

	lessening of slope from ~ phic positions below.					
These units were mapped by field 1975). Initial work consisted of a 10-ft contours on the published to phy. Mapping from aerial photog separating the map units. Line we quadrangle. Not all air photograp private property near Tularosa. It using the aerial photographs. Co map units (probably more error in cally differentiated at a scale of 1 terpret $\leq 10\%$ of other units prese such as Qf2 or Qf3, within that m						
A brief discussion is warranted o ments, we separate units based or relations. For example, unit Qf2 three alluvial fan units have litho tion, surface processes dependent original bar-and-swale topograph						
units Qf vious in with min	e subdivided the basin-flo 3 and Qf2 (for Qbfy) an the field. Instead, Qbf3 nor gravelly channel-fills Qgy , is readily recognizab					
Grain sizes follow the Udden-We are subdivided as shown in Comp bedding thickness follow Ingram (Munsell Color, 1994). Soil hori Birkeland (1999). Stages of pede cic and gypsum often accumulate indicate that gypsum accumulation accompanying report.						
Unless otherwise noted below, of and siltstone clasts, and trace to has a composition consistent wi						
SLOPE	WASH					
Qgysw	Gyspiferous slopewash raphically higher basin- surface (see discussion i slopewash deposits are l					
ARTIFICIAL FILL AND EXC						
ae	Artificial excavation deposits of clay, silt, s					
af	Artificial fill (modern highways and railroad Sands Missile Range,					
DEPOS	SITS SPANNING THE					
Qam	Sand, silt, gravel, and a clay in various proportion The surface of this unit a light reddish brown (5Y moderate to dense cover may still be present beca such as grass clumps and					
Qah	Historical deposition o fine- to fine-grained san exhibits subtle scouring than 20 cm-thick and ov ever, field investigations ogy was not apparent. T					
Qamh	A composite unit consis					
Qahm	A composite unit cons					
ALLUVIAL FAN DEPOSITS						
Qf3	Silty-clayey sand, sand surfaces in the study are brown (5YR 6/3-4), redu- to light gray (10YR 7/2) ment is typically massive grained sand is present a pebbly sand to sandy pe very fine to very coarse dish brown (5YR 4/2-5/ this unit from gravelly C has a pebble to fine cobl low). The surface has sl Soil development is cha Qf3 unconformably ove Qbfgy). Unit generally Unit correlates to the Or on the Mule Canyon alla 1999, and Koning et al., +/- 10 (radiocarbon year parts of the fan).					
Qf3am	Comination unit of Q					

1-3 m-thick.

1-2 m-thick. Qf3gh Gravel-capped, slightly high-standing ridges of Qf3 (middle to upper Holocene) – This is a subunit of Qf3 which is differentiated elevation (ft above MSL) 4600 ft

4400 ft 4200 ft 4000 ft 3800 ft

DESCRIPTION OF MAP UNITS

OUATERNARY UNIT DESCRIPTIONS

	QUATERNARY UNIT DESCRIPTIONS		
ern and parts of in clay,	aternary units on this quadrangle are found in two topographic positions: 1) on the gently westward-sloping basin floor in the southwest- western parts of the quadrangle, and 2) on steeper alluvial fans emanating from the Sacramento Mountains in the north-central and eastern the quadrangle. The laterally gradational contact between the basin-floor and alluvial fans is drawn based on a variety of factors: increase lessening of slope from ~0.7° to 0.3-0.6°, and farthest eastern extent of gypsum deposits. We categorize the map units according to these phic positions below.		3gh surface is probably about 12 ka, assuming a regional incision event starting about that time (see ac underlying the surface is probably slightly older (2-4 ka). Base of unit not observed in field, but pres Qf1 . Unit is approximately 1-2 m-thick and includes the lower, gravelly channel-fills immediately ut tles.
1975). I 10-ft com phy. Ma separatin	nits were mapped by field traverses and aerial photography (White Sands Missile Range project, December and November of 1985; BLM, Initial work consisted of mapping representative parts of the alluvial fan and basin-floor sediment with a hand-held GPS unit and using the ntours on the published topographic map. This preliminary map was then utilized in identifying and mapping units using aerial photogra- apping from aerial photographs using the PG-2 plotter at the U.S. Geological Survey in Denver produces relatively precise lines (contacts) ng the map units. Line work from the aerial photographic-based mapping was then field-checked during subsequent field visits to the		Clay in the distal alluvial fan (middle to upper Holocene) – Reddish brown (5YR 5/4) clay and sat sive and hard. Sand is very fine- to medium-grained and moderately sorted. Estimate 20% gypsum files, with 30-40% gypsum filaments in the upper 10-20 cm. Unit grades laterally eastward into Qf3s
private µ using th map uni cally dif terpret ≤ such as	gle. Not all air photographic-based mapping could be field-checked because of access restrictions for the White Sands Missile Range and property near Tularosa. In the areas we did field-check, we found that there was an approximate 5-10% error in map unit identification is aerial photographs. Consequently, the user should assume that there is a potential 5-10% error in the identification of the Quaternary its (probably more error in the White Sands Missile Range). Some areas of the alluvial fan have two or more units that cannot be practi- fferentiated at a scale of 1:24000. In such cases, we use nomenclature reflecting a combination of units (e.g., Qf3am). Otherwise, we in- $\leq 10\%$ of other units present within a single-named unit. For example, in a map unit labeled "Qf1" we interpret $\leq 10\%$ of other map units, Qf2 or Qf3, within that mapped polygon.	Qf2	Sandy gravel and gravelly sand (lower(?) to middle Holocene) – This unit is only preserved in relation mountain front, where it is distinguished by its gravelly surface that is both less varnished than the Q cally than the Qf3 surface. This quadrangle offers no good exposure of the unit. Surface descriptions bly sand to sandy pebble-cobble; the sandy matrix is a light brown (7.5YR 6/4), silty-clayey, very fin fine- to medium-grained), and poorly to moderately sorted. Surface mantled (>50% clast density) b and minor fine to coarse cobbles. These clasts are non- to moderately varnished. Surface clasts gene are poorly sorted, subangular to subrounded, and composed of limestone with an estimated 3-5% arke (trace quartzite clasts). Pavement is moderately to well-developed and has minor underlying Av pede
ments, v relations three all	discussion is warranted on the difference between lithostratigraphic and allostratigraphic units. For the alluvial fan depositional environ- we separate units based on unconformable contacts (representing inferred time gaps between overlying and underlying deposits) or by inset s. For example, unit Qf2 unconformably overlies unit Qf1 , and both are inset and back-filled by Qf3 . However, it so happens that these luvial fan units have lithostratigraphic differences as well, that is, one can use sedimentological criteria to recognize these units. In addi- face processes dependent on age such as desert pavement development, clast varnishing, gypsum accumulation, and eradication of	Off	accumulation is apparent on the surface. Surface lacks bar and swale topography and is undissecteed 1 m) or level with this surface. The gravel of Qf2 is commonly draped over Qf1 . Estimate about 1 m
original We have	bar-and-swale topography can be used to differentiate the alluvial fan deposits. e subdivided the basin-floor deposits into a younger (Qbfy) and older (Qbfo) unit, which probably temporally correlate to alluvial fan	Qf1	Sandy gravel, gravelly sand, and silty-clayey fine sand (upper middle(?) to upper Pleistocene) – tain-front, this reddish alluvium is generally not well-exposed. It is recognized by its topographically gullies (0.5-1.0 m-deep) that have been partly back-filled by Qf3 deposits. This surface is smooth an pography. This surface is slightly reddish in color, has a weak to moderate pavement of well-varnish
vious in with min	f3 and Qf2 (for Qbfy) and Qf1 (for Qbfo) . Although there may be an unconformity separating Qbfy and Qbfo , such a contact is not ob- the field. Instead, Qbf3 and Qbf1 are differentiated based on lithostratigraphic criteria: Qbfo consists largely of clayey sand and clay nor gravelly channel-fills, and Qbfy consists of intercalated sand, pebbly sand, and clayey-silty sand. Another prominent basin-floor de- Qgy , is readily recognizable because it consists predominately of gypsum.		and has much indications of high gypsum accumulation (equivalent to a stage III in a clacic soil). Sh reddish brown (2.5YR 5/4) silty-clayey very fine- to medium-grained sand (minor medium- to very c sorted. Surface gravel include very fine to very coarse pebbles and 8-10% fine cobbles. In the distal intercalated channel-fill gravel and overbank fine sediment. The gravel beds are >1 m-thick and cons pebbles and cobbles. Overbank sediment consists of clay, silt, and very fine- to fine-grained sand; ca
are subd bedding (Munsel Birkelar cic and indicate	zes follow the Udden-Wentworth scale for clastic sediments (Udden, 1914; Wentworth, 1922) and are based on field estimates. Pebbles divided as shown in Compton (1985). The term "clast(s)" refers to the grain size fraction greater than 2 mm in diameter. Descriptions of thickness follow Ingram (1954). Colors of sediment are based on visual comparison of dry samples to the Munsell Soil Color Charts Il Color, 1994). Soil horizon designations and descriptive terms follow those of the Soil Survey Staff (1992), Birkeland et al. (1991), and nd (1999). Stages of pedogenic calcium carbonate morphology follow those of Gile et al. (1966) and Birkeland (1999). Because both cal- gypsum often accumulate together in a given soil horizon on this quadrangle, we may use the term "apparent carbonate morphology" to that gypsum accumulation is influencing the determination of the carbonate stage. Discussion of a unit's age control is presented in the anying report.		present in the clayey soils. The topsoil of this unit appears to lack a calcic horizon because of the hig unit characteristically exhibits multiple buried soils consisting of reddish horizons possessing illuviat overlie whitish calcic-gypsic horizons. Correlates to the Jornada II alluvium in the Desert Project, wl upper Pleistocene in age (Gile et al., 1981, table 9). This age range is consistent with a possibly finite ka from charcoal collected from fine-grained sediment correlated to Qf1 located 1.5 km southeast of (UTM coordinates of 414,580 \pm 60 m E, 3,641,500 \pm 60 m N; fig. 9 of Koning et al., 2002). Base of sediment filling the basin here is several hundred meters thick. Greater than 8 m-thick.
and silt: has a co	otherwise noted below, Quaternary gravel on this quadrangle consists of limestone and possible dolomite with 1-10% sandstone stone clasts, and trace to 5% Tertiary igneous rocks (unit Ti). Sand is subrounded to subangular. Medium to very coarse sand omposition consistent with a litharenite, whereas very fine- to fine-grained sand is more arkosic (as inferred using a hand lens).	Qf1sc	Silty clayey fine sand with subordinate sandy gravel and gravelly sand; deposited by fluvial, slonear the mountain front (upper middle(?) to upper Pleistocene) – Temporally equivalent to Qf1, wall of the Alamogordo fault, immediately adjacent to the mountain front, and has received much det processes. Sediment is light brown to pink (7.5YR 6/4-7/3) sand with very minor pebbles. Sand is a grained, subangular, and poorly sorted. The high gypsum content is consistent with high eolian input slopewash or colluvial processes. Sediment is massive, bioturbated, and has strong gypsum accumulation.
SLOPE	WASH		a stage III morphology in a calcic soil). At least 3 m-thick.
Qgysw	Gyspiferous slopewash (late Holocene) – gypsum and gypsiferous silt and very fine to fine sand reworked from locally adjacent, topographically higher basin-floor deposits (i.e., Qgy and Qbfy). Because these deposits lie below the inferred 1-2 ka maximum depositional surface (see discussion in report), they are inferred to post-date 2 ka. In the valleys cut into gypsum in the western quadrangle, these slopewash deposits are lumped with unit Qbfvf and Qah . Estimated thickness of 2-5 m.	BASIN Qbfy	FLOOR DEPOSITS Younger basin-floor deposits of intercalated clayey sand, fine sand, silt, and gypsum (middle locally in the northwestern part of the quadrangle. Not exposed, but surface sediment seems similation of more gypsum accumulation. Probably 1-2 m-thick were mapped
ARTIF	ICIAL FILL AND EXCAVATIONS	Qgy	Gypsum accumulation (middle(?) Holocene) – Yellowish white to pink (7.5YR 7/4) to very pale
ae	Artificial excavation (modern) – Pit, quarry, or reservoir; the base of these excavations have generally been filled by >10 cm-thick deposits of clay, silt, sand, and gravel carried into the pit by mass-wasting or slopewash processes.		been subjected to multiple dissolution and precipitation events. These processes have formed a har of this deposit. Underneath, gypsum is generally moderately consolidated, massive or in tabular be of silt and very fine- to coarse-grained sand-size, platy crystals (mostly very fine to fine-grained) th well-sorted. Locally, this gypsum sand is planar-laminated to low-angle cross-laminated. Very th
af	Artificial fill (modern) – Compacted silt, clay, and very fine to medium sand (minor coarse to very coarse sand and pebbles) under highways and railroads; also found in berms surrounding pits, quarries, or reservoirs. In the case of railroads and mounds in the White Sands Missile Range, very coarse pebbles and cobbles drape compacted fill.		foresets, seen at one locality near base of the deposit. Gypsum sand may include subordinate plagi a "fluffy" feel. Surface of unit may have microkarst topography where exposed on slope shoulders lain by pale brown (10YR 6/3) silt and very fine- to fine-grained sand a few 10s of meters thick. Ir ward expansion of the White Sands dune field in the middle Holocene. Deposit thickens westward ward with unit Qf3 (this transitional zone was mapped as Qbfgy). Deposit overlies Qbfo , probably ter of deposit commonly grades into more siliclastic sand that is clean, fine- to coarse-grained, and
	SITS SPANNING THE ALLUVIAL FAN AND BASIN FLOOR		ded (included in Qgy). In the western and southwestern parts of the quadrangle, the surface of this dant sinkholes and similar collapse features, whose locations and extents are shown on the map. T
Qam	Sand, silt, gravel, and clay associated with modern drainages on alluvial fans and the basin-floor (0-50 yrs old) – Sand, silt, and clay in various proportions at the mouths of small, discontinuous gullies. Sand and gravel dominate in the channel of Tularosa Creek. The surface of this unit exhibits fresh-appearing bar and swale topography (up to 30 cm relief). Sand is generally pink (5-7.5YR 7/3) to light reddish brown (5YR 6/3), very fine- to very coarse-grained, and poorly to well sorted. In the distal alluvial fans, this unit supports a moderate to dense cover of grass and mesquite. Bar and swale topography may be absent on distal alluvial fans. However, topography	fgy	of gypsum beds several meters below the surface (in underlying Qbfo). Up to 4 m-thick. Gradation-interfingering between gypsum and younger basin-floor deposits (middle to upper
	may still be present because of fine sediment (i.e., clay, silt, and very fine- to fine-grained sand) accumulating around dense vegetation, such as grass clumps and creosote bushes. Loose. Generally less than 2 m-thick.	ıgy	contains about 1/3-2/3 gypsum to 2/3-1/3 fine-grained, basin-floor sediment of unit Qbfy . Surface pinkish, gypsiferous silt and very fine- to medium-grained sand. Mapped where unit Qgy transition 1-3 m-thick.
Qah	Historical deposition of sand and silt at the mouths of discontinous drainages (50-200 yrs) – Light brown (7.5YR 6/4) silt and very fine- to fine-grained sand that is distinctly planar-laminated, low-angle cross-laminated (<0.5 cm-thick), or wavy laminated. Surface exhibits subtle scouring or possible bar forms. No observable soil development, desert pavement or clast varnish. Unit is generally less than 20 cm-thick and overlies unit Qf3. Only mapped where fluvial morphology can be seen on surface using aerial photographs. However, field investigations indicate that unit Qf3 may be locally overlain by 10-20 cm of this deposit, even though surface fluvial morphol-	Qgyes	Gypsum sand sheet (middle to uppermost Holocene) – Light-colored gypsum sand that lacks du described in detail because of access restrictions in the White Sands Missile Range.
	ogy was not apparent. This unit was deposited by sheet flood processes. 10-30(?) cm-thick.	Qgyh	Hardpan gypsum accumulation (uppermost Holocene) – Gypsum, as described in Qgy, that is f pan. Probably accumulated by repeated evaporation of ponded water during the late Holocene. Le
Qamh	A composite unit consisting of Qam (mostly) and Qah (0-200 years) – See descriptions of Qam and Qf3y above.	Qbfvf	Combined basin-floor and undifferentiated uppermost Holocene deposits (upper Pleistocene
Qahm	A composite unit consisting of Qf3y (mostly) and Qam (0-200 years) – See descriptions of Qam and Qf3y above.		unit occupies the floors of valleys of drainages that incised below unit Qgy. Lack of exposure and presented difficulty in recognizing thin, discontinuous latest Holocene to modern deposits (Qam and deposits (unit Qbfo). Thus, these units were generally combined on these valley floors. Latest Holocene (2.5Y 6/3), internally massive, well-sorted, subangular, and consists of silty sand composed
			plagioclase).

nd, and subordinate gravelly sand and clay (upper Holocene) – This unit underlies the majority of alluvial fan Obfo area, and coincides with both agricultural and urban areas. Sediment color generally ranges from light reddish eddish brown (5YR 5/3-4), brown to light brown to pink (7.5YR 5/4, 6/3-4, and 7/4), and pinkish gray (7.5YR 6/2) (2). Sediment consists of a clayey-silty very fine- to medium-grained sand that is moderately sorted. The fine sedissive or in thick, vague beds that may be bioturbated (minor planar-laminations). Locally, coarse to very coarseat and minor pebbles may be scattered in a sandy matrix. There are also minor coarse channel-fills consisting of bebbles. These coarse channel fills are in thin to medium beds that are broadly lenticular to lenticular. Pebbles are e with 1-5% fine cobbles, subrounded, and poorly sorted. Sand in coarse channel-fills is dark reddish gray to red-(5/3), very fine- to very coarse-grained, and poorly sorted. The overall less gravelly texture helps in differentiating y Qf2 deposits. The surface is generally not as bouldery and cobbly as that associated with Qf2, but yet commonly bbble gravel lag in the medial and proximal fan areas that indicates erosion of the surface (see Qf3c description bes slight bar and swale relief of 10-30 cm. Its desert pavement has weak to no clast armor and no to slight varnish. haracterized by gypsum accumulaton as filaments or disseminated (comparable to a stage I in a calcic soil horizon). **Obfu** verlies Qf1 (see Figure 3), and appears to interfinger laterally into unit Qgy (the transitional zone was mapped as v corresponds to Qf3m and Qf3L of Koning (1999) and Koning et al. (2002), and to Qf3 of Koning et al. (2007). Organ alluvium in the Desert Project, which have been assigned an age of 7-1 ka (Gile et al., 1981). A Qf3 deposit lluvial fan south of Alamogordo consisting of an in-filled swale returned a C-14 age of 1980 ± 50 yrs (Koning, , 2002). On the distal alluvial an southeast of this quadrangle, a C-14 date from charcoal returned an age of 5140 TERTIARY IGNEOUS ROCKS IN SACRAMENTO MOUNTAINS ears; Table 2). Generally less than 2 m-thick, but locally as much as 3-4 m (particularly in the medial and proximal

Qf3am Comination unit of Qf3 and Qam (upper Holocene to modern) – See descriptions of Qf3 and Qam above. Qf3c Gravelly sand and gravelly sand (upper Holocene) – Sediment color generally ranges from light reddish brown (5YR 6/3-4), reddish brown (5YR 5/3-4), brown to light brown to pink (7.5YR 5/4, 6/3-4, and 7/4), and dark reddish gray (5YR 4/2). This unit consists of silty-clayey sand intercalated coarse channel-fills This sediment is similar to unit Qf3 (see above), but has slightly more coarse channelfills of pebbly sand to sandy pebbles. Beds are thin to medium and broadly lenticular to lenticular (locally cross-stratified). Pebbles are very fine to very coarse with 1-5% fine cobbles, subrounded, poorly sorted, and composed of limestone with very minor clasts of Paleozoic sandstone-siltstone and Tertiary intrusives. Sand is very fine- to very coarse-grained and poorly sorted. Because of the general lack of exposures, this unit was mapped via aerial photographs for deposits underlying surfaces with more than 10-20% surface gravel coverage. Surface has slight bar and swale relief of 10-30 cm. Its desert pavement has weak to no clast armor and no to slight varnish. Surface soils characterized by gypsum accumulation (for comparative purposes, similar in amount to a stage I to II in a calcic soil). Commonly has a pebble to fine cobble gravel lag in the medial and proximal fan areas that indicates erosion of the surface; however, the surface has less coarse gravel compared to the surface of Qf2. Unit unconformably overlies Qf1 (see Tu-154 stratigraphic section in Figure 3). Like unit Qf3, this unit correlates to the Organ alluvium of the Desert Project by Las Cruces and ranges in age from 7 to 1 ka (Gile et al., 1981); most deposits are probably 5-2 ka. Weakly consolidated and 1-4 m-thick.

Qf3s Sand and silty sand (middle to upper Holocene) – Pink to reddish brown (7.5YR 7/4 to 5YR 5/4) silty very fine- to fine-grained sand with minor medium- to very coarse-grained sand. Sand is moderately to well sorted and contains minor pebble beds. Mapped immediately north of Tularosa Creek for an area that is tanner and sandier than sediment found near the northern border of the quadrangle. This unit probably extends south of Tularosa Creek, but its extent there is obscured by agricultural activity. Unit is also differentiated in the southeastern quadrangle near the railroad tracks. Base of unit not observed in field, but presumably it probably overlies **Qf1**. Probably

Qf3sh Sandy distal alluvial fan deposits forming topographic highs (middle to upper Holocene) – Sand and minor pebbly sand forming slight topographic highs near the basin-floor alluvial fan transition. Only mapped in the south-central portion of the quadrangle. Sand is light brown (7.5YR 6/3-4), very fine- to medium-grained, moderately sorted, and contains minor silt. Has <15% patches of strong gypsum accumulation exposed on its surface, but generally gypsum accumulation in the soil is probably similar to that of unit Qf3. Base of unit not observed in field, but presumably it overlies **Qbfo**, **Qf3**, or **Qf1**. Unit supports moderate creosote and grass vegetation. Probably

because of its gravelly texture, slightly older surface (and associated higher gypsum content), and its topographically high nature. Unit consists of a reddish brown (5YR 5/4) pebbly sand. Sand is very fine- to very coarse-grained. Pebbles are very fine- to very coarse and locally includes 5% fine cobbles. Pebbles are subrounded to subangular, dominated by limestone, and form a weak to moderate pavement (generally greater than 10% clast surface cover). Clasts are weakly to moderately varnished. Surface lacks original bar- and swale relief and generally has <15% patches of strong gypsum accumulation. Surface gravel may overlie pink (7.5YR 7/3), internally massive, silty-clayey very fine- to fine-grained sand, with minor medium to very coarse sand; sediment contains 5% gypsum filaments (equivalent to a stage I in a calcic soil). The clast armor allows preservation of broad but yet elongated, relatively flat surfaces that stand 20-120 cm above surrounding, eroded low areas. Surface supports a moderate cover of creosote (mostly) and other shrubs (about 3 plants per 5 m²).

trachyandesites, trachyandesites, and dacites by McManus and McMillan (2002) and as diorite (minor camptonite) by Asquith (1974). However, we call this rock a syenite, consistent with mapping of these intrusive rocks to the northeast on the Cat Mountain quadrangle

tions of these units above.

several hundred meters thick before Paleozoic bedrock is encountered.

SEDIMENTARY ROCKS IN SACRAMENTO MOUNTAINS

v York, John Wiley & Sons, Inc., 398 p.

east (McManus and McMillan, 2002).

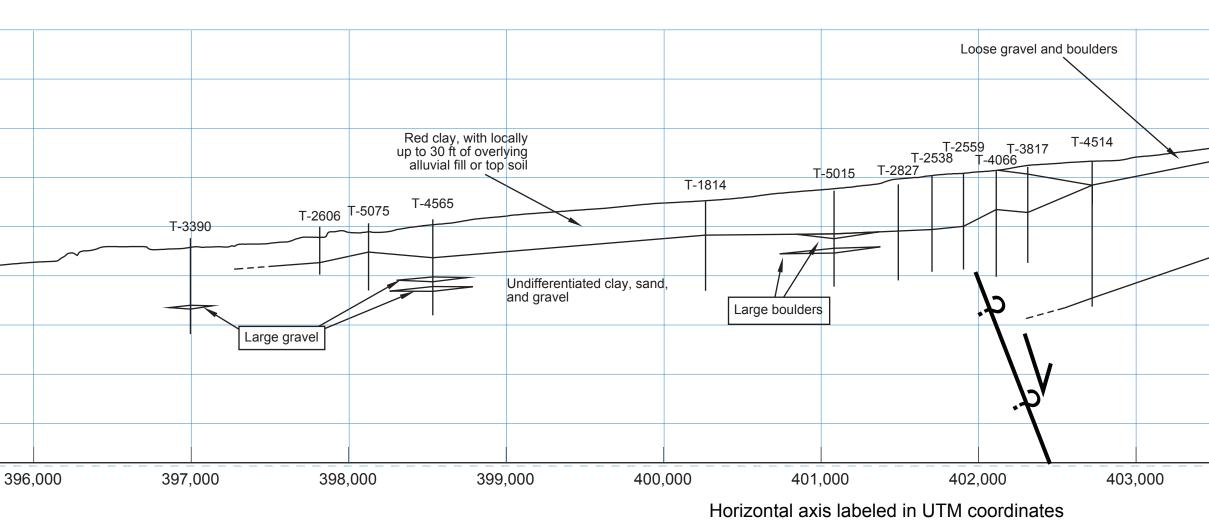
(1961).

Bursum Formation (uppermost Pennsylvanian(?) to lowermost Permian) – Subequal mudstone relative to sandstone and pebbly sandstone beds; these sediments are intercalated with 20-25% limestone beds. Mudstone consists of weak red, reddish gray, and dark reddish gray (2.5-5YR 4-5/2) mudstone and sandy claystone, where the minor sand is very fine- to coarse-grained and arkosic. Sandstone and pebbly sandstone occupy medium to thick, lenticular to tabular channel-fills; internal bedding is massive to planar-laminated or in very thin to medium, planar to lenticular beds. Channel-fill sediment is pinkish gray to reddish gray (5YR 5-6/2) to pinkish gray (7.5YR 6/2). Sand is fine- to very coarse-grained, angular to subangular (mostly) to subrounded, moderately sorted, and an arkose to lithic arkose. Pebbles are very fine to very coarse (mostly very fine to medium) and consists of poorly sorted subangular to subrounded granite with various proportions of subrounded to rounded quartzite. One conglomerate bed on the northern quadrangle boundary consists of imbricated, subrounded to rounded, very fine to very coarse pebbles and fine cobbles (up to 10 cm-long) of quartizite and granite; estimate a 60:40 ratio of granite to quartzite and clast imbrication is to the west. Limestone beds occupy medium to thick (mostly thick), tabular beds and are gray to light gray (2.5-5Y 5-7/1) and commonly micritic (at least in the quadrangle area). Very thick limestone beds (~2 m-thick) that cap the ridge top contain intraformational conglomerate of locally transported limestone clasts (probably transported only a few meters); these weather to form a knobbly outcrop. Strata are well-cemented. Unit called the Laborcita Formation by Otte (1959), but we favor retaining the Bursum Formation here (see Lucas and Krainer, 2004). Exposed thickness on quadrangle is 40 mthick. Age control obtained from fusulinids indicate a general lower to middle(?) Wolfcampian age (~299-290 Ma); this would be equivalent to earliest Permian given that the Wolfcampian is included in the Permian at the time of writing. Total thickness of this for-

ACKNOWLEDGMENTS

REFERENCES

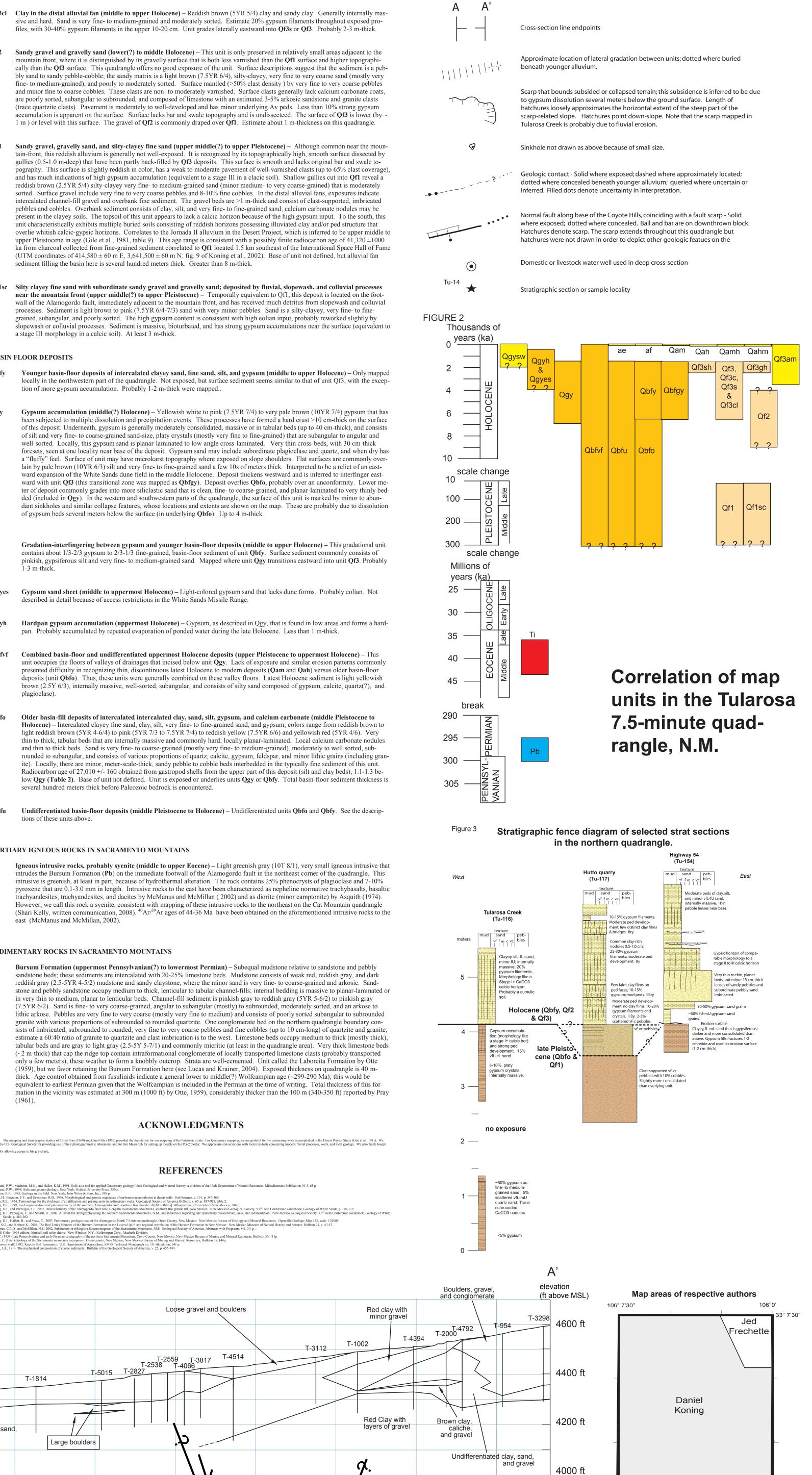
csedimentary rocks: Geological society of American Duration and the society of New Mexico and fault, southern Rio Grande rift [M.S. thesis]: Albuquerque, University of New Mexico Compared to Manufating Southern Rio grande rift, New Mexico: New Mexico



(meters, zone 13).

e accompanying report). The deposit resumably it overlies **Qbfo**, **Qf3**, or y under any silty-clayey fine sand man-

EXPLANATION OF MAP SYMBOLS



TULAROSA 7.5-MINUTE QUADRANGLE, NM

3800 ft

4906,000

FIGURE [^]

relatively small areas adjacent to the e Qf1 surface and higher topographitions suggest that the sediment is a peby fine to very coarse sand (mostly very y) by very fine to very coarse pebbles generally lack calcium carbonate coats, arkosic sandstone and granite clasts peds. Less than 10% strong gypsum

ut 1 m-thickness on this quadrangle. **ne**) – Although common near the mouncally high, smooth surface dissected by h and lacks original bar and swale tomished clasts (up to 65% clast coverage), . Shallow gullies cut into **Qf1** reveal a ry coarse-grained) that is moderately istal alluvial fans, exposures indicate consist of clast-supported, imbricated ; calcium carbonate nodules may be

viated clay and/or ped structure that , which is inferred to be upper middle to inite radiocarbon age of $41,320 \pm 1000$ st of the International Space Hall of Fame e of unit not defined, but alluvial fan

slopewash, and colluvial processes Qf1, this deposit is located on the footh detritus from slopewash and colluvial is a silty-clayey, very fine- to fineinput, probably reworked slightly by imulations near the surface (equivalent to

Idle to upper Holocene) – Only mapped imilar to that of unit Qf3, with the excep-

pale brown (10YR 7/4) gypsum that has hard crust >10 cm-thick on the surface r beds (up to 40 cm-thick), and consists ed) that are subangular to angular and y thin cross-beds, with 30 cm-thick lagioclase and quartz, and when dry has alders. Flat surfaces are commonly over-Interpreted to be a relict of an eastward and is inferred to interfinger eastbably over an unconformity. Lower meand planar-laminated to very thinly bedthis unit is marked by minor to abun-

oper Holocene) – This gradational unit face sediment commonly consists of sitions eastward into unit **Qf3**. Probably

dune forms. Probably eolian. Not

is found in low areas and forms a hard-Less than 1 m-thick.

ene to uppermost Holocene) - This and similar erosion patterns commonly **n** and **Qah**) versus older basin-floor Holocene sediment is light yellowish osed of gypsum, calcite, quartz(?), and

Older basin-fill deposits of intercalated intercalated clay, sand, silt, gypsum, and calcium carbonate (middle Pleistocene to Holocene) – Intercalated clayey fine sand, clay, silt, very fine- to fine-grained sand, and gypsum; colors range from reddish brown to light reddish brown (5YR 4-6/4) to pink (5YR 7/3 to 7.5YR 7/4) to reddish yellow (7.5YR 6/6) and yellowish red (5YR 4/6). Very thin to thick, tabular beds that are internally massive and commonly hard; locally planar-laminated. Local calcium carbonate nodules and thin to thick beds. Sand is very fine- to coarse-grained (mostly very fine- to medium-grained), moderately to well sorted, subrounded to subangular, and consists of various proportions of quartz, calcite, gypsum, feldspar, and minor lithic grains (including granite). Locally, there are minor, meter-scale-thick, sandy pebble to cobble beds interbedded in the typically fine sediment of this unit. Radiocarbon age of 27,010 +/- 160 obtained from gastropod shells from the upper part of this deposit (silt and clay beds), 1.1-1.3 below Qgy (Table 2). Base of unit not defined. Unit is exposed or underlies units Qgy or Qbfy. Total basin-floor sediment thickness is

Undifferentiated basin-floor deposits (middle Pleistocene to Holocene) - Undifferentiated units Qbfo and Qbfy. See the descrip-

Igneous intrusive rocks, probably syenite (middle to upper Eocene) – Light greenish gray (10T 8/1), very small igneous intrusive that intrudes the Bursum Formation (**Pb**) on the immediate footwall of the Alamogordo fault in the northeast corner of the quadrangle. This intrusive is greenish, at least in part, because of hydrothermal alteration. The rock contains 25% phenocrysts of plagioclase and 7-10% pyroxene that are 0.1-3.0 mm in length. Intrusive rocks to the east have been characterized as nepheline normative trachybasalts, basaltic (Shari Kelly, written communication, 2008). ⁴⁰Ar/³⁹Ar ages of 44-36 Ma have been obtained on the aforementioned intrusive rocks to the

mation in the vicinity was estimated at 300 m (1000 ft) by Otte, 1959), considerably thicker than the 100 m (340-350 ft) reported by Pray

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