mediataby to subrounded. Shale clasts are angular. Matrix is light yellow Medium: to very coarse-grained sand is comprised of angula grains of Mancos Shale and minor feldopar. I-15107 m-thick.</li> <li>Qlst Landslide deposits on slopes of Carrizo Peak (lower to middle in a sandy matrix. Clasts are well-graded, subrounded (most yellow, clayey-silly very fine-grained sandstone (from Creass composed of igneous synite-trachyte fragments with -5% compared matrix. No intact bedding. No exposure. Up to 20 nd RLUVVAL DEPOSITS</li> <li>Quy Younger alluvium (Holocene) – Very fine- to fine-grained sand below the top of adjoining2a deposits and has a relatively w brown to light olive brown (25% 5/2-3). Sediment becomers 10% fines (stimated volume) but ranging up to 40%. Typica dium: to very coarse-grained sand is generally lithic grains (ig posed of quartz, feldspar, and lithic grains, 1-10% wery thin the variable amorto of cobles. (Gaets are subschanded to submatrix and the class and y grain and entiticular. Deposit to oney finit days morphology. Minor grasum accumulation below a meter de taining minor pebbles (20-20%, this upper unit exhibits very unit (Clast-supported pebbles and cobbles with lesser bould consolidated. Unit includes minor modern and historical allu compared parts (10% 6/27) or light yellow/s thin to medium and lenicular. Deposit is comply by strating applic relations 05-10. Minosuthas at feeters Spring after this submotra and lenic</li></ul>	DEBRIS	FLOW AND HILLSLOPE DEPOSITS
<ul> <li>Olsbm Landslide deposit on slopes of Baxter Mountain (middle to la cabbles of Mancos Shale and/or Baxter Mountain melatrachyte to subrounded. Shale clasts are angular. Matrix is light yellow Medium: to very coarse-grained sand is comprised of angula grains of Mancos Shale and ninor feldograp. 1-15(7) m-thick.</li> <li>Olst Landslides on slopes capped by trachyte sills (upper Pleistocen capped by fractured, transported trachyte sills. 210(7) m-thick</li> <li>Clandslide aposits on slopes of Carrizo Peak (lower to middle in a sandy matrix. Clast are well-graded, subrounded (most yellow, clavey-silly very fine-grained sandstone (from Creass composed of igneous synite-trachyte fragments with –5% c</li> <li>Outlier landslide remnants west of Baxter Mountain (upper Pligrained matrix. No intact bedding. No exposure. Up to 20 m 24LLUVAL DEPOSITS</li> <li>Qay Younger alluvium (Holocene) – Very fine- to fine-grained sa below the top of adjoining2ao deposits and has a relatively w brown to light of low brown (23Y 5/2-3). Sediment becomes 1 10% fines (estimated volume) but ranging up to 40%. Typica dium: to very coarse-grained sand is generally liftic grains (it posed of quartz, feldspar, and liftic grains. 1-10% very finit to very faint 20 ym orphology. Minor gypsum accumulation below a meter de taining minor pebbles (10-20%), this upper unit exhibits very unit (Clast-supported belbes and cobbles with tesser boulde consolidated. Unit includes minor modern and historical allu</li> <li>Quo Older alluvium (middle to late Pleistocene) – Deposit of vari Typically sandy gravel up and gravel substant do substant to remove dy Stratigraphic reliations 0.5-1.0 km southeast of Fetters Spring and Fetters Spring both of which are marked by Stratigraphic reliations 0.5-1.0 km southeast of there south at the gas and grave were substant to a moredeff a. An exposure of OTA texposure C.497, 1.5 – 2.0 m of sedimert underlies the suit in to cassociated with Nogal Draw. Unit Qao and Y and ywere thin to medium a</li></ul>	Qdct	Debris flow deposits, colluvium, and talus (upper Pleistocene to clayey-silty sand matrix. Gravel are angular to subrounded; gra to very coarse-grained sand that isporly sorted and subangula
<ul> <li>Qist Landslides on slopes capped by trachyte sills (upper Pleistocen capped by fractured, transported trachyte sill. 2-10(?) m-thic</li> <li>Qisto Landslide deposits on slopes of Carrizo Peak (lower to middle in a samdy matrix. Clasts are well-graded, subrounded (most yellow, claye-silty very fine-grained sandstone (from Creass composed of igneous syenite-trachyte fragments with ~5% c</li> <li>Qutlier landslide remnants west of Baxter Mountain (upper Pligrained matrix. No intact bedding. No exposure. Up to 20 m</li> <li>ALLUVIAL DEPOSITS</li> <li>Qay Younger alluvium (Holocene) – Very fine- to fine-grained sa below the top of adjoining/Jao deposits and has a relatively w brown to light olive brown (2.5 Y 2/-3). Sediment becomes r 10% fines (estimated volume) but ranging up to 40%. Typica dium- to very coarse-grained sand is generally lithic grains (i. posed of quartz, feldspar, and lithic grains (i. 1-0% yer) thin t variable amounts of cobbles. Clasts are subrounded to subar Draw, gravel consist of felsic igneous clasts, sandstone, hornf there is a cumulic soil developed throughout the sediment. J dry state. Clay illuviation is marked by faint to very faint clay morphology. Minor gypsum accumulation below a meter de taining mior pebbles (10-20%), this upper unit exhibits very unit (clast-supported pebbles and cobbles with lesser boulde consolidated. Unit includes minor modern and historical allu Qao</li> <li>Older alluvium (middle to late Pleistocene) – Deposit of vari Typically a sandy gravel near topographic highs along the a (mostly fine sand), silty-claye fine sand, silt, and clay, with 11 brown (10Y 6-7.3) or pale yellow (25 77.3) or light yellowid thin to medium- to very coarse-grained sand is composed of aclic coil horizon (tsare line to 11.4000 and pale to 11.40000 and the morphology has that are slightly hard to very hard. Except where removed by Stratigraphic relations 05-10. Km southeast of Fetters Spring after this erosion event. Weakly to moderately consolidated. zo</li></ul>	Qlsbm	Landslide deposit on slopes of Baxter Mountain (middle to late cobbles of Mancos Shale and/or Baxter Mountain melatrachyte to subrounded. Shale clasts are angular. Matrix is light yellow Medium- to very coarse-grained sand is comprised of angular grains of Mancos Shale, and minor feldspar. 1-15(?) m-thick.
<ul> <li>Qisçp Landsilde deposits on slopes of Carrizo Peak (lower to middle in a sandy matrix. Clasts are well-graded, subrounded (most yellow, clayey-silty very fine-grained sandstone (from Crevas: composed of igneous syenite-trachyte fragments with ~5% cg</li> <li>Qutlier landslide remnants west of Baxter Mountain (upper PI) grained matrix. No intact bedding. No exposure. Up to 20 m</li> <li>ALLUVIAL DEPOSITS</li> <li>Qay Younger alluvium (Holocene) – Very fine- to fine-grained sa below the top of adjoiningAo deposits and has a relatively w brown to light olive brown (2.57 5/2-3). Sediment becomes r 10% fines (estimated volume) but ranging up to 40%. Typica (dium- to very coarse-grained sand is generally lithic grains (dium- to very coarse-grained sand is generally lithic grains (dium- to very coarse-grained sand is generally lithic grains (dium- to very coarse-grained sand is generally lithic grains (dium- to very coarse-grained sand is generally lithic grains (dium- to very coarse-grained sand is generally lithic grains (dium- to very coarse-grained sand is optimal division a meter de taining minor pebbles (10-20%), this upper unit exhibits very unit (Clast-supported pebbles and cobbles with lesser boulde consolidated. Unit includes minor modern and historical allu Qao</li> <li>Older alluvium (middle to late Pleistocene) – Deposit of vari Typically a sandy gravel neticular. Deposit is commonly gypsift from sont, silty neticular species discomenol y gypsift from sorted. Medium- to very coarse-grained sand is composed of calcic soil horizon (stage Ih- to III carbonate morphology) has that are slightly hard to very hard. Except where removed by Stratigraphic relations 05-10. Im southeast of Fletters Spring after this erosion event. Weakly to moderately consolidated. Zozo spring and Fetters spring-both of which are marked by Stratigraphic relations 05-10. Im southeast of the very lard. Except where removed by Stratigraphic relations 05-10. Im southeast of the very dard. Except where removed</li></ul>	Qlst L	andslides on slopes capped by trachyte sills (upper Pleistocene capped by fractured, transported trachyte sill. 2-10(?) m-thick.
<ul> <li>QTIS Outlier landslide remaints west of Baxter Mountain (upper PI grained matrix. No intact bedding. No exposure. Up to 20 m state of the second state of the</li></ul>	Qlscp	Landslide deposits on slopes of Carrizo Peak (lower to middle F in a sandy matrix. Clasts are well-graded, subrounded (mostly yellow, clayey-silty very fine-grained sandstone (from Crevasse composed of igneous syenite-trachyte fragments with ~5% gy
<ul> <li>ALLUVIAL DEPOSITS</li> <li>Qay Younger alluvium (Holocene) – Very fine- to fine-grained sa below the top of adjoining/ao deposits and has a relatively w brown to light olive brown (2.5Y 5/2-3). Sediment becomes r 10% fines (estimated volume) but ranging up to 40%. Typica dium- to very coarse-grained sand is generally lithic grains (i posed of quart, feldspar, and lithic grains. 11-0% very thin to very faint to very faint day morphology. Minor gypsum accumulation below a meter day taining minor pebbles (10-20%), this upper unit exhibits very unit (clast-supported pebbles and cobbles with lesser boulde consolidated. Unit includes minor modern and historical allu Gao Older alluvium (middle to late Pleistocene) – Deposit of vari Typically a sandy gravel near topographic highs along the ea (mostly fine sand, slit, and lenicular. Deposit is commonly gypsife composed of various igneous clasts, with sandstone and hor sorted. Medium- to very coarse-grained sand is composed of calcic soil horizon (13ge 1H+ fo III carbonate morphology) has that are slightly hard to very hard. Except where removed by Stratigraphic relations 05-10. Km southeast of Fetters Spring after this erosion event. Weakly to moderately consolidated. 2020 spring and Fetters spring- both of which are marked by</li> <li>Unit Qao underlies a geomorphic surface that is 1-10 m lower than th Qao may be equivalent to an erodeQTa. A nexposure 0 dTA texposure C-361. Because of this uncit in the cassociated with Nogal Draw. Unit Qao-QTa is about 30 mth data suggest a bedrock high near the north part of tovQao-QTa (Combined unit of Qao and QTa (upper Pliocene to combined unit is used in cross-section AV. Three wells and a subout30 motion data suggest a bedrock high near the north part of tovQao-QTa (active) appla Draw. Unit Qao-QTa is about 30 mth data suggest a bedrock high near the north part of tovQao-QTa (active) appla Draw. Unit Qao-QTa is about 30 mth data suggest a bedrock high near the north part of tovQao-QTa (active) appla Draw. Unit Qao-QTa is</li></ul>	QTIs	Outlier landslide remnants west of Baxter Mountain (upper Plio grained matrix. No intact bedding. No exposure. Up to 20 m-
<ul> <li>Qay Younger alluvium (Holocene) – Very fine- to fine-grained sa below the top of adjoiningao deposits and has a relatively w brown to light olive brown (2.5Y 5/2-3). Sediment becomes r 10% fines (estimated volume) but ranging up to 40%. Typical fines (estimated volume) but ranging up to 40%. Typical posed of quartz, feldspar, and lithic grains. 1-10% very thin to variable amounts of cobbles. Clasts are subrounded to subar Draw, gravel consist of felsic igneous clasts, sandstone, hornf there is a cumulic soil developed throughout the sediment. 1 dry state. Clay illuviation is marked by faint to very faint clay morphology. Minor grypsum accumulation below a meter de taining minor pebbles (10-20%), this upper unit exhibits very unit (clast-supported pebbles and cobbles with lesser bould consolidated. Unit includes minor modern and historical allu Qao</li> <li>Older alluvium (middle to late Pleistocene) – Deposit of vari Typically a sandy gravel near topographic highs along the ea (mostly fine sand), silty-clayery fine sand, silt, and clay, with 1-brown (10% 6-7/3) or pale yellow (2.5Y 7/3) or 11ght yellowish thin to medium and lenticular. Deposit is commonly grypsife composed of various igneous class, with sandstone and hor sorted. Medium- to very coarse-grained sand is composed or calcic soil horizon (stage li+ to ill carbonate morphology) has that are slightly hant to very hard. Except where removed by Stratigraphic relations 0.5-1.0 km southeast of Fetters Spring after this erosion event. Weakly to moderately consolidated. Zozo spring and Fetters spring- both of which are marked by</li> <li>Qao underlies a geomorphic surface that is 1-10 m lower thant 1 Qao may be equivalent to an erode@Ta . An exposure of QT. At exposure C-397. 1.5 – 2.0 m of sediment underlies the surg to the ostimate the base of this unit in the cassociated with Nogal Draw. Unit Qao-QTa is about 30 m-thi data suggest a bedrock high near the north part of towQaO-QTa Combined unit of Qao and QTa (upper Pliocene to combany)</li></ul>	ALLUVI	AL DEPOSITS
<ul> <li>Qao Older alluvium (middle to late Pleistocene) – Deposit of vari Typically a sandy gravel near topographic highs along the ea (mostly fine sand), slity-clayey fine sand, silt, and clay, with 1 brown (10YR 6-73) or pale yellow (2.5Y 7/3) or light yellowisi thin to medium and lenticular. Deposit is commonly gypsifer composed of various igneous clasts, with sandstone and horn sorted. Medium- to very coarse-grained sand is composed of calcic soil horizon (stage II+ to III carbonate morphology) has that are slightly hard to very hard. Except where removed by Stratigraphic relations 0.5-1.0 km southeast of Fetters Spring after this erosion event. Weakly to moderately consolidated. zozo spring and Fetters spring- both of which are marked by</li> <li>Unit Qao underlies a geomorphic surface that is 1-10 m lower than th Qao may be equivalent to an erode@Ta . An exposure of QT At exposure C-361. Because of this uncertainty, we do not kn exposure C-361. Because of this uncertainty, we do not kn data suggest a bedrock high near the north part of tow@a(o-QTa Combined unit of Qao and QTa (upper Pliocene to combined unit is used in cross-section A4'. Three wells and a company) were used to estimate the base of this unit in the cassociated with Nogal Draw. Unit Qao-QTa is about 30 m-th data suggest a bedrock high near the north part of tow@a(o-QTa Alluvium underlying high-level surfaces in the northeastern q poorly to non-bedded; generally interpreted as debris flow d maximum observed boulder length is about 2 m. Sand is ligh grained, angular to subangular (mostly) to subrounded, and ptrachyte-syenite grains, quartz, and feldspar.</li> <li>Along White Oaks Canyon, lower 2-3 m of deposit is mostly imbricate Gravel consists of well-graded pebbles-boulders of diverse lit (mostly felsic), hornfels, and sandstone. Sand is light gray to cludes a well-graded mixture of quarta, feldspar, and lithic gr.</li> <li>Ta High-level gravel in northwest corner of quadrangle (Pliocene to subangular and poorly sorted. Gr</li></ul>		brown to light olive brown (2.5Y 5/2-3). Sediment becomes re 10% fines (estimated volume) but ranging up to 40%. Typicall dium- to very coarse-grained sand is generally lithic grains (igr posed of quartz, feldspar, and lithic grains. 1-10% very thin to variable amounts of cobbles. Clasts are subrounded to subarg Draw, gravel consist of felsic igneous clasts, sandstone, hornfe there is a cumulic soil developed throughout the sediment. Pe dry state. Clay illuviation is marked by faint to very faint clay fi morphology. Minor gypsum accumulation below a meter dep taining minor pebbles (10-20%), this upper unit exhibits very t unit (clast-supported pebbles and cobbles with lesser boulder consolidated. Unit includes minor modern and historical alluw
<ul> <li>Unit Qao underlies a geomorphic surface that is 1-10 m lower than the Qao may be equivalent to an erode@Ta . An exposure of QT. At exposure C-497, 1.5 – 2.0 m of sediment underlies the surfat exposure C-361. Because of this uncertainty, we do not kn</li> <li>Qao-QTa Combined unit of Qao and QTa (upper Pliocene to combined unit is used in cross-section AA'. Three wells and a company) were used to estimate the base of this unit in the coassociated with Nogal Draw. Unit Qao-QTa is about 30 m-th data suggest a bedrock high near the north part of tow@do-QTa Alluvium underlying high-level surfaces in the northeastern q poorly to non-bedded; generally interpreted as debris flow di maximum observed boulder length is about 2 m. Sand is ligh grained, angular to subangular (mostly) to subrounded, and I trachyte-syenite grains, quartz, and feldspar.</li> <li>Along White Oaks Canyon, lower 2-3 m of deposit is mostly imbricate Gravel consists of well-graded pebbles-boulders of diverse lift (mostly felsic), hornfels, and sandstone. Sand is light gray to cludes a well-graded mixture of quartz, feldspar, and liftic gr.</li> <li>Ta High-level gravel in northwest corner of quadrangle (Pliocene to subangular and poorly sorted. Gravel are composed of tra clasts have thick calcium carbonate coats and there is eviden to subangular and poorly sorted. Gravel are insorted appears i grees of hydrothermal alteration occurred in this rock on the This fluid flow likely occurred shortly after the emplacement of are associated with this unit.</li> <li>Tibmt Baxter Mountain melatrachyte (upper(?) Oligocene) – Ligh blage includes: 7-13% mafic minerals, 0.2-6.0 mm long and eir erals are mostly augite and horblende, with minor and varia solved, leaving casts. Groundmass is 0.1-0.2 mm in size and cordinate and boordly to euhedral. Mafic minerals min length. Groundmass is 0.1 (mostly) to 0.5 mm and cordinate of hornblende or potassium feldspar are present (up to 30 m.this length. Groundmass is 0.1 (mostly) to 0.5 mm and cordinate of hornbl</li></ul>	Qao	Older alluvium (middle to late Pleistocene) – Deposit of varia Typically a sandy gravel near topographic highs along the east (mostly fine sand), slity-clayey fine sand, silt, and clay, with 1-5 brown (10YR 6-7/3) or pale yellow (2.5Y 7/3) or light yellowish thin to medium and lenticular. Deposit is commonly gypsifer composed of various igneous clasts, with sandstone and horn sorted. Medium- to very coarse-grained sand is composed of I calcic soil horizon (stage II+ to III carbonate morphology) has f that are slightly hard to very hard. Except where removed by e Stratigraphic relations 0.5-1.0 km southeast of Fetters Spring i after this erosion event. Weakly to moderately consolidated. S zozo spring and Fetters spring- both of which are marked by re
<ul> <li>Qao-QTa Combined unit of Qao and QTa (upper Pliocene to combined unit is used in cross-section AA'. Three wells and a company) were used to estimate the base of this unit in the c associated with Nogal Draw. Unit Qao-QTa is about 30 m-th data suggest a bedrock high near the north part of towQa(o-QTa Alluvium underlying high-level surfaces in the northeastern q poorly to non-bedded; generally interpreted as debris flow d maximum observed boulder length is about 2 m. Sand is ligh grained, angular to subangular (mostly) to subrounded, and   trachyte-syenite grains, quartz, and feldspar.</li> <li>Along White Oaks Canyon, lower 2-3 m of deposit is mostly imbricate Gravel consists of well-graded pebbles-boulders of diverse lit (mostly felsic), hornfels, and sandstone. Sand is light gray to cludes a well-graded mixture of quartz, feldspar, and lithic gr.</li> <li>Ta High-level gravel in northwest corner of quadrangle (Pliocene to subangular and poorly sorted. Gravel are composed of traclasts have thick calcium carbonate coats and there is eviden</li> <li>Igneous intrusions</li> <li>Baxter Mountain melatrachyte</li> <li>The Baxter Mountain melatrachyte is a distinctive, darker igneous roc multitude of dikes emanate south from this stock as far as Wi cross-cuts other syenite-trachyte igneous rocks and appears to grees of hydrothermal alteration occurred in this rock on the This fluid flow likely occurred shortly after the emplacement of are associated with this unit.</li> <li>Tibmt Baxter Mountain melatrachyte (upper(?) Oligocene) – Light blage includes: 7-15% mafic minerals, 0.2-6.0 mm long and ei erals are mostly augite and hornblende, with minor and varia solved, leaving casts. Groundmass is 0.1-0.2 mm in size and cor of hornblende or potassium feldspar are present (up to 30 mm of hornblende or potassium feldspar are present (up to 30 mm of hornblende or potassium feldspar are present (up to 30 mm of hornblende or potassium feldspar are present (up to 30 mm of hornblende or potassium feldspar are present).<!--</td--><td>Unit Qa</td><td>ao underlies a geomorphic surface that is 1-10 m lower than the Qao may be equivalent to an erode<math>\mathbf{Q}</math>Ta . An exposure of QTa At exposure C-497, 1.5 – 2.0 m of sediment underlies the surfa at exposure C-361. Because of this uncertainty, we do not kno</td></li></ul>	Unit Qa	ao underlies a geomorphic surface that is 1-10 m lower than the Qao may be equivalent to an erode $\mathbf{Q}$ Ta . An exposure of QTa At exposure C-497, 1.5 – 2.0 m of sediment underlies the surfa at exposure C-361. Because of this uncertainty, we do not kno
<ul> <li>QTa Alluvium underlying high-level surfaces in the northeastern q poorly to non-bedded; generally interpreted as debris flow d maximum observed boulder length is about 2 m. Sand is ligh grained, angular to subangular (mostly) to subrounded, and p trachyte-syenite grains, quartz, and feldspar.</li> <li>Along White Oaks Canyon, lower 2-3 m of deposit is mostly imbricate Gravel consists of well-graded pebbles-boulders of diverse lit (mostly felsic), hornfels, and sandstone. Sand is light gray to o cludes a well-graded mixture of quartz, feldspar, and lithic gr.</li> <li>Ta High-level gravel in northwest corner of quadrangle (Pliocene to subangular and poorly sorted. Gravel are composed of tra clasts have thick calcium carbonate coats and there is eviden</li> <li>Igneous intrusions</li> <li>Baxter Mountain melatrachyte</li> <li>The Baxter Mountain melatrachyte is a distinctive, darker igneous rock multitude of dikes emanate south from this stock as far as Wh cross-cuts other syenite-trachyte igneous rocks and appears t grees of hydrothermal alteration occurred in this rock on the This fluid flow likely occurred shortly after the emplacement of are associated with this unit.</li> <li>Tibmt Baxter Mountain melatrachyte (upper(?) Oligocene) – Light blage includes: 7-15% mafic minerals, 0.2-6.0 mm long and effect are mostly augite and hornblende, with minor and varia solved, leaving casts. Groundmass is 0.1-0.2 mm in size and composition of the symplage includes: 7-13% mafic minerals, 0.2-5.0 mm long mm-long and subhedral (mostly) to euhedral. Mafic minerals mm in length. Groundmass is 0.1 (mostly) to 0.5 mm and com of hornblende or potassium feldspar are present (up to 30 mm)</li> </ul>	Qao-Q	Ta Combined unit of Qao and QTa (upper Pliocene to u combined unit is used in cross-section AA'. Three wells and an company) were used to estimate the base of this unit in the cru associated with Nogal Draw. Unit Qao-QTa is about 30 m-thic data suggest a bedrock high near the north part of towQa(o-QT
<ul> <li>Along White Oaks Canyon, lower 2-3 m of deposit is mostly imbricate Gravel consists of well-graded pebbles-boulders of diverse lit (mostly felsic), hornfels, and sandstone. Sand is light gray to cludes a well-graded mixture of quartz, feldspar, and lithic gr</li> <li>Ta High-level gravel in northwest corner of quadrangle (Pliocene to subangular and poorly sorted. Gravel are composed of tra clasts have thick calcium carbonate coats and there is eviden</li> <li>Igneous intrusions</li> <li>Baxter Mountain melatrachyte</li> <li>The Baxter Mountain melatrachyte is a distinctive, darker igneous rock multitude of dikes emanate south from this stock as far as Wr cross-cuts other syenite-trachyte igneous rocks and appears to grees of hydrothermal alteration occurred in this rock on the This fluid flow likely occurred shortly after the emplacement of are associated with this unit.</li> <li>Tibmt Baxter Mountain melatrachyte (upper(?) Oligocene) – Light blage includes: 7-15% mafic minerals, 0.2-6.0 mm long and ei- erals are mostly augite and hornblende, with minor and varia solved, leaving casts. Groundmass is 0.1-0.2 mm in size and con- misemblage includes: 7-13% mafic minerals, 0.2-5.0 mm long mm-long and subhedral (mostly) to euhedral. Mafic minerals mm in length. Groundmass is 0.1 (mostly) to 0.5 mm and cor- of hornblende or potassium feldspar are present (up to 30 m)</li> </ul>	QTa	Alluvium underlying high-level surfaces in the northeastern qu poorly to non-bedded; generally interpreted as debris flow de maximum observed boulder length is about 2 m. Sand is light grained, angular to subangular (mostly) to subrounded, and p- trachyte-syenite grains, quartz, and feldspar.
<ul> <li>Ta High-level gravel in northwest corner of quadrangle (Pliocent to subangular and poorly sorted. Gravel are composed of tra clasts have thick calcium carbonate coats and there is eviden</li> <li>Igneous intrusions</li> <li>Baxter Mountain melatrachyte</li> <li>The Baxter Mountain melatrachyte is a distinctive, darker igneous room multitude of dikes emanate south from this stock as far as Wh cross-cuts other syenite-trachyte igneous rocks and appears to grees of hydrothermal alteration occurred in this rock on the This fluid flow likely occurred shortly after the emplacement of are associated with this unit.</li> <li>Tibmt Baxter Mountain melatrachyte (upper(?) Oligocene) – Light blage includes: 7-15% mafic minerals, 0.2-6.0 mm long and everals are mostly augite and hornblende, with minor and varia solved, leaving casts. Groundmass is 0.1-0.2 mm in size and commong and subhedral (mostly) to euhedral. Mafic minerals mm in length. Groundmass is 0.1 (mostly) to 0.5 mm and com of hornblende or potassium feldspar are present (up to 30 mm)</li> </ul>	Along	White Oaks Canyon, lower 2-3 m of deposit is mostly imbricated Gravel consists of well-graded pebbles-boulders of diverse lith (mostly felsic), hornfels, and sandstone. Sand is light gray to ve cludes a well-graded mixture of quartz, feldspar, and lithic grai
Igneous intrusions Baxter Mountain melatrachyte The Baxter Mountain melatrachyte is a distinctive, darker igneous rock multitude of dikes emanate south from this stock as far as Wh cross-cuts other syenite-trachyte igneous rocks and appears to grees of hydrothermal alteration occurred in this rock on the This fluid flow likely occurred shortly after the emplacement of are associated with this unit. Tibmt Baxter Mountain melatrachyte (upper(?) Oligocene) – Light blage includes: 7-15% mafic minerals, 0.2-6.0 mm long and eter erals are mostly augite and hornblende, with minor and varia solved, leaving casts. Groundmass is 0.1-0.2 mm in size and c TibmtdBaxter Mountain melatrachyte dike (upper(?) Oligocene) – assemblage includes: 7-13% mafic minerals, 0.2-5.0 mm long mm-long and subhedral (mostly) to euhedral. Mafic minerals mm in length. Groundmass is 0.1 (mostly) to 0.5 mm and com of hornblende or potassium feldspar are present (up to 30 mm	Та	High-level gravel in northwest corner of quadrangle (Pliocene to subangular and poorly sorted. Gravel are composed of trac clasts have thick calcium carbonate coats and there is evidence
<ul> <li>Baxter Mountain melatrachyte</li> <li>The Baxter Mountain melatrachyte is a distinctive, darker igneous rook multitude of dikes emanate south from this stock as far as Wh cross-cuts other syenite-trachyte igneous rocks and appears i grees of hydrothermal alteration occurred in this rock on the This fluid flow likely occurred shortly after the emplacement of are associated with this unit.</li> <li>Tibmt Baxter Mountain melatrachyte (upper(?) Oligocene) – Light blage includes: 7-15% mafic minerals, 0.2-6.0 mm long and ereals are mostly augite and hornblende, with minor and varia solved, leaving casts. Groundmass is 0.1-0.2 mm in size and complexes and subhedral (mostly) to euhedral. Mafic minerals mm in length. Groundmass is 0.1 (mostly) to 0.5 mm and com of hornblende or potassium feldspar are present (up to 30 mm)</li> </ul>	lgneou	s intrusions
<ul> <li>The baster Mountain melatractive is a distinctive, darker igneous for multitude of dikes emanate south from this stock as far as Wh cross-cuts other syenite-trachyte igneous rocks and appears is grees of hydrothermal alteration occurred in this rock on the This fluid flow likely occurred shortly after the emplacement are associated with this unit.</li> <li>Tibmt Baxter Mountain melatrachyte (upper(?) Oligocene) – Light blage includes: 7-15% mafic minerals, 0.2-6.0 mm long and everals are mostly augite and hornblende, with minor and varia solved, leaving casts. Groundmass is 0.1-0.2 mm in size and common distributed and subhedral (mostly) to euhedral. Mafic minerals mm in length. Groundmass is 0.1 (mostly) to 0.5 mm and com of hornblende or potassium feldspar are present (up to 30 mm).</li> </ul>	Baxter	Mountain melatrachyte
<ul> <li>Tibmt Baxter Mountain melatrachyte (upper(?) Oligocene) – Light blage includes: 7-15% mafic minerals, 0.2-6.0 mm long and ereals are mostly augite and hornblende, with minor and varia solved, leaving casts. Groundmass is 0.1-0.2 mm in size and c</li> <li>TibmtdBaxter Mountain melatrachyte dike (upper(?) Oligocene) – assemblage includes: 7-13% mafic minerals, 0.2-5.0 mm long mm-long and subhedral (mostly) to euhedral. Mafic minerals mm in length. Groundmass is 0.1 (mostly) to 0.5 mm and com of hornblende or potassium feldspar are present (up to 30 mm)</li> <li>Tibmts Baxter Mountain melatrachyte sill (upper(?) Oligocene) – S</li> </ul>	ine Ba	multitude of dikes emanate south from this stock as far as Whi cross-cuts other syenite-trachyte igneous rocks and appears to grees of hydrothermal alteration occurred in this rock on the e This fluid flow likely occurred shortly after the emplacement of are associated with this unit.
TibmtdBaxter Mountain melatrachyte dike (upper(?) Oligocene) – assemblage includes: 7-13% mafic minerals, 0.2-5.0 mm long mm-long and subhedral (mostly) to euhedral. Mafic minerals mm in length. Groundmass is 0.1 (mostly) to 0.5 mm and con of hornblende or potassium feldspar are present (up to 30 mi Tibmts Baxter Mountain melatrachyte sill (upper(?) Oligocono)	Tibmt	Baxter Mountain melatrachyte (upper(?) Oligocene) – Light blage includes: 7-15% mafic minerals, 0.2-6.0 mm long and eu erals are mostly augite and hornblende, with minor and variab solved, leaving casts. Groundmass is 0.1-0.2 mm in size and co
Tibmts Baxter Mountain melatrachyte sill (upper(?) Oligocopo)	Tibmtd	Baxter Mountain melatrachyte dike (upper(?) Oligocene) – L assemblage includes: 7-13% mafic minerals, 0.2-5.0 mm long ( mm-long and subhedral (mostly) to euhedral. Mafic minerals a mm in length. Groundmass is 0.1 (mostly) to 0.5 mm and com of hornblende or potassium feldspar are present (up to 30 mm
	Tibmts	Baxter Mountain melatrachyte sill (upper(?) Oligocene) – Sir

melatrachyte of Grainger (1974). Dikes are up to 4 m-wide. Mapped as a line only. Tbmtad; locally, some of the mafic grains are biotite. Unit correlates to melatrachyte of Grainger (1974). Andesite andesite is a less-alkalic derivative of the Baxter Mountain melatrachyte.

Grainger (1974).



### DESCRIPTION OF MAP UNITS

- We arrange map units in the Carrizozo East quadrangle into three categories: 1) Quaternary, 2) igneous intrusions, and 3) Cretaceous fluvial and marine strata. Quaternary units on this quadran- Tibap Baxter Mountain porphyritic andesite (upper Eocene?) Bluish gray, weathering to a brown varnish. Groundmass is composed of 0.2-0.5 mm plagioclase with 20-25% anhedral gle are grouped into the following three categories: 1) sheetflood and eolian deposits, 2) debris flow and hillslope deposits, and 3) alluvial deposits. raphy (White Sands Missile Range project, JanuanydaMarch of 1986). Field mapping emphasized bedrock unit thophotos were used for much of the Quaternary deposits. Aerial photographs from the White Sands Missile Range otographs that covered the eastern quadrangle (from the U.S. Forest Service) were ordered but did not arrive before Tiapd Porphyritic andesite dike (lower to upper Oligocene) – Porphyritic andesite, as described in uniTiap, but in a dike form. rn 40% of the quadrangle is of lesser quality compared t**ow<del>liste</del>ern** 60% of the quadrangle. Note that access restriche quadrangle.
  - 1914; Wentworth, 1922) and are based on field estimates. Pebbles are subdivided as shown in Compton (1985). n in diameter. Descriptions of bedding thickness folled ngram (1954). Colors of sediment are based on visual complor, 1994). Soil horizon designations and descriptive terms follow those of the Soil Survey Staff (1992), Birkeland et nate morphology follow those of Gile et al. (1966) and Birkland (1999). Discussion of a unit's age control is preretations regarding structure and geologic history.
  - t deposits have been affected to some degree by sheetflooding olocene) –Very fine-lower to medium-lower sand (mostly fine-upper sand) and silty-clayey fine sand (5-15% estibrown to dark yellowish brown (10YR 5-6/4 and 4-5/6) to pale brown (10YR 6/3) to very pale brown (10YR 7/4). coarse pebbles of sandstone and calcium carbonate (felsic igneous clasts are common in eastern half of guadrangle). ell sorted, and composed of quartz, 15-20% feldspar, and 7-15% lithic and mafic grains. Pebbles are subangular to an-
  - arked by ped development. Typically there is a pebble lag on the surface (10-20% surface coverage by pebbles). At gher amounts of feldspar and lithic grains than found ir Galleup Sandstone. Unit includes minor coppice dunes, genower to medium-lower (mostly fine-upper), subrounded to subangular, well-sorted, and composed of guartz, ~15% Titd and defining the contact between the two is difficult. Unit is less than 1 m-thick, but may be thicker at the base of etflood and eolian deposits, as described in un@se, which overlie Gallup Sandstone. Generally less than 1 mtflood and eolian deposits, as described in un@se, which overlie older alluvium. Generally less than 50 cm-thick.
  - deposits Sheetflood and eolian deposits, as described in un@se, which overlie Carrizo Peak landslides. Genes on an eolian sand ramp; dunes are up @m-tall, commonly centered around junipers. Sand color of reddish yellow and is mostly fine-upper grain size, with lesser fine-lower or medium-lower grain sizes, and subrounded to subangugray lithic grains and black mafic grains. Loose. Eolian sand ramp thickness is estimated at 1-6 m.
  - plocene) Poorly sorted and well-graded, commonly matrix-supported pebbles through boulders in a sandy or composition varies with source lithology of a given drainage. Matrix is light yellowish brown (10YR 6/4), very fineubrounded. Variable clay and silt (1-15% of sediment volume, estimated). Moderately consolidated. 1-12 m-thick
  - stocene) Cobbles and boulders (and minor pebbles) composed of quartzitic Gallup Sandstone and pebbles to matrix of disarticulated (ground-up) Mancos Shale. No beddinsandstone clasts are very poorly sorted and angular rown (2.5Y 6/3) sand with an estimated 10-15% clay. Sand is very fine- to very coarse-grained, and poorly sorted. prounded pieces of Mancos Shale. Very fine- to fine-grained sand is composed of subrounded to subangular quartz, Holocene) – Slump blocks within the D-cross Tongue of Mancos Shale or the Crevasse Canyon Formation, locally ocene) – Very poorly sorted pebbles, cobbles, and boulders, composed of Carrizo Peak trachyte-syenite complex,
  - ubangular, and monolithic. There is a single, 2 m-thick tabular zone where syenite-trachyte clasts are mixed with ron Formation?). Matrix is very fine- to very coarse-grained sand that is well-graded, subangular to subrounded, and and/or calcite. Moderately consolidated. Greater than 30 mkthic to middle Pleistocene?) – Jumbled boulders of Gallup Sandstone (metamorphosed to quartzite) in a finer-
  - pil. Colors of grayish brown to brown (10YR 5/2-3), light brownish gray to pale brown (10YR 6/2-3), or grayish ear the base of the deposit (brown to strong brown, 7.5YR 5/4-6). Variable clay-silt mixed with sand, typically 1 ssive, with varying degrees of bioturbation. Sand is moderately to poorly sorted and subrounded to subangular. Mes detritus, sandstone, hornfels, or shale epending on source area) whereas very fine- to fine-grained sand is comocally rounded), poorly sorted, and locally imbricated. Clast composition varies with source area. In White Oaks d shale. In Nogal Arroyo, clasts are predominately intermediate igneous types, with minor sandstone. Generally, relopment is moderate to strong, medium to very coarse, subangular blocky to prismatic; peds are generally hard in a
  - n ped faces and faint clay bridges. Calcium carbonate accumulation is characterized by a stage I to I+ carbonate pcally, a sandier subunit (<1 m-thick) is found at the top of this unit, disconformably overlying oldar strata; conthin, lenticular bedding or horizontal-planar laminatio hs.White Oaks Canyon, gravel beds are common in this ng-upward into the finer-grained deposits described above. Weakly to moderately consolidated, mostly moderately Miscellaneous trachytic rocks that are generally in narrow, incised arrows. Typical thickness of 1-3 m. exture that underlies higher geomorphic surfaces and typically has a strong calcic horizon on or near its surface. order of the guadrangle, but within a few kilometers the sediment grades laterally eastward into interbedded sand rcalated pebble-cobble beds. Gravel is locally scattered withyin finer sediment. Colors of pale brown to very pale
  - /n (2.5Y-10YR 6/4). Non-gravelly sediment is generally in very thin to medium, tabular beds. Gravel beds are very 15% gypsum filaments comprised of sand-size gypsum grains). Gravel are subrounded to angular, poorly sorted, and mmon in the northeast corner of the quad. Sand is generally subrounded to subangular and moderately to poorly grains; very fine- to fine-grained sand is composed of quartz, feldspar, and minor lithic grains. A soil with a strong ed on the surface of this unit; this calcic horizon has **o**derate to strong, very fine to coarse, subangular blocky peds n, a strong brown to reddish yellow (7.5YR 5-6/6) Bw or illuviated clay (Bw) soil horizon overlies the calcic soil. te significant erosion followed deposition of this unit dath e strong calcic soil found on the unit's surface formed -pebbly channel-fills transmit groundwater in this unit, which discharges at two localities on the quadrangle: Carriely low discharges.
  - face on urQTa . However, we cannot state with confidence thatao is a distinct deposit; in other words, mapped a point C-497 on map) and an exposure o ${f Q}$ ao (data point C-361 on map) exhibit similar sediment characteristics. ociated wit@ao, and this sediment is inset intcQTa. However, this relatively thin, inset sediment was not observed Rhyolite rocks thickness of ao. Combined thicknesses of Qao-QTa are discussed under unit Qao-QTa. Pleistocene) – Used in cross-section A- A' only. Because of uncertainty associated with the base of ao, this vium isopach map (obtained from a local landowner, Stirlin&pencer, who in turn received it from a coal mining this paleovalley and about 15-20 m-thick on either side. The unit thins south of Nogal Draw. Near Carrizozo, well cknesses of 5-7 m at the Cimarron Mining Corporation site) and deeper alluvium to the south (26 m at well T-3271). gle (upper Pliocene to middle Pleistocene) – Sandy pebbles-boulders (mostly cobbles to boulders) that are Gravel are subrounded (mostly) to subangular, very poorly sorted, and composed of Carrizo Peak syenite-trachyte; wish brown to pale yellow (2.5Y 6/3-7/4) or light gray to very pale brown (10YR 7/2-3), very fine- to very coarsesorted. Medium to very coarse sand is composed of trackyterite grains, and very fine to fine sand is composed of y gravel. Bedding is generally vague, thin-medium, and lenticular; locally cross-stratified (2 m-thick foresets).
  - types. Clasts are subrounded to subangular and include Carrizo Peak syenite-trachyte, other igneous rock types ale brown (10YR 7/2-3), fine- to very coarse-grained (mostly coarse- to very coarse-grained), poorly sorted, and inoderately consolidated. 12 m-thick. - Gravel consisting of very fine to very coarse pebbles, cobbles, and ~15% boulders. Clasts are subrounded (mostly) e-svenite, minor sandstone and hornfels, and 1-3% limestone. Exposure does not permit observations of bedding. All stage IV calcic horizon on the surface of this unit. Atast 6 m-thick.
  - intruded around Baxter Mountain. The largest intrusion is a stock in the vicinity of the South Homestake Shaft. A aks Draw. On the southwest slopes of Baxter Mountain, this neous rock occurs as both sills and dikes. This rock ide of Baxter Mountain. Fluids evidently preferred to flow through this rock than the lower-permeability Mancos Shale. e intrusion and is associated with mineralization. Most of the prospect pits, adits, and shafts in the northeast quadrangle to very light yellowish gray, porphyritic trachyte with significant amounts of mafic phenocrysts. Phenocryst asse l to subhedral, and 12-15% potassium feldspar phenocrysts, 0.5-6.0 mm-long and euhedral to subhedral. Mafic min- Cretaceous fluvial and marine strata
  - ounts of biotite. Hornblende phenocrysts may be up to 20 mlenigth. Mafic minerals locally "plucked" or disof feldspar with 25% mafic minerals. Unit correlates to melatrachyte of Grainger (1974). gray to very light yellowish gray, porphyritic trachyte with significant amounts of mafic phenocrysts. Phenocryst ly as much as 22 mm-long) and euhedral (mostly) to subhedral, and 10-20% potassium feldspar phenocrysts, 0.3-6.0 nostly augite and hornblende, with minor and variable amounts of biotite. Hornblende phenocrysts may be up to 20 of potassium feldspar with ~10% mafics. Unit correlates to melatrachyte of Grainger (1974). Locally, megacrysts kes are up to 4 m-wide. Mapped as a line only. r to unit Tibmt, but in a sill form.
- ellowish to reddish orange, porphyritic trachyte that has been notably hydrothermally altered. Phenocryst assem al to subhedral, and 0-20% potassium feldspar phenocrysts, 1-5 mm-long and subhedral. Mafic minerals are mostly e. Hornblende phenocrysts may be up to 20 mm in length. Unit correlates to melatrachyte of Grainger (1974). Tibmtad Altered Baxter Mountain melatrachyte dike (upper(?) Oligocene) – As in unit Tibmta, but occurring in sub-vertical dikes1 to 4 m-wide. Unit locally mineralized and was the focus of past mining activity. Locally silicified. Phenocrysts consist of: 1) 5-20% 1-10 mm-long potassium feldspar (mostly 0.5-3.0 mm) that is locally replaced by bluish-gray minerals; 2) 10 -15% pyroxene and hornblende that are commonly dissolved and replaced by a rusty, fine-grained substance (goethite or limon Maric casts are typically 0.5-6.0 mm. Hornblende casts are as much as 20 mm-long. Matrix is about 0.1-0.5 mm grain-size and composed of potassium feldspar with 3-5% mafic minerals. Locally trace to 1% biotite. Unit correlates to
- tain melatrachyte sill (upper(?) Oligocene) Altered Baxter Mountain melatrachyte in a sill. Pinkish white, weathering to very pale brown. Similar to unit A single stock(?) of andesite was identified near the mouth of White Mountain Canyon. This stock appears to cross-cut a sill of trachyte and is thus younger than the trachyte. We suspect this
- Tiap Porphyritic andesite (lower to upper Oligocene) Gray color, weathering to an orangish gray. Matrix is mostly 0.1-0.3 mm (grain size) and composed of feldspar laths with 1-20% hornblende, pyroxene, and biotite. Phenocrysts comprise 3-10% of rock surface area and consist of 0.2-10 mm-long pyroxene, hornblende, and +/- biotite. Unit correlates to andesite of

### Tiaps Porphyritic andesite sill (lower to upper Oligocene) – Porphyritic andesite, as described in uniTiap, but in a sill form. Svenite-trachyte stocks, sills and dikes Portions of two large stocks of trachyte are found in the northeastern part of the quadrangle. To the south is the Carrizal Psyenite-trachyte complex. Finer-grained trachyte is found in the map area, but to the east this trachyte appears to grade into a syenite. Various sills and dikes of trachyte that are mapiged/hite Oaks Canyon are probably associated with the Carrizo Peak syenite-trachyte complex. These trachytes are invariably cross-cut by the Baxter Mountain melatrachyte and thus pre-date that unit. North of Baxter Mountain is a distinctive pro phyritic syenite-trachyte that occurs as a stock in the north-central part of the main White Oaks mining area. We informally refer to this as the White Oaks syenite-trachyte complex. This intrusion has larger alkali feldspar phenocrysts than the Carrizo Peak svenite-trachyte complex. On the northwest slopes of Baxter Mountain, north-striking dikes of the White Oaks syenite-trachyte complex extend south onto this quadrangle. Here, a dike of Baxter Mountain melatrachyte cross-cuts the trachyte-syenite and thus the trachyte-syenite is older. Felsic tuffs have returned ages of 28-29 Ma in the Sierra Blanca volcanic complex. Felsic intrusions in the Gallinas Mountains (trachyte, syenite, and rhyolite) have been dated by the K/Ar method at 29.9 Ma (Perhac, 1970). Thus, a 28-29 Ma age is reasonable for the syenite and trachyte intrusions on this quadrangle. Carrizo Peak igneous complex

3-5% augite (1-8 mm-long and euhedral to subhedral). Unit appears to have intruded into a trachyte sTilt\$ ).

nally massive, but at base of tall slopes there may be thin to medium, lenticular beds of sandy pebbles. Minor, varipotassium feldspar 0.5-5.0 mm-long; phenocrysts have been locally altered. Trachyte predominates on this quadrangle, which is inferred to laterally grade eastward into syenite at the core of the complex.

mafic minerals. Phenocrysts include: 1) 20-25% plagioclase (0.5-5.0 mm-long and subhedral); 2) 15% of an unknown, granular, greenish mineral forming subhedral phenocrysts; and 3)

- spar). 0.1-0.3 mm grain size. 3-4% mafic minerals (probably pyroxene and hornblende) that includes some biotite. Rock has a foliated or sheared fabric. Within sheared areas are grayer or oranger zones containing north-south elongated vugs, many of which are filled by quartz. Generally less than 8 m-wide. Tits Trachyte sill (lower to upper(?) Oligocene) – Slightly to non-porphyritic trachyte sill that is non- to variably (but minor) altered. Non-altered rock is white to orangish white to very pale brown, weathering to various orange and tan shades. Groundmass is composed of feldspar (probably potassium feldspar) b0.5 mm grain size. 0-4% mafic minerals (probably
- pyroxene and hornblende) that includes some biotite. <2% phenocrysts, which include potassium feldspar (up to 4 mm-long and subhedral) and mafic grains (0.3-3.0 mm-long hornblende or pyroxene). Locally FeO stains on fracture faces. Titbs Trachyte sill at Bald Hills (lower to upper(?) Oligocene – Slightly porphyritic trachyte sill that caps the Bald Hills. Groundmass is aphanitic (<0.2 mm grain size) and white, light tan, or light gray. Rock weathers to light gray, light brownish gray, or pinkish gray. 1-3% phenocrysts that are 0.2-8.0 mm (mostly 0.2-4.0 mm), anhedral to euhedral, and composed of hornblende and/or biotite. Similar rock caps the two conical hills northwest of Moss Windmill (1-2 km south of Bald Hills). The northern of these two conical hills has 10-15%
- Base is not exposed and thickness is highly uncertain; our best estimate is 40-60 m-thick. Fitps Porphyritc trachyte sill (lower to upper(?) Oligocene) – Porphyritic trachyte. Very pale brown to yellow color, weathering to light gray. Phenocryst assemblage: 15-25% potassiun feldspar phenocrysts (euhedral to subhedral) that range from 0.5-10 mm. Matrix consists of potassium feldspar (subhedral) that is 0.1-0.5 mm-long. Titad Altered trachyte dike (lower to upper(?) Oligocene) – Trachyte dike that has been altered. White to light gray to very pale brown to pinkish gray, weathering to a creamy orange o yellow color. Grain size is 0.1-0.5 mm. Rock composed of potassium feldspar laths that are not aligned, in addition to 10% original mafic minerals (pyroxene or hornblende) that have
- been altered to rust-colored, replacement minerals. Locally, quartz fills vugs that are 1-3 mm-long and elongated. Variable precipitation of limonite and/or goethite. Locally abundant cavities (generally less than 1 cm across). 4 to 15 m-wide. Mapped as a line only. Titas Altered trachyte sill (lower to upper(?) Oligocene) – Pale yellow sill that is 1.5 m-thick. Sill is equigranular (~0.3 mm grain size) and composed of potassium feldspar that is altered
- (to kaolinite?). About 2% altered and corroded biotite grains are present. Alteration of this sill is greater than the ditent cross-cuts it (unit Titad). Mapped as a line only. Titpad Porphyritic trachyte dike that is altered (lower to upper(?) Oligocene) – Porphyritic dike that is creamy white to orange in color. 1-3% casts of former mafic minerals (probably pyroxene or hornblende), which have dissolved or weathered away. Casts are 1-8 mm-long and euhedral. 0-1% potassium feldspar phenocrysts 0.5-1.0 mm-long. Groundmass is 0.1-0.5 mm (mostly ~0.1 mm) and composed of subhedral potassium feldspar. Weathering may produce a pattern of swirly laminae on exposed surfaces.
- Titpas Porphyritic trachyte sill that is altered (lower to upper(?) Oligocene) Porphyritic sill; pink to white to light gray fresh color that weathers to pale yellow, reddish yellow, very pale brown, and yellow. Matrix is composed of 0.1-0.4 mm potassium feldspar grains. 3-10% phenocrysts that are 0.2-4.0 mm long, euhedral, and composed of mafic minerals (hornblende or pyroxene) that are altered to a rust-colored mineral or completely dissolved away (leaving casts). 0-3% relatively unaltered potassium feldspar that may have formed during hydrothermal alteration. 0.5-1% vugs (1-3 mm-wide) filled with calcite. Composition of rock similar to that of Titad .
- White Oaks igneous complex Tiwst White Oaks syenite-trachyte stock (lower to upper(?) Oligocene) – Porphyritic trachyte. Phenocryst assemblage: 30% potassium feldspar phenocrysts (euhedral) that range from 0.2-
- 6.0 mm, and 1-7% hornblende (euhedral) that ranges from 0.2-5.0 mm. Unit correlates to trachyte-syenite porphyry stock of Grainger (1974). Fiwstd White Oaks syenite-trachyte dike (lower to upper(?) Oligocene) – Porphyritic trachyte-syenite; gray, weathering to light gray. Rock has 10% phenocrysts composed of euhedral to subhedral potassium feldspar that are 1-11 mm in length. 5-6% phenocrysts composed of euhedral biotite, hornblende, and pyroxene that are 0.5-3.0 mm in length. Groundmass is 0.2- Pa 0.4 mm, anhedral to subhedral, and composed of potassium feldspar with ~5% mafic minerals (biotite with lesser pyroxene and hornblende).
- th minor medium- to very coarse-grained sand and scattered (commonly 3-15%) pebbles. Unit generally is inset Tiwsts White Oaks syenite-trachyte sill (lower to upper(?) Oligocene) Porphyritic trachyte-syenite, as described in unit inset Tiwstb White Oaks breccia sill (lower to upper(?) Oligocene) – Porphyritic trachyte sill, as described in Tistps , but with abundant clasts of argillite and hornfels. Clasts are fine to very coarse pebble-size and subangular.
- ium (mostly thin), lenticular beds of medium to very coarse sand and gravel. Gravel is generally pebbles with minor, Tiwsta White Oaks syenite-trachyte stock that is significantly altered (lower to upper(?) Oligocene) Porphyritic trachyte that has been significantly altered by hot fluids. Phenocryst assemblage: 30% potassium feldspar phenocrysts (euhedral) that range from 0.2-6.0 mm, and 1-7% hornblende (euhedral) that ranges from 0.2-5.0 mm (mostly 1 mm). Locally, it is corroded, vuggy and heavily sericitized. Locally, there is 1% syn-alteration(?) biotite 0.5-1.0 mm. Abundant FeO stains in vugs and fracture faces. Tiwstad White Oaks syenite-trachyte dike that is significantly altered (lower to upper(?) Oligocene) – Rock is similar to that in unit Tistpa but occurs in dikes 1-3 m-wide.
  - Fiptd Plagioclase-bearing trachyte dike (lower to upper(?) Oligocene) Porphyritic, sericitized dike rock. Color is slightly greenish white, weathering to pale yellow. Matrix is composed of potassium feldspar and minor plagioclase (anhedral and 0.2-1.0 mm). Phenocrysts are elongated amphibolite(?) and biotite (0.5-5.0 mm, with biotite being the longest). 0.5% secondary guartz. Dike is 5-6 m-wide and strikes 325 degrees. Mapped as a line only. Tite Epidotized trachyte intrusion (lower to upper(?) Oligocene) – Epidotized intrusion of trachyte. Color is white to light gray, weathering to yellow to creamy orange. Grain size evenly
  - ranges from 0.2-4.0 mm. Matrix is composed of euhedral to subhedral potassium feldspar. 15% phenocrysts of euhedral biotite and slender prisms of hornblende, both generally 0.2-2.0 mm in length; more hornblende than biotite and trace hornblende phenocrysts (up to 13 mm-long). 1% unknown mafic mineral. Epidotization of mafics is observed. Erodes into spheroidal blocks Tite+Tmah Epidotized trachyte intrusion plus argillite of the Mancos Shale (lower to upper(?) Oligocene) – Epidotized trachyte intrusion (ite) complexly intruding argillite of the
  - Mancos Shale (Kma ). Intrusions are too small to be mapped at 1:24000 scale. Extremely sericitized and altered dike (lower to upper(?) Oligocene) – Yellowish white to shiny white, very fine-grained clayey rock in a dike form. Locally, 1% elongated vugs (1-7 mm) filled by a rusty substance. No mafics seen. Interpreted as an extremely altered igneous dike. Cannot tell original cposition. Mapped as a line only.
  - Ne have mapped rhyolite only in a single dike immediately northwest of White Mountain Draw. This dike is splotchy in appearance and has abundant argillitic xenoliths. Its relation to other intrusive rocks is unclear.
- ction. The isopach map was constructed from coal prospect borings and indicates a westward-trending paleovalley Tird Rhyolite; gray and aphanitic. About 50% of rock consists of brownish clasts of argillite that have been folded and flattened; minor fossils have also been incorporated into the dike. 1 m-wide. Mapped as a line only.
  - Basaltic andesite, basalt, and trachygabbroic rocks A distinctive suite of mafic rocks are mapped in the northeast and northwest parts of the quadrangle. In the northeast corner is a distinctive megacrystic basaltic andesite that occurs in northstriking dikes that are several meters-wide. A similar, but less porphyritic, dike strikes east-northeast in the vicinity of Manchester Spring. On the northwest slope of Baxter Mountain, a
  - porphyritic trachyte-syenite dike, related to the White Oaks complex, appears to cross-cut a megacrystic basaltic andesite intrusion, but this cross-cutting relation is not conclusive. An extrusive equivalent to these basaltic andesites is found stratigraphically low in the Sierra Blanca volcanic complex and leath any felsic tuffs or extrusions (i.e., northeast slopes of Jackass Mountain, Oscura Peak quadrangle of Koning et al, 2010). We use these observations to assign a relatively old age **to**e basaltic andesite rocks (upper Eocene?). Above the ower tongue of the Gallup Sandstone is a trachygabrro sill that is up to 10 m-thick. This sill is similar to others mapped south of Carrizozo. One of these sills to the south returned an  $^{40}$ Ar/ $^{39}$ Ar age of 36.32 ± 0.35 Ma (Dowe et al., 2002).
  - Fibap Porphyritic basaltic andesite (upper Eocene to lower Oligocene) Very dark gray (N3/), porphyritic andesite. 25% plagioclase phenocrysts that are 0.5-4.0 mm-long (euhedral to subhedral). 0.5-1% pyroxene phenocrysts that are 0.5-1.5 mm-long. Groundmass is composed primarily of 0.1-0.2 mm plagioclase. Tibam Megacrystic basaltic andesite (upper Eocene to lower Oligocene) – Very dark gray to dark gray color, weathering to gray. Rock contains distinctive megacrysts of plagioclase that are 1-20 mm long and tabular. These megacrysts are commonly aligned subparallel to dike strike and are euhedral to subhedral. Groundmass is 0.1-0.5 mm (mostly 0.2-0.3 mm) and composed of subequal, subhedral(?) mafic and plagioclase crystals; pilotaxitic texture noted by Grainger (1974). Unit correlates to the basalt porphyry dikes of Grainger (1974). This worker
  - measured an anorthite content of An60-62 in the plagioclase megacrysts and An46-49 in groundmass plagioclase. He also noted olivine and augite in the ground mass. Tibd Basalt dike (middle(? Eocene to lower Oligocene) – Dark gray color, weathering to gray and commonly exhibiting a strong varnish. Rock is aphanitic (grain size less than 0.25 m and anhedral) and composed of plagioclase with 30-35% unidentified mafic minerals. There is trace brownish olivine. Dike is ~10 m wide and jointed parallel to dike trend; joints are spaced 10-40 cm.
- ne youngest intrusive rock in the quadrangle. We assign a tentative late Oligocene age to this intrusion. Various de- Titgs Trachygabbro sill (middle(?) to upper Eocene) Light gray to grayish brown, weathering to gray-grayish brown. Rock is composed of plagioclase (euhedral and 0.5-3.0 mm long) with 10-40% hornblende and pyroxene (mostly anhedral, ranging to euhedral, and 1-7 mm long). Plagioclase minerals are locally aligned. 5-10% bronze-colored mica, which may be secondary. A similar sill at the Three Rivers Petroglyph site returned an<sup>40</sup>Ar/<sup>39</sup>Ar age of 36.32 ± 0.35 Ma (Dowe et al., 2002), and was called a trachybasalt sill by McLemore (2002). 3-

  - Kccm Crevasse Canyon Formation, middle part (upper Cretaceous, middle Coniacian to Maastrichtian(?) Stage) Interbedded yellow sandstone and yellow to gray mudstone. Unit has relatively distinct fluvial channel and floodplain facies in an estimate ration of 35-45% to 55-65%. Channel-fills are composed of fine- to medium-grained sandstone in thin to thick (mostly medium to thick), tabular beds that are internally massive, horizontal-planar laminated, or tangential cross-laminated. Sandstone beds are white to light gray (5Y 8/1) to yellow (5Y 7/3), weathering yellow or orange. Sand is subrounded to subangular, well-sorted, and composed of quartz with 3-15% feldspar and 3-10% gray lithic grains and black mafic grains; common glauconite. Swirly weathering patterns locally found on exposed sandstone. Fossils were not found. Floodplain detacare light yellowish brown (2.5Y 6/3), dark gray to light gray (2.5Y 4-5/1), yellow (5Y 7/3), light olive brown to yellowish brown (2.5Y 5/6) mudstone, claystone, siltstone, and very fine-lower to fine-lower sand. Floodplain strata are nostly horizontal-planar laminated, with subordinate very thin to medium, tabular beds. Exposed strata on this quadrangle lacks pebbles or coarse sandstone in the channel-fills, so it
  - appears to lie below the Ash Canyon Member. Greater than 150 m-thick. Kccl Crevasse Canyon Formation, lower, coal-bearing part (upper Cretaceous, middle Coniacian Stage) – Gray claystone (N5/) interbedded with light gray (2.5Y 7/1) siltstone, and very fine- to fine-grained sandstone interbedded with coal seams. Sandstone is in thin to thick, tabular beds. Siltstone and claystone are in thin to medium, tabular beds. Only exposure of this unit showed 5-25% coal seams that are up to 15 cm-thick. Sand is subrounded to subangular, well-sorted, and composed of quartz, ~15% feldspar, and 7% gray lithic and black mafic grains. Sand has up to 10% clay-silt in matrices. Lack of exposure hampers definition of top of unit. We provisionally assign the top of the unit as the stratigraphic level correponding to the base of the sill at Bald Hill, but the coal-bearing may not extend up that high. This definition results in a thickness of 120-130 m.
  - Kcc Crevasse Canyon Formation, undifferentiated (upper Cretaceous, middle Coniacian to Maastrichtian(?) Stage) Used in cross-section A- A' only. Undifferentiated Crevasse Canyon Formation. See descriptions for units ccm and Kccl.
  - Kgs Gallup Sandstone (upper Cretaceous, lower Coniacian Stage) Unit dominated by sandstone that is described in different parts of the quadrangle. 100-130 m-thick. North of mouth of Baxter Creek (C-475): Yellow sandstone with variable amounts of glauconite. Medium to thick, tabular beds that are internally planar-horizont. angle- or tangential-cross-laminated. Rock varnishes strongly. Sand grain size is fine-lower to medium-lower (mostly finapper). Sand is subrounded to subangular, well-sorted, and composed of quartz with 10% mafics and unknown amounts of probable feldspar. Friable to indurated. South of mouth of Baxter Creek (C-433 wpt 84): Pale yellow, weathering red to purplish red. Thick beds of sandstone that are internally horizontal-planar laminated to very thinly bedded. 5% low angle, tangential cross-stratification (laminated to very thin); foresets are 1-2 ft-thick. Sand grain size is finepper to medium-lower. Sand is subrounded to subangular, well-
  - sorted, and composed of quartz with trace lithics and mafics and 1-5% feldspar. In plains east of highway 50: Very pale brown to light gray (10YR 7/1-3) or pale yellow (2.5Y 8/3-4) sandstone, commonly in medium beds. Sand is fine- to medium-grained, subangular to subrounded, well-sorted, and composed of quartz, 5-15% feldspar, and 5-12% lithic grains. Locally fossiliferous.

#### In NW corner of quad: Light yellowish brown (mostly) to very pale brown (2.5Y-10YR 6-7/4) to pale yellow (2.5Y 8/2-4) sandstone, weathering to yellowish brown (10YR 5/6), very pale brown (10YR 8/2), strong brown (7.5YR 5/6), light yellowish brown (10YR 6/4), or light gray (2.5Y-10YR 7/2). Locally strongly varnished. Medium to thick, tabular beds that are internally cross-stratified (laminated to very thin beds) or internally massive; subordinate planar-horizontal, laminated to very thin beds; local bioturbation. Sand grains are mostly fine upper, with slightly subordinate, but variable, fine-lower and medium-lower (locally minor very fine-grained sand, but very fine-grained sand is not typical), subangular to subrounded, well-sorted, and composed of guartz, 3-15% feldspar, and 3-15% mafic and lithic grains; locally as much as 20% feldspar and 20% lithic + mafic grains. Glauconitic and locally calcareous. Locally fossiliferous; invertebrate shells are especially common in calcareous, yellow to light yellowish brown, fine-lower to coarse-lower sandstone beds. Minor interbeds of a white, guartzose sandstone that weathers to a purplish color; sand is fine-grained, subrounded, well-sorted, and has 3-5% dark gray-black lithic grains and ~5% feldspar. In a very few areas, there are very fine to medium, guartzite and chert pebbles in coarse- to very coarse-grained, subrounded sandstone (composed of guartz with 10% lithic grains). Lowest sandstone tongue is tangentially cross-stratified to planar-horizontal bedded (laminated to very thinly bedded), with foresets up to 40 cm-thick; sand is bright white, weathering to pale yellow (2.5Y 8/2-3), and fine-upper, subangular to subrounded, well-sorted, and composed of quartz with 1% dark gray lithic grains and black mafic grains. Upper 6 m of the lower tongue is ledgeformer (~6 m-thick), fine-upper to medium-lower sandstone, where the sand is pale yellow to white (2.5Y 8/1-3), subrounded to subangular, well-sorted, and composed of guartz, 20% feldspar, and 10% dark gray lithics and black mafics (uppermost part of this ledge is heavily burrowed or internally massive Sandstone is generally well-cemented.

Kgsm Gallup Sandstone marker bed (upper Cretaceous, lower Coniacian Stage) – A distinctive, thick bed with abundant oysters (probably crassostria soleniscus) in the upper part of the Gallup Sandstone. Sandstone is pale brown to light yellowish brown (10YR-2.5Y 6/3), very fine- to fine-grained, and very calcareous. Bed was mapped to illustrate tight folding. Kgsq Gallup Sandstone metamorphosed to a quartzite (upper Cretaceous, lower Coniacian Stage) – Quartzite in very thin to thick, tabular beds. Internal bedding is massive or horizontal -planar laminated, with 20-25% low-angle, tangential cross-laminations. Original sand quartz grains have been fused together. 1-3% un-identified mafic minerals. About 60 m preserved thickness eastern guadrangle boundary. Rock is very light gray weathering to pale yellow. Groundmass is potassium feldspar (0.1-0.4 mm grain size). 0.5-3% phenocrysts composed of subhedral – Kmd – Mancos Shale, D-Cross Tongue (upper Cretaceous, middle Turonian to lowest Coniacian Stage) – Very dark gray and very fissile (weathering to 0.1-0.5 mm-thick plates); very thin bedded to horizontal planar-laminated near upper contact. Trace cobble-size concretions that are strongly cemented by calcium carbonate. Non-calcareous. Unit seems more fissile than the Rio Salado tongue and weathers to a darker color. Approximately 110-120 m-thick.

Trachyte dike (lower to upper(?) Oligocene) – Trachyte dike that is non- to variably (but minor) altered. Non-altered rock is white and composed of feldspar (probably potassium feld- Kth Tres Hermanos Formation (upper Cretaceous, middle Turonian Stage) – Very fine- to fine-grained sandstone. Color of pale yellow to light gray, weathering to brownish yellow, very pale brown, or pale yellow. Sandstone is in thin to medium, tabular beds that are locally internally tangential cross-laminated (up to 13 cm-thick). Local burrows are observed. Upper 1 m of formation is in very thin to thin, tabular beds that are locally ripple-marked. Woody debris and organic litter is locally present in the upper part of the unit. 10-15 m-thick. Sandstone interval in Mancos Shale above Tres Hermanos Formation (upper Cretaceous, Turonian Stage) – Olive-colored, calcareous, very fine- to medium grained sandstone (mostly fine-grained) that is in very thin to thin (minor medium), tabular beds. Locally low angle, tangential cross-laminations. Common bioturbation and marine fossils. Sandstone contains minor shale interbeds. Unit constitutes a useful marker on the western slopes of Baxter Mountain. 3 m-thick.

Kml Lower tongue of Mancos Shale (upper Cretaceous, middle Cenomanian to middle Turonian Stage) – Hard, calcareous shale; very dark gray, weathering to gray to light gray to light yellowish brown. Generally planar-horizontal laminated, with subordinate wavy laminations, and minor very thin to thin, tabular beds. Cross-section suggests 200 m-thickness, but this may be too high. phenocrysts that are 0.1-2.0 mm, anhedral, and are altered to a reddish brown, unknown mineral; the original mineral was likely biotite based on alteration rims of trace observed biotite. Kmlb Bridge Creek Limestone Beds of the lower tongue of the Mancos Shale (upper Cretaceous, upper Cenomanian to lower Turonian Stage) – Marker interval consisting of closely spaced, medium- to thick-bedded, tabular limestones. Limestones are dark gray, weathering to light gray and micritic. Internally massive, with local shells. Unit does not include a lime-

tone bed found about 10-11 m above this marker interval. Interval is 4.0-4.5 m-thick and is mapped as a line. Kmah Mancos Shale, undifferentiated, metamorphosed into an argillite and hornfels (upper Cretaceous, middle Cenomanian to lowest Coniacian Stage) – Light gray to light brownish gray argillite, with vague to none planar-horizontal laminations. Unit includes meta-sandstone hornfels that is typically white to light gray to light yellowish gray to pale yellow, very fine- to fine-grained (sand-size), mostly very fine-grained, and quartzose. Hornfels locally weathers to an orange or red color. Rock is more resistant than non-metamorphosed Mancos Shale and erodes into angular, blocky to platy clasts. Approximately 140-150 m-thick. Dakota Sandstone (Upper Cretaceous, Cenomanian Stage) – Cross-stratified sandstone. Sand is white, varnishing to a near-black color. Strata are tangential cross-laminated (mostly)

to cross- very thinly bedded. Sand is grain size is fine-upper to medium-upper. Locally (~10%) coarse to very coarse sand. Trace very fine pebbles of quartz, quartzite, and chert; however, these likely increase in abundance towards the bottom of the unit. Sand is subrounded (minor subangular), well-sorted, and composed of quartz with 1% lithic and mafic grains. Indurated. No strong vertical joint sets observed, but on surface rock readily fractures along bed planes. 46-61 m-thick (Smith, 1964; Haines, 1968). SUBSURFACE UNITS IN CROSS-SECTION A- A'

Triassic strata, Chinle Group overlying the Santa Rosa Formation or Moenkopi Formation (middle Triassic) – The Chinle Group is described by Grainger (1974) as red to purple, variegated shale and siltstone intercalated with subordinate red to brown sandstone and minor pebble-conglomerate lenses. Strata are mostly thinly bedded and total 75 m-thick. The Santa Rosa Formation, which we suspect may actually be Moenkopi Formation, was described by Grainger (1974) as a dark reddisbrown, micaceous, quartz sandstone and siltstone having a thickness of 60-90 m. A total thickness of 150 m was used for this unit in the cross-section. Grayburg Formation, Artesia Group (upper Permian) – In the Little Black Peak quadrangle to the northwest, where it was called the Bernal Formation, this unit is red to buff, calcareous sandstone, siltstone, and shale; 60-90 m-thick (Smith and Budding, 1959).

Psa San Andres Formation, undifferentiated (lower to upper Permian) – Interbedded limestone, sandstone, dolomite, anhydrite, and gypsum beds. Near the base is a 6-12 m-thick sandstone (Weber, 1964). ~180 m-thick to the north of this guadrangle (Smith and Budding, 1959). Yeso Formation (lower Permian) – Yellow and red siltstone, limestone, and gypsum. A thickness of 630 m is given in the Three Rivers quadrangle to the south (Koning, 2009). Abo Formation (lower Permian) – Reddish color; consists of overbank deposits of mudstone and clayey fine-grained sandstone that are intercalated with coarse channel-fills of sand-

# ACKNOWLEDGMENTS

stone and pebbly sandstone. Thickness not known in map area and unit may not even be present.

Birkeland, P.W., 1999, Soils and geomorphology: New York, Oxford University Press, 430 p.

Conference Guidebook, p. 26-27.

We wish to thank Stirling Spencer, Gary Vega, Warren Malkerson, Rick Virden, Odis McClellan, David Dotson, Jake Stafford, and Paul Pino for allowing access to their land. Stirling Spencer shared an isopach map for alluvium as well as insights relating to the association of vegetation and surficial sediments.

### REFERENCES

Birkeland, P.W., Machette, M.N., and Haller, K.M., 1991, Soils as a tool for applied Quaternary geology: Utah Geological and Mineral Survey, a division of the Utah Department of Natural Resources, Miscellaneous Publication 91-3, 63 p

Compton, R.R., 1985, Geology in the field: New York, John Wiley & Sons, Inc., 398 p. Gile, L.H., Peterson, F.F., and Grossman, R.B., 1966, Morphological and genetic sequences of carbonate accumulation in deservoils: Soil Science, v. 101, p. 347-360. Ingram, R.L., 1954, Terminology for the thickness of stratification and parting units in sedimentary rocks: Geological Society of America Bulletin, v. 65, p. 937-938, table 2. Dowe, C.E., McMillan, N.J., McLemore, V.T., and Hutt, a., 2002, Eocene magmas of the Sacramento Mountain, NM – subduction or rifting?: New Mexico Geology, v. 24, p. 59-60. Grainger, J.R., 1974, Geology of the White Oaks Mining District, Lincoln County, New Mexico [M.S. thesis]: Albuquerque, University of New Mexico, 69 p. Haines, R.A., 1968, The geology of the White Oaks-Patos Mountain area, Lincoln County, New Mexico [M.S. thesis]: Albuquerque, University of New Mexico. Koning, D.J., 2009, Preliminary geologic map of the Three Rivers 7.5-minute quadrangle, Otero County, New Mexico: New Mexico Bureau of Geology, open-file geologic map, scale McLemore, V.T., 2002, The Three Rivers Petroglyph site, Otero County, New Mexico [non peer-reviewed mini-paper]: New Mexico Geological Society, 53rd Annual Field

Pehrahc, R.M., 1970, Geology and mineral deposits of the Gallinas Mountains, Lincoln and Torrence Counties, New Mexico: New Mexico Bureau of Mines and Mineral Resources, Munsell Color, 1994 edition, Munsell soil color charts: New Windsor, N.Y., Kollmorgen Corp., Macbeth Division. Smith, C.T., 1964, Reconnaissance geology of the Little Black Peak Quadrangle, Lincoln and Socorro Counties, New Mexico: New Mexico Institute of Mining and Technology, State Bureau of Mines and Mineral Resources, Circular 75. Smith C.T., and Budding, A.J., 1959, Reconnaissance geologic map of the Little Black Peak quadrangle, east half: New Mexico Institute of Mining and Technology, State Bureau of Mines and Mineral Resources Geologic Map 11. Soil Survey Staff, 1992, Keys to Soil Taxonomy: U.S. Department of Agriculture, SMSS Technical Monograph no. 19, 5th edition, 541 p. Sprankle, D.G., 1983, Soil survey of Lincoln County area, New Mexico: U.S. Department of Agriculture, Soil Conservation Service, 217 p. Udden, J.A., 1914, The mechanical composition of clastic sediments: Bulletin of the Geological Society of America, v. 25, p. 655-744.

Varney, P. 1981, New Mexico's Best Ghost Towns: Flagstaff, Arizona, Northland Press, 190 p. Weber, R.H., 1964, Geology of the Carrizozo quadrangle, New Mexico: New Mexico Geological Society, 15<sup>th</sup> Field Conference Guidebook, p. 100-109. Wentworth, C.K., 1922, A scale of grade and class terms for clastic sediments: Journal of Geology, v. 30, p. 377-392.

