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Geomorphic Surface Maps of the southern Animas Creek valley, Hidalgo County, New Mexico

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INTRODUCTION

Scope and Acknowledgments

This report is the initial product of a study aimed at linking geomorphology, as a substrate, with the ecology of high desert grasslands in southwestern New Mexico (Figure 1). Fourteen geomorphic surface maps (7.5' quadrangles at 1:24,000 map-scale) accompany this document, and the location of each plate is shown on Figure 2. The report elaborates on the philosophical basis and methods of the project including brief geologic history, then explains the meaning of the symbols used to identify the map units. Detailed soil descriptions are provided for reference. Interpretation of the area's earthquake hazard, based on this work, is discussed by Vincent (1998).

This project was funded by the U.S. Forest Service[1]. The Animas Foundation provided accommodations and welcome, and the University of Arizona and the U.S. Geological Survey provided administrative and technical support. We thank Carl Edminster, Bob Webb, Ben Brown, Jennifer Madina, Natalie Runyan, Ray Turner, and Pete Sundt for encouraging the project, for making the logistics smooth, for insight, and for friendship. Ground-truth access was granted by the Animas Foundation, the Hadley families, and the Gault and Woodling families. Other land-ownership areas were not visited, rather were mapped with aerial photographs alone, without on-the-spot approval or prior approval for our field companion Pete Sundt. Ben Bass excavated soil pits. Waite Osterkamp, Phil Phearthree, Jay Quade, Bill Bull, Esteban Muldavin, and John Kipp freely gave their perspectives on the geomorphology, soils, and manuscript.

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[1] Rocky Mountain Forest and Range Experiment Station cooperative agreement 28-C5-902.

Mapping Philosophy and Purpose

Purpose

The objective of mapping the Animas Creek valley (Figure 1) was to present the surficial geology in a way most relevant to ecology. This was done in hope of establishing associations between plants and their geological substrate or environment (Vincent et al, in prep.) that might ultimately provide scientific bases for land-use (grazing) management tools. The result is a set of fourteen geomorphic-surface maps (Figure 2). As used here, a geomorphic surface is a piece of the landscape, an area of ground, that has the same geomorphologic origin within; be that erosional hillslope, depositional bottom land, or abandoned and stable alluvial fan remnant. Stream terraces and fan remnants were also mapped by age to account for time-dependent soil development that usually occurs on stable landforms. Hillslopes were distinguished by the geology of the material being weathered, eroded, and transported downhill; be that rhyolitic bedrock or unconsolidated basin-fill alluvium. Substrate properties should be uniform, ostensibly, among surfaces having similar geomorphologic origin. Surfaces designated with the same map symbol should have similar position in the landscape, slope, and aspect, in addition to soil properties.

Geomorphic surface map-units are therefore ideal for predicting landscape areas having similar surface and substrate properties (physical, chemical, and hydrological) important to plants, and for distinguishing among those areas with significantly differing properties. The soul of the endeavor is understanding the history of processes affective in the landscape, the sequence of events, as the basis for the map-unit scheme and map-unit correlation.

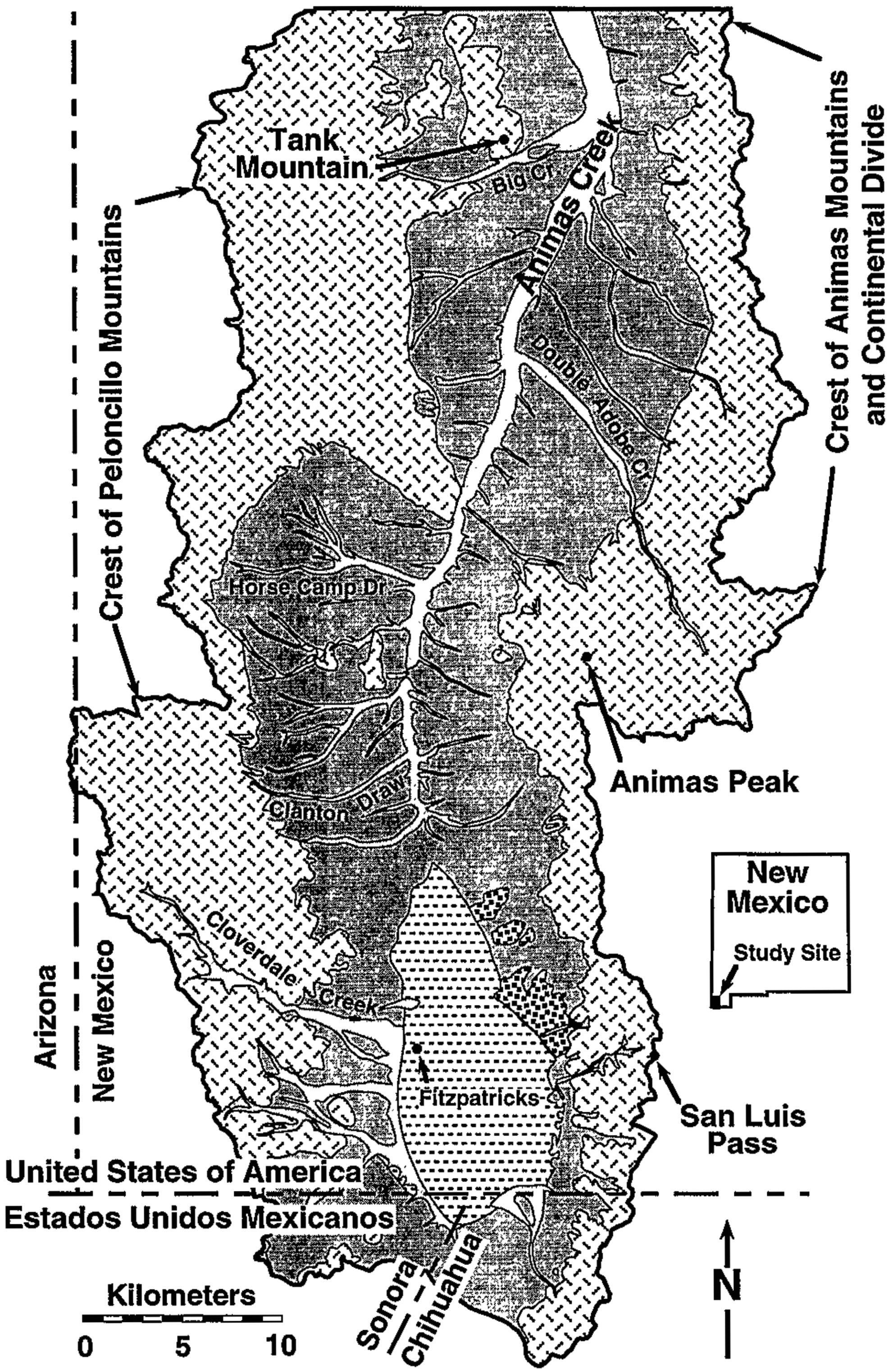


FIGURE 1: Location of the geomorphic mapping study in the Animas Creek valley of southwestern New Mexico.

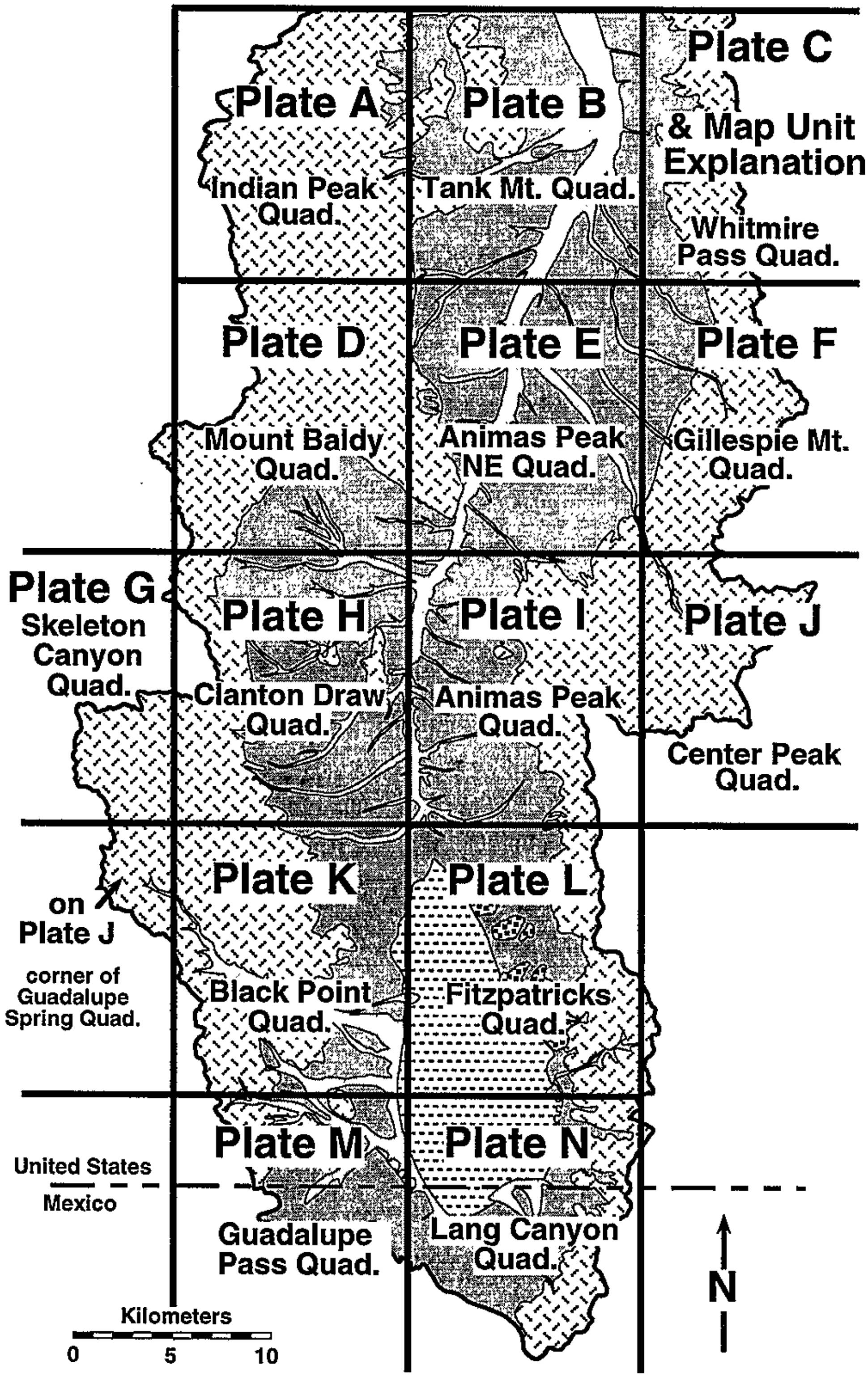


FIGURE 2: Location of geomorphic surface maps (Plates) within the study area.

Methods

To learn that geomorphic history, we searched the field for characteristic topography and geologic composition indicative of landform origin, and for crosscutting relationships indicative of the sequence of events. We inspected natural soil exposures and excavated soil pits and described the nature of soils and deposits therein to help us understand further the geomorphic history, to refine the map unit scheme, to confirm map unit correlation over the region. The sources of soils terminology are found in the section on soil descriptions. We concentrated our efforts mapping the alluvial piedmont, but also compiled bedrock hillslopes by lithology (Table 1) from the geologic maps of previous workers.

We roved the landscape with aerial photographs in hand to calibrate the photographic appearance of each landform and to recognize the spatial extent of landforms. We traced map-unit contacts on mylar overlays, and then transferred them from photographs to base maps by eye, after studying the topographic contours and geography together with the similar-scale photographs. Most of the study area was covered by 1:24,000 color aerial photographs[2], but the western and northwestern margins (Figure 3) were covered only by black-and-white photographs enlarged (about three times original) to 1:24,000 scale[3]. Mapping with the black-and-white photographs was less accurate than with the color photographs. The thickness of contact-lines on the finished plates represents ≈20 m on the ground, and accurately depicts the location of most geomorphologic

[2] Color aerial photographs were provided by the Animas Foundation.
[3] Black-and-white photographs were used courtesy of Javier Montoya, USDA Natural Resources Conservation Service, Lordsburg office.

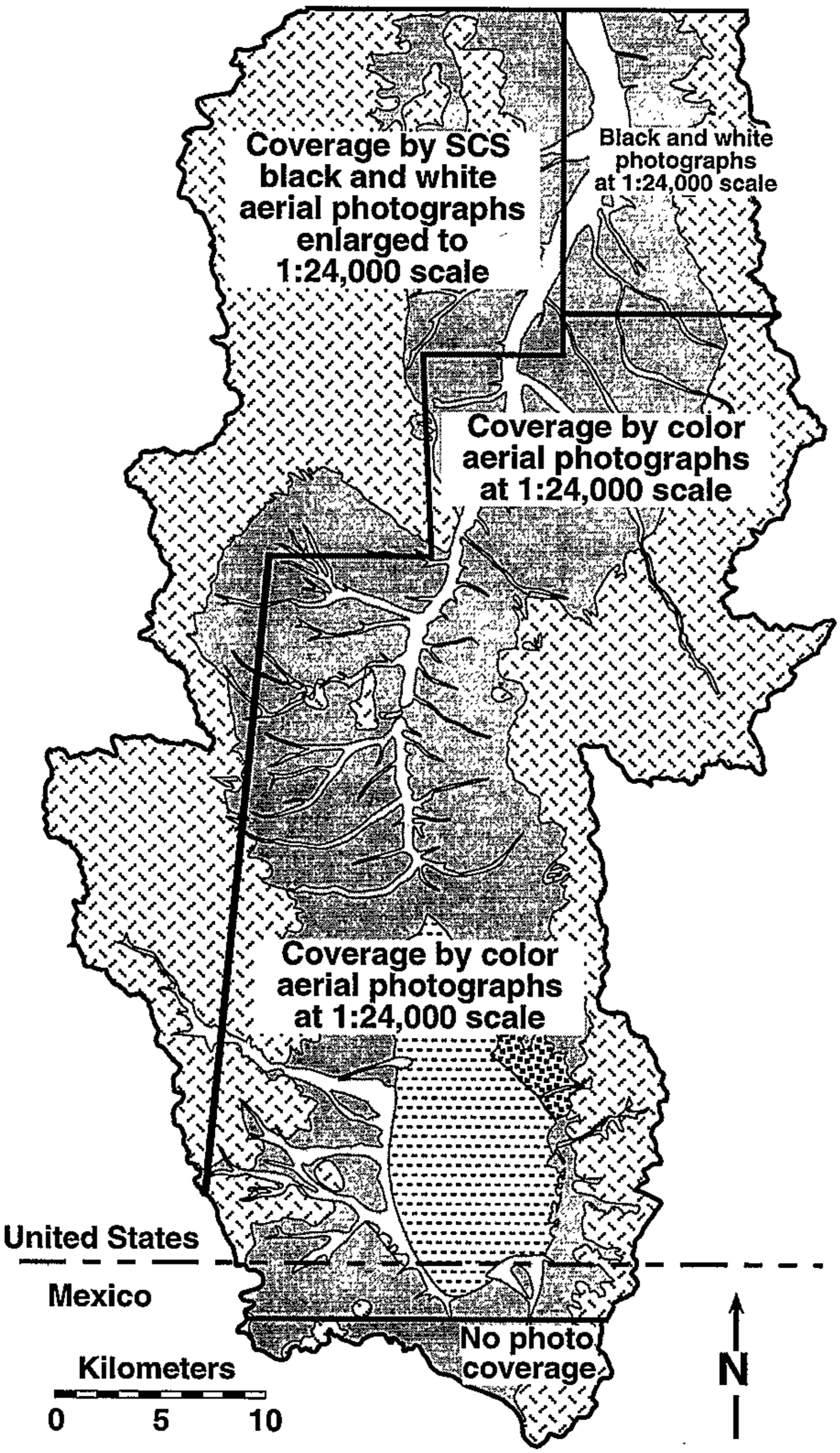


FIGURE 3: Coverage of aerial photograph resources used by this study.

contacts. Certain landscape contacts, like the crests of terrace risers cut into old fan remnants, are transitional and thus their locations are subjective

The mapping effort was focused on the ecological purpose, and thus deviates from some geological mapping conventions. Two conceptual differences between this and other geologic maps in particular are worth mentioning.

Surfaces in Alluvium

The geomorphic surface maps presented here differ from traditional geologic-deposit maps or Quaternary geology maps: like the generalized geology of the study area on Figure 4. Traditional geologic maps depict the locations of deposits (volumes) that accumulated during some period of geologic time. In concept at least, our maps depict the contact of earth and atmosphere (surfaces), as illustrated on Figure 5. The ground surface is composed of extant unconformities, in that time is missing from the depositional geologic record. Steep hillslopes are erosional unconformities, as hillslope processes slowly detach colluvium, and underlying rock or sediment, and transport them downslope. Alluvial fan remnants are capped by surfaces of non-deposition by streams, since the threshold change from basin aggradation to abandonment by stream incision. The time since fan or terrace formation is recorded not by stream deposits, but by soil development over centuries and millennia (e.g. Harden, 1982) including accumulation of air-fall dust and chemical weathering among other processes (e.g. Reheis et al., 1995).

Geomorphic surface maps, in contrast to deposit maps, subdivide terrace treads from terrace-riser hillslopes (Figure 5), even though they may overlie the same deposit. For example, we distinguish the old fan

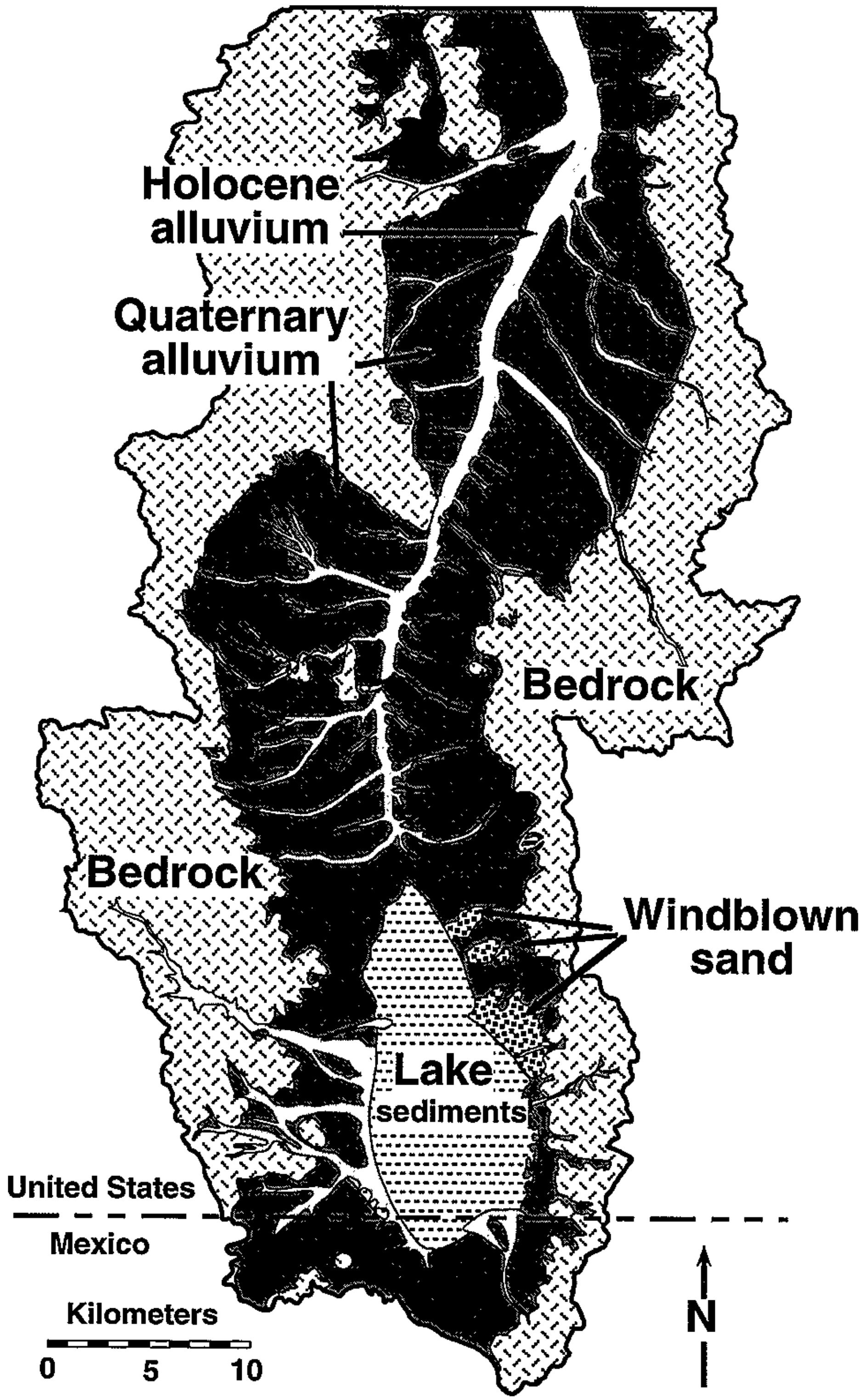


FIGURE 4: Generalized geologic map of the study area.

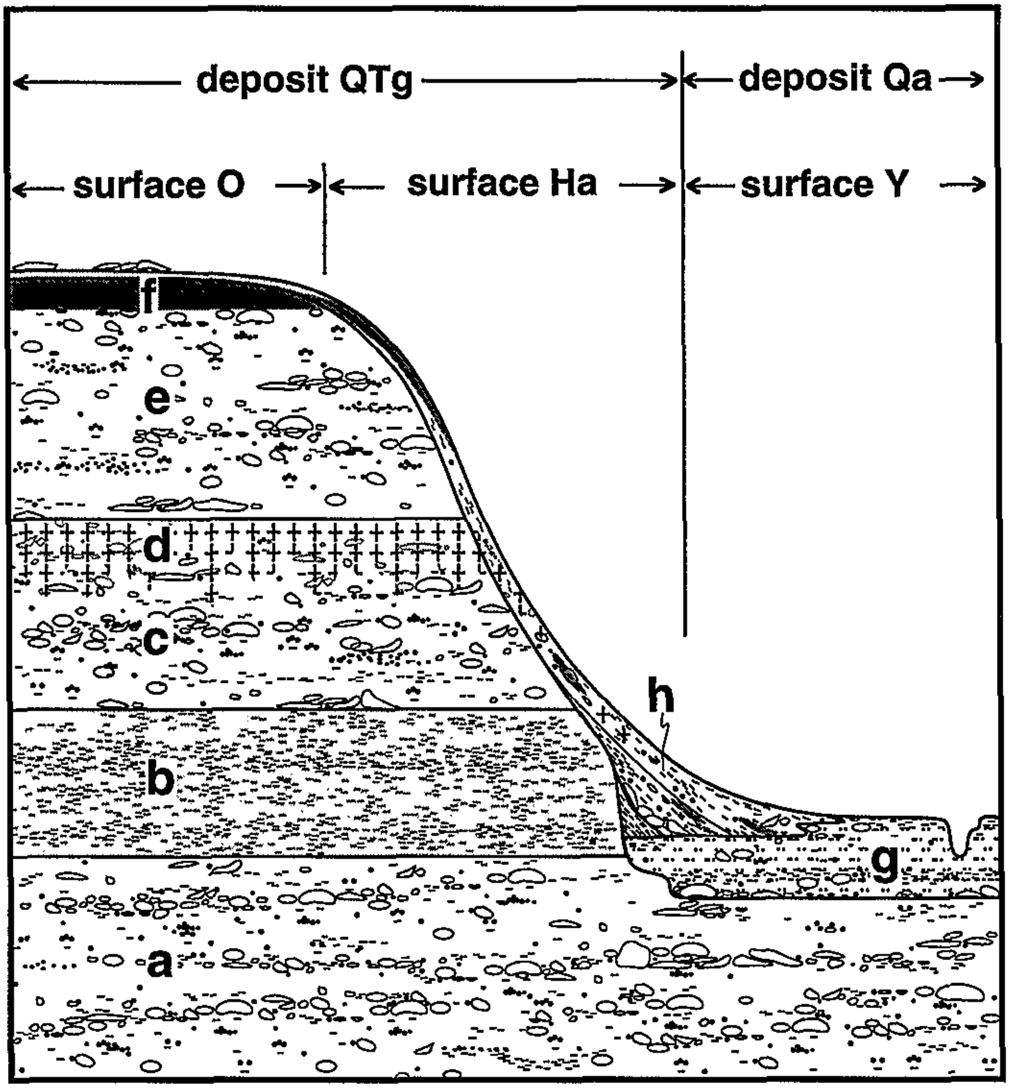


FIGURE 5: Idealized cross-section of a terrace-riser hillslope cut into alluvium (Ha) illustrating a distinction between Quaternary deposit and geomorphic surface map-units. The example, although hypothetical, is drawn from observations made in the Animas Creek valley. The letters indicate the geologic sequence from oldest (a) to youngest (h). The basin was filling with sediment (QTg) in the Quaternary (and posibly late Tertiarty) that consists of fan-gravel (deposits a, c, and e) with an interbedded over-bank silt (deposit b). A carbonate paleosol (d) indicates a pause in fluvial deposition. The basin stopped filling, abandoning broad alluvial fans surfaces (O), because climate change more than 100 thousand years ago caused streams to incise. Subsequently, red clay soil-horizons (f) developed in-place on the old fans. About 6,000 years ago streams began slow aggradation of silt, sand and gravel (deposits g or Qa) in the valley bottoms culminating in the present surface (Y). Throughout the Holocene, and before, many processes have acted to detach and transport material down hillslopes, leaving thin colluvial soils (h), of highly variable composition, underlying geomorphic surface Ha.

remnant surface (O), with its clay rich soil, from the terrace riser hillslopes cut into Quaternary alluvium (Ha). This distinction is ecologically significant because terrace risers can have greater bio-diversity than do terrace treads (McAuliffe, 1994). Terrace treads are depositional unconformities that are necessarily low in gradient, have uniform parent-material (the same gravel everywhere, more or less), and the formative process (stream flow) ceased everywhere during a brief period of geomorphic time. Their low gradients (< 2°) are important for two reasons. First, soil-mixing processes involving rodents, insects, plant roots and shrink/swell of clay are not effective at downslope transport of soil mass, so dust fall accumulates and weathers to clay soil. Low gradients also mean that solar aspect has minimal importance. The result is spatially homogenous soil and vegetation, evidently, on fan remnants. Terrace riser hillslopes, in contrast, can be ecologically diverse because they are erosional, steep (often 20°) with effective downslope mass-transport, and are faceted into small areas with many solar aspects. Detachment and transport processes may uncover parent material of great variety (Figure 5), thus hillslope surfaces may overly soils of various types and thicknesses.

Bedrock Hillslopes

Geologic maps traditionally organize bedrock map-units by rock-type (mineral/chemical composition and fabric or structure), age, local or formational name, and facies, among other characteristics. Here bedrock lithology (mineral/chemical composition) is a subcategory of hillslopes, without regard to other geological information. The bedrock geology of the area has been mapped in various detail by previous workers (Table 1; Figure 6). We remapped only small areas along the mountain/basin fill margin, because the focus of this project was on the unmapped alluvial

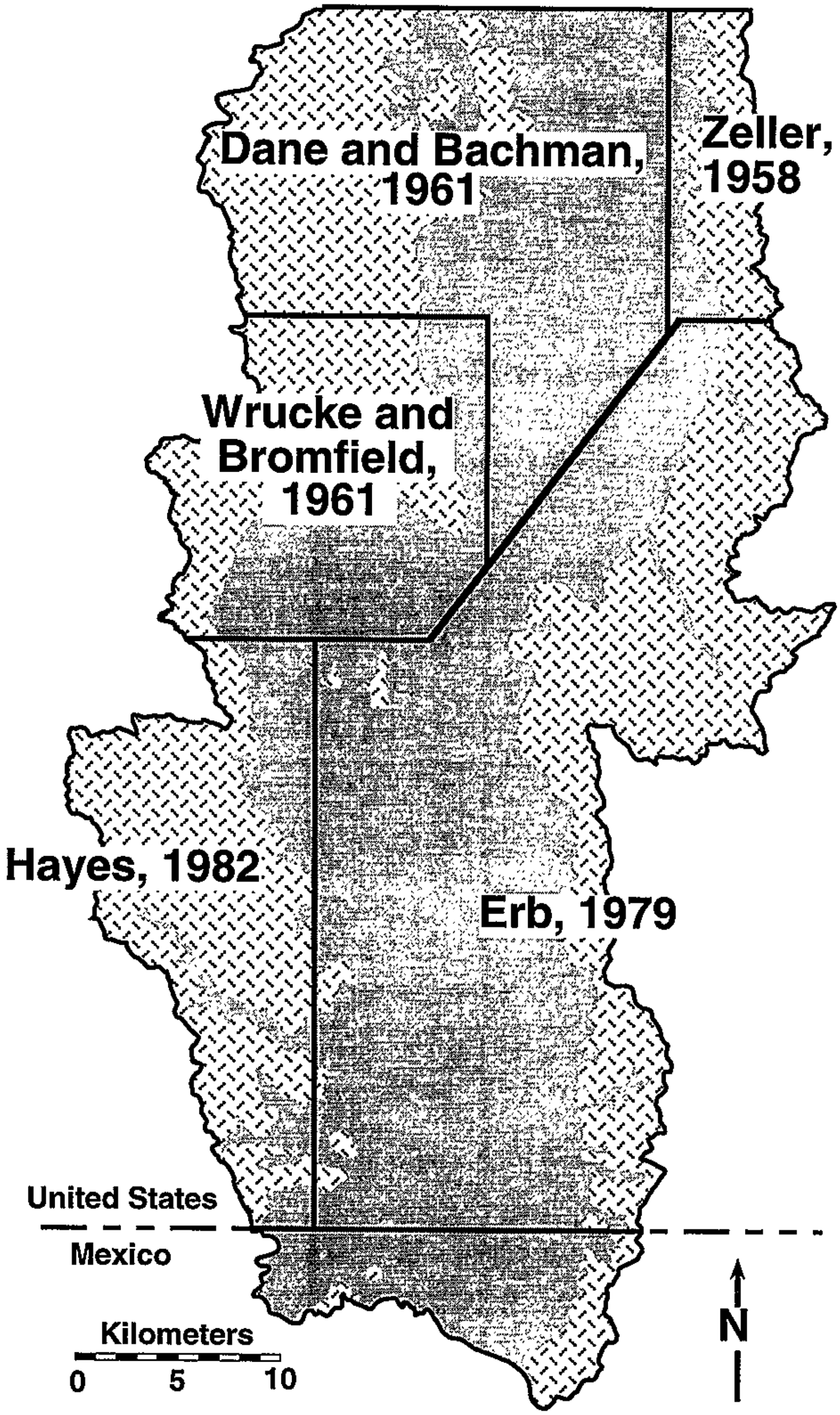


FIGURE 6: Location of bedrock geology maps, from previous workers, used by this study.

TABLE 1: Rock map-units from previous workers, in and near the Animas Creek valley, New Mexico, grouped by lithology for this study.

Map symbols used in this report											
Hr	Hl	Hd	Hn	Hb	Hn-r	Hc	Hv	Hq	He	Au ††	Yu ††
Rock lithology											
Rhyolite	Latite ‡	Dacite	Andesite	Basalt	Mixed	Congl-omerate	Volcani-clastic	Sand-stone †	Lime-stone	Alluvium undiff.	Holocene alluvium
Map units from Erb, 1979											
Tbr	Ta	Tdg	Tch	QTpm		Tcc	Tbb	Tkt	Kb	QTg	Qal
Tcd	Tbbc	Tgp	Tcp	Tsm		Tcr	Tbc	Km	Pch	Tav	
Tg	Tbs	Tom	Ttd	Tsp		Tec	Tbh	Ku	Pcl	Tavu	
Tgc	Tcq	Trh		Twm		Tgs	Tc		PIPh		
Tgr	Tda					Tok	Tub				
Tmc	Tql					Tps	Tvap				
Toc	Ts					Tss	Tvcr				
Tp	Tsq						Tvnh				
Tpc	Tw						Tvs				
Tpt											
Trt											
Tsc											
Tsr											
Twc											
Twg											
Map units from Hayes, 1982											
Trl	Tb	Td		Qtb		Tct	Tps	Km	Kmu	QTg	Qal
Tro	Tl					Tvc			PIPn		
Trt	Tql										
Try											
Map units from Wrucke and Bromfield, 1961											
Trt					Tal	Ts				QTal	Qal
Tt											
Tr											
Map units from Zeller, 1958											
	KTI				P€g ‡‡			€ODu	KI		
					Tvu			Ks	Mu		
									IPPu		
Map units from Dane and Bachman, 1961											
Tvu					Tvl						

‡ Tw, Ta, and KTI are monzonite, but are included under chemically equivalent Latite.
† Hq sandstone may be limy, contain limestone beds, or contain shale.
‡‡ P€g is a small body of granite (chemically equivalent to rhyolite) is included under Hn-r.
†† Undifferentiated alluvium Au and Yu are used only where aerial photographs were not available for remapping, like in Mexico. Otherwise, hillslopes in unconsolidated alluvium (Ha), and alluvial depositional surfaces (V, O, M, and Y), were mapped.

piedmonts—the uplands of grasses and scrubs. The 90 rock units identified by previous workers (Table 1) were collapsed by lithology into 7 hillslope map units, and by necessity into several mixed-lithology units. The southern Animas Creek valley is unique because virtually all rocks are volcanic in origin, and span the range of volcanic rock-types (Figure 7): basalt, andesite, dacite, latite, and rhyolite. Thus there are systematic trends in major-element chemistry in the source rocks of the entire area (Figure 7). The influence of mineralogy (chemistry) on rock weathering susceptibility and weathering products should be a first-order explanation of extant hillslope soils (e.g. Birkeland, 1984). If rock chemistry is manifest in the ecology of hillslopes, then it should be discovered by mapping by rock-type, as done here.

Note that most rocks in the area are rhyolite (surface Hr) and latite (Hl) that are rich in silica (SiO2), and andesite (Hn). Basalt (Hb) is found at only isolated locations. Limestone (He) and limy sandstone (Hq) are limited to the extreme northeast corner of the map area on Plate C, and colluvial and alluvial soils on those materials have elevated pedogenic calcium carbonate (denoted with the k+ symbol) as expected (e.g. McFadden et al., 1991). Mixed-volcanic lithology classes were used for hillslopes underlain by undifferentiated rock (Hn-r). Volcaniclastics (Hv), conglomerates (Hc), and unconsolidated alluvium (Ha) were further distinguished by degree of consolidation. Other rock properties (like joint spacing, fabric, welding, and interbedding) probably influence mountain hillslope ecology, but those data were not consistently available. Localized cliffs, for example, clearly result from these other rock properties. Fortunately, topographic manifestations (slope, aspect, and altitude) of these "rock controls" are captured in the contour lines of the base maps.

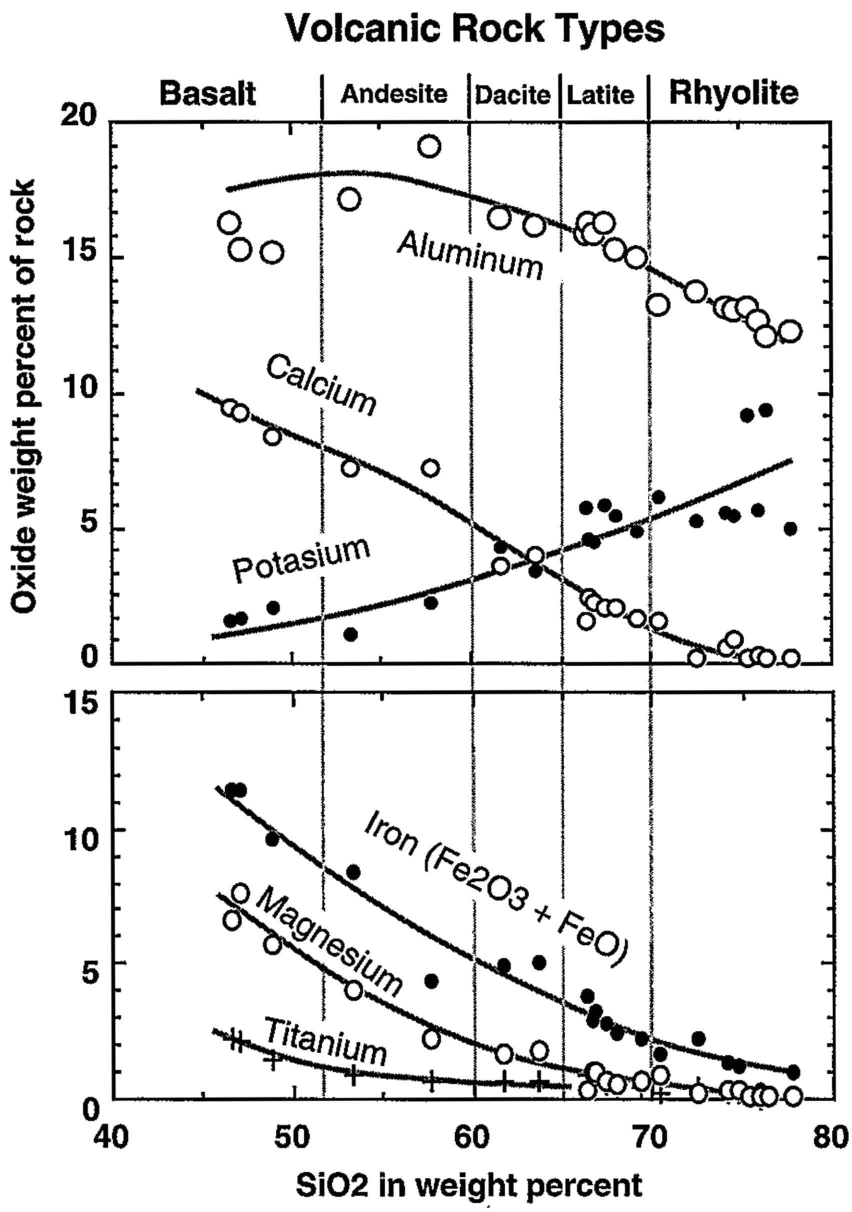


FIGURE 7: Major element geochemical trends in the volcanic rock suite, illustrated using data from Bryan (1995) for rocks in the southern Animas Creek valley, New Mexico, study area. Basalt (rich in calcium, iron, and magnesium) is closest to the composition of the mantle: the source of volcanic mass and heat. Rhyolite is at the other end of the spectrum, resulting from chemical differentation (separation or isolation of compounds) as mantle material migrates and melts its way through the earth's crust to vent at the surface; and as such is enriched in potassium and silica. Rock lithology, as a proxy for the control of available chemistry on weathering-derived soils, could provide a partial explanation of plant distributions on mountainous hillslopes.

DISTRIBUTION OF GEOMORPHIC SURFACES AND GEOLOGIC HISTORY

The distribution and nature of geomorphic surfaces, and their underlying deposits and soils, is the result of the geologic history of the southern Animas Creek valley. That history is outlined here for completeness and to clarify the map-unit scheme based upon it. We use numeric age estimates[4] of deposits and surfaces to help quantify the history. These age estimates rely on general familiarity with soil chronosequences (e.g. Vincent et al., 1994) and Quaternary geomorphic history based on other studies in the Southwest (e.g. Gile et al., 1981; Bull, 1991), as well as direct dating of local deposits (Krider, 1997; Bryan, 1995; and Erb, 1979).

The Animas Creek valley is divided into three alluvial sub-basins on Figure 8 (upper, middle, and lower), because the distribution and nature of landforms are not uniform throughout the study area (Figures 4 and 9). In summary, the lower (downstream) basin has experienced tectonic subsidence relative to the rest of the area, and is lower in altitude. It also has a drier climate (Cox, 1973) explaining the greater abundance of calcium carbonate in the soils of that area. The middle basin (Figure 8) experienced accentuated stream incision, caused by the relative subsidence (base-level fall) of the lower basin, and this allowed more episodes of climate change to be able to form distinct terraces (Figure 9). The upper basin, in contrast, experienced little tectonic activity during the Quaternary but was impounded by an alluvial fan complex shed from Foster, Clanton, and Whitmire creeks resulting in a closed basin, intermittent lakes, and

[4] The symbols used here to denote timing and periods of time are 1 ka = 1,000 years before present, 1 ky = 1,000 years, 1 Ma = 1 million years before present, 1 My = 1 million years.

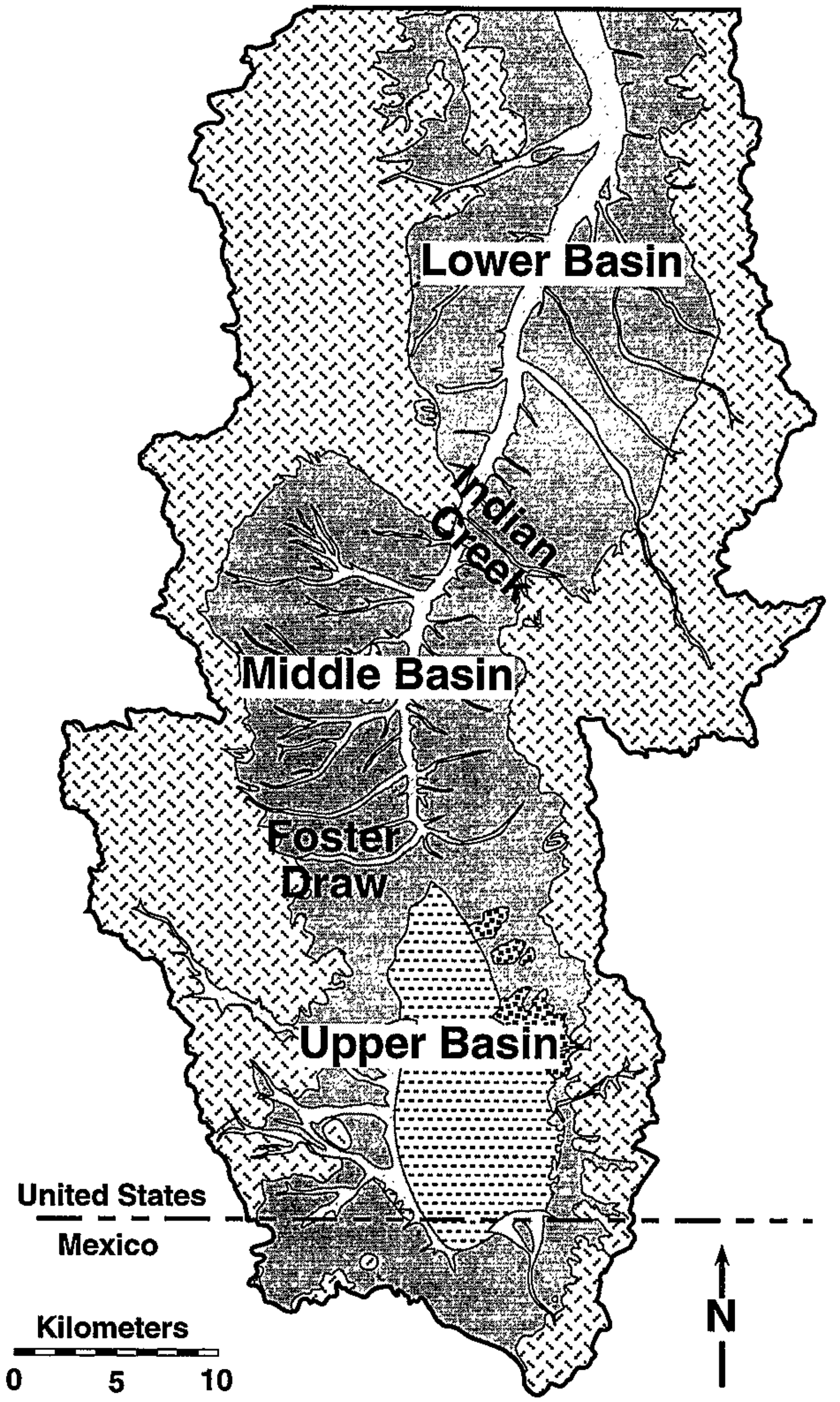


FIGURE 8: Division of southern Animas Creek valley, New Mexico, into sub-basins with the basin boundaries located approximately at Indian Creek and Foster Draw.

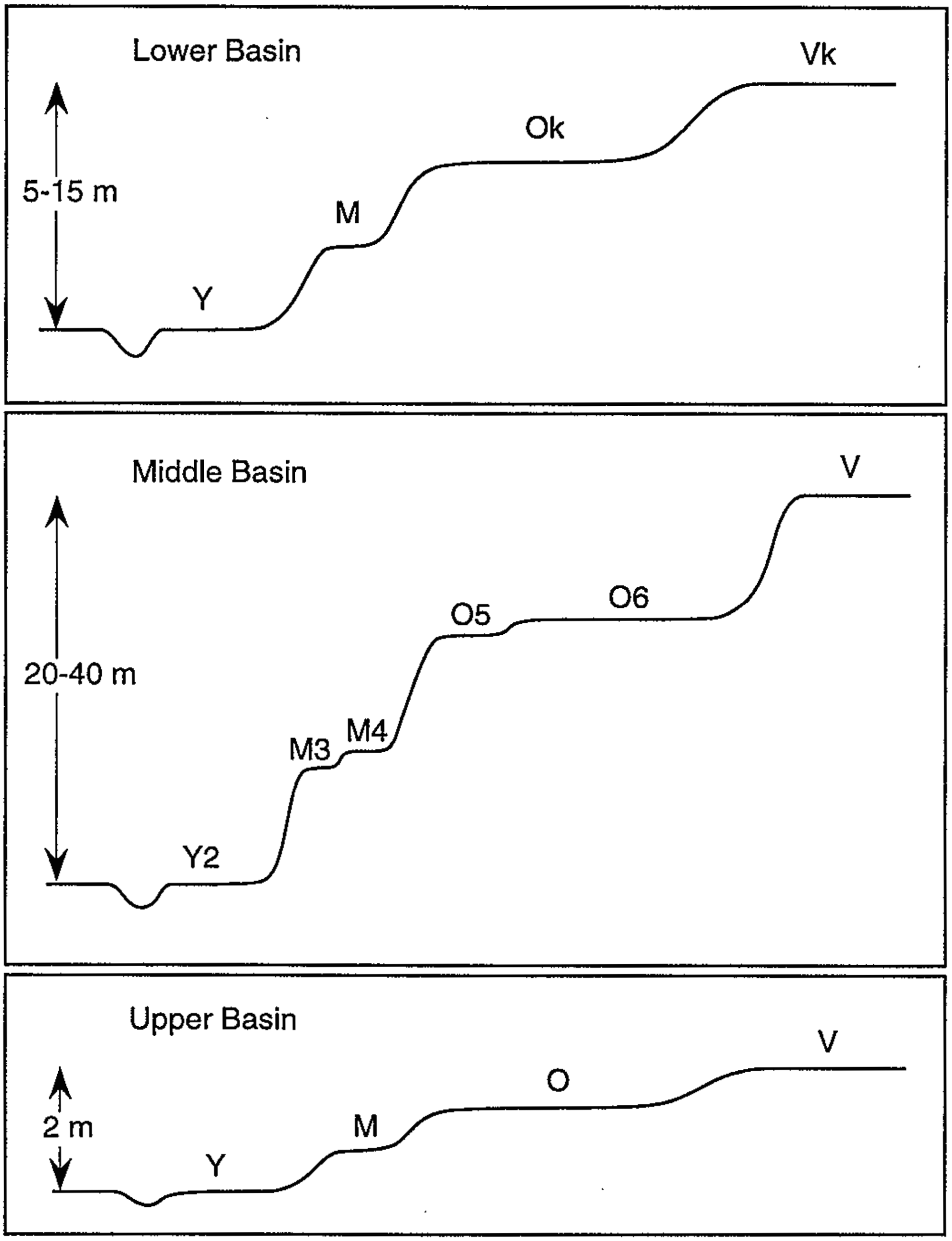


FIGURE 9: Idealized cross sections of flights of stream terraces along tributaries of Animas Creek. The relief and number of terraces present differ in the three sub-basins of the valley. See Figure 8 for the location of sub-basins. The letters (or letter/number combinations) are the map unit designation for the terrace tread surfaces, and the terraces riser hillslopes (not labeled) were mapped using the symbol Ha.

source (during lakes and their recessions) of windblown sediment (Figure 4). This stable base-level restricted climate induced stream incision so the flights of terraces have very low relief (Figure 9).

Late Tertiary and Quaternary tectonism, and earlier Tertiary volcanism are the primary geologic controls on the regional geomorphology. They created the relief that drives denudation and basin deposition, and volcanism created the rocks being eroded. The New Mexican boot heal and adjacent Arizona is the site of a Tertiary volcanic field (Elston, 1984), like others in western North America, which disrupted and covered older rocks. Bedrock of the study area (Figure 4) therefore consists of ash flow tuffs and lava flows, primarily rhyolitic to andesitic in composition (figure 7), erupted from cauldrons and many smaller vents during the period 36 Ma to 26 Ma (Bryan, 1995; McIntosh, 1991; Erb, 1979). The only non-volcanic rocks are Paleozoic limestone and sandstone (Zeller, 1958) exposed in the extreme northeast corner of the study area. In addition to lesser volcanic activity, nine regional ash flows erupted from cauldrons in two brief periods, at the beginning of volcanism from 35 to 33 Ma and a million year period around 27 Ma[5] (Bryan, 1995). Five of the source cauldrons are in, or border, the study area. Silicic volcanism ended with the eruption of the Double Adobe latite (Zeller and Alper, 1965; Erb, 1979) about 27 Ma[5], but minor eruptions of basalt occurred much later, after 7 Ma[5], with the basalt of San Luis Pass the most extensive. The volcanics with thickness greater than 2 km at least locally created volcanic constructional topography, but little of that topography is still preserved, however, having been disrupted by faulting and removed by erosion.

[5] Further details are included in Vincent (1998).

Normal-faults developed at the end of slicic volcanism, creating shallow basins[5], which may be among the best examples of "early Basin and Range" structures in the Southwest. These faults, and associated sedimentary basins, are oriented northwest-southeast with shorter east-west oriented cross faults (Erb, 1979). The duration of faulting on these structures is not known, but activity ceased by 7 Ma[5]. Early Basin and Range tectonism still exhibits an influence on the geomorphology of the region in the northwest-southeast orientation of Deer Creek and nearby mesas composed of O.K. Bar Conglomerate (in the Animas range), and the orientation of Cloverdale Creek, Skeleton Canyon, and a variety of smaller canyons and ridges in the Peloncillo Mountains. Sometime after 27 Ma and perhaps as late as 7 Ma[5], Basin and Range tectonism began (or resumed) with creation of more typical north-south oriented faults that are active at present (Figure 10). This latter tectonism created the gross form of the study area.

The Animas Creek valley is then a structural graben (down-thrown block) of a major, north-south oriented Basin and Range feature. The valley is flanked on the west by the Peloncillo (and Guadalupe) Mountains and flanked on the east by the Animas (and San Luis) Mountains. Over much of its length the valley consists of a full-graben: the basin is bounded on both sides by normal faults that have opposing dips. In the study area (Figure 10) these are the west dipping Gillespie Mountain fault and the east dipping Gray Ranch fault zone (Machette and others, 1986). In the southern part of the valley, however, the structure transforms into a half-graben with single west-dipping fault. This fault, the Lang Canyon fault (Vincent, 1998), is located at the western foot of the Animas and San Luis Mountains and accommodated the eastward tilt of both the Animas block and the Peloncillo block. The transition from full-graben to half-graben is

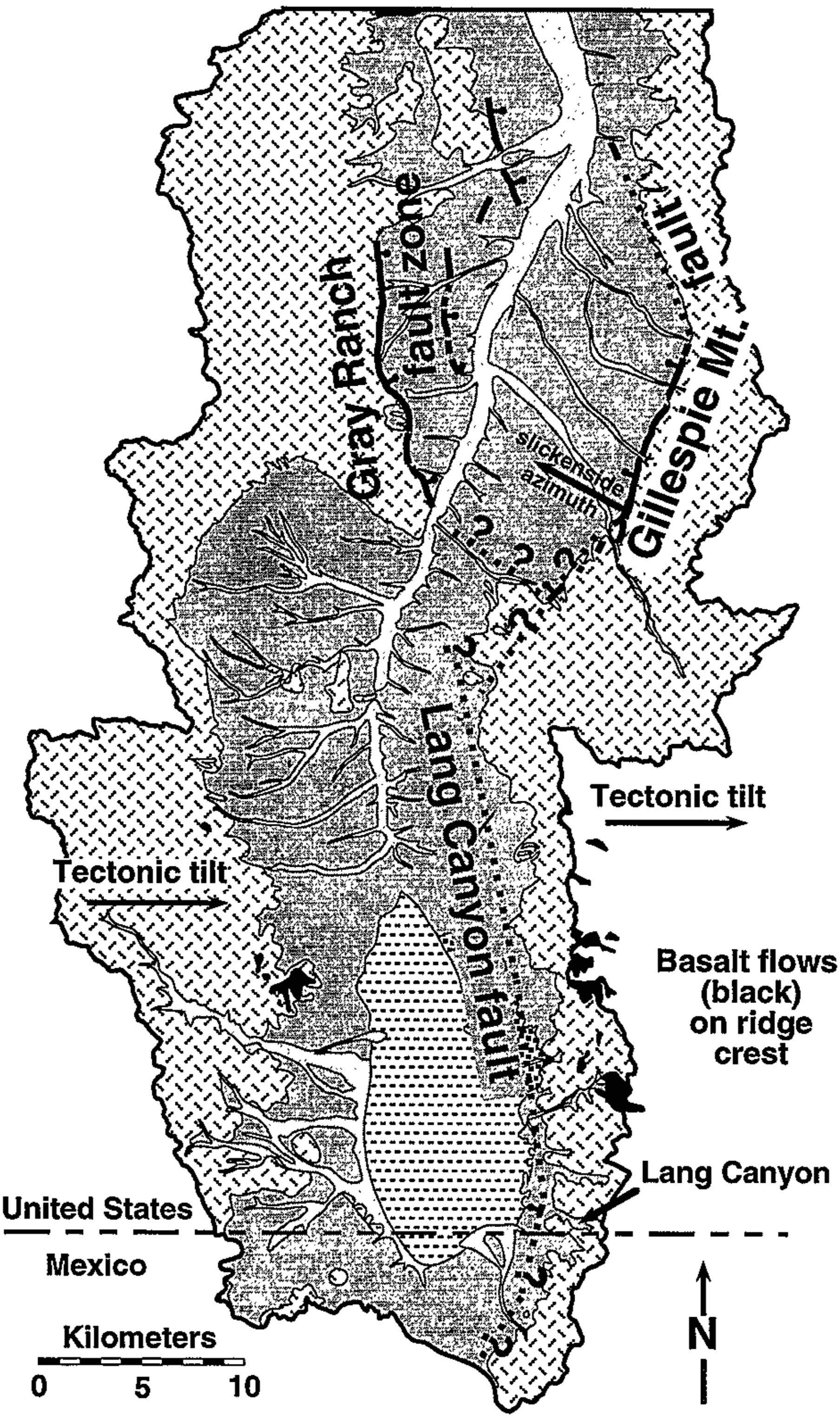


FIGURE 10: Quaternary faults, and other tectonic information, in the southern Animas Creek valley, New Mexico.

located near the confluence of Animas and Indian Creeks, and is coincident with both a 6 km step-to-the-right jog in the Animas range-front and a bedrock promontory that extends into the valley from the Peloncillo Mountains. There is also a change in ground water depth (O'Brien and Stone, 1981) at the transition, with ground water deeper (and basin fill thicker?) in the full graben. The Gillespie Mountain fault and the Gray Ranch fault zone trend into the transition zone, and the less active Lang Canyon fault must extend south from there, but its exact location can only be inferred (Figure 10).

The tectonic basins were the sites of long term sediment accumulation which culminated in aggradation of broad alluvial fans that appear to be middle Pleistocene in age, perhaps 750 to 500 ka. Note these fans are probably not all precisely the same age. These fans impounded the closed depression of the upper basin (Figure 8) as discussed later. The well preserved depositional surfaces of the remnant fans are designated as unit V, or Vk where their soils contain significant calcium carbonate.

Aggradation of the unit V fans culminated during a pause in tectonism. Prominent fault escarpments are found along the trace of the Gillespie Mountain and Gray Ranch faults (Figure 10) in the lower basin (Figure 8). At many locations, the crest of those escarpments form the edge of narrow pediments ($\leq$ 1 km wide) notched into the mountain blocks. The pediments are low-gradient and low-relief erosion surfaces carved into bedrock, and may have taken a million years of base-level stability to form. The unit V alluvial fans once spilled from the mountains, reworking and covering the pediments with alluvial veneer, and extending by deposition out into the valley. These fan surfaces are now displaced at the faults. This indicates tectonism paused in the early Quaternary allowing a long period of base-level stability required for the pediments to form, followed by renewed displacement activity on the faults in the middle Quaternary that continues to the present.

After aggregation of unit V fans, stream incision commenced that was presumably driven by climate change (e.g. Bull, 1991), but also accentuated by renewed tectonic activity. As discussed by Vincent (1998), the slip rates are slower and recurrence interval longer on the largely-obscured Lang Canyon fault in the middle and upper basins, compared to the Gillespie Mountain and Gray Ranch faults to the north in the lower basin. This resulted in the relative subsidence of the lower basin, effectively a base-level fall for Animas Creek, and consequently deep dissection of the middle basin (Figure 9).

Basin aggregation resumed in the late Pleistocene again creating broad low gradient alluvial fans. The surfaces of these fans are designated as unit O and they dominate the piedmonts of the middle and lower basins. In the middle basin there are two O-age surfaces (Figure 9): the broad aggradational fan surfaces designated at unit O6, and the surfaces of stream terraces (designated as unit O5) inset 5 m into the deposits under O6 surfaces. Surface O5 soils are nearly indistinguishable with those of O6 surfaces, and the broad fans are the result of the more efficacious event. In the upper basin unit O consists of the surface of terraces cut into deposits under surface V, and as the surface of small, steep aggradational fans at the bases of mountain fronts. The O surfaces represent the culmination of the youngest episode of basin aggradation, they were abandoned about 100 to 150 ka with subsequent long-term stream incision.

In the latest Pleistocene stream terraces and small fans were formed. In middle and lower piedmonts they occur as cut terraces inset (below surface O) into alluvial hillslopes flanking streams tributary to Animas Creek, and fans that aggrade onto the Animas Creek floodplain. In the upper piedmont, they occur as small, steep alluvial fans that emanate from range fronts and cover (or rework) older deposits. The surface of these landforms are designated as unit M. In the middle basin there are two M-age surfaces (Figure 9) designated as M3 and M4 and both are cut terraces. They merge together upstream and have soils that are nearly indistinguishable. These surfaces (with probable age of 10 to 30 ka) represent a pause in downcutting and lateral beveling by streams during the most recent ice age, and aggradation of fans by small mountain-front streams.

Following the most recent ice age, streams in the study area resumed incision, but ultimately formed fill terraces and floodplains in the present bottomlands and locally formed small, steep alluvial fans emanating from range fronts. The surfaces of these landforms are designated as unit Y, with a variety of subdivisions. During the early Holocene Animas Creek flushed its valley of sediment and trimmed hillslopes and M-age fans that had encroached on the valley bottom. In the middle Holocene, about 6,000 years ago (Davis, 1994; Krider, 1997), aggradation began and was dominated by the tributaries of Animas Creek which built small fans (Y2f) on the Animas Creek floodplain (Ya). These tributary streams incised several centuries ago, but the Animas Creek floodplain did not and has continued to aggrade slowly (Krider, 1997). Animas Creek has not had the power to remove the surface Y2f fans and indeed at several locations these fans appear to have impounded cienegas (Yc), rare sites of perennial water with marshy vegetation (Davis, 1994).

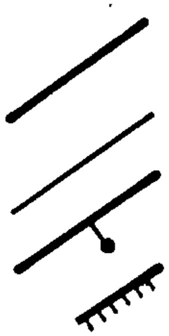
The upper basin (Figure 8) is topographically closed and the site of prehistoric intermittent lakes, named pluvial Lake Cloverdale by Schwennesen (1918). These lakes were shallow at ≤ 14 m (≤ 47 ft) deep. The basin was impounded by an alluvial fan complex shed from Foster, Clanton, and Whitmire creeks in the middle Pleistocene (see the extant V fan remnant in the northeast corner of Plate K). This process of impoundment by fan aggradation is apparently also responsible for the closed basin of pluvial Lake Animas (Fleischhauer and Stone, 1982), located 100 km north down the Animas Creek valley.

We have recognized evidence of four lakes during and since the last ice age, discussed as lakes 1 through 4. Evidence is not exposed for earlier lakes during the long period between basin closure, at perhaps 500 ka, and 20 ka. Lake 1 filled to its highstand altitude of 1578 m (5177 ft) at about 18 or 20 ka, and appears to have been contemporaneous with formation of surface-M stream terraces (Krider, 1997). A section of the road from Cloverdale to the San Luis Pass is built on a prominent lacustrine spit. This spit and other shoreline deposits were primarily formed during the glacial-age high stand (suggesting lake 1 persisted longer then subsequent lakes), but during lake 2 the spit was extended further west bisecting the lake basin. Lake 2 filled to its highstand at 1577 m (5175 ft) in the middle to late Holocene, and Krider (1997) reasons this occurred at about 3 ka. A paleosol (see soil 27A) in lake 1 deposits and buried by lake 2 deposits, indicates a long period between these high stands when either lake levels were low or lakes were nonexistent in the basin. Since lake 2, lakes filled to low levels at least twice. Lake 3 filled to the 1573 m (5160 ft) level, perhaps 1000 years ago (Krider, 1997), and formed a depositional bench along the shoreline. Lake 4 filled to the 1570 m (5150 ft) level and formed a second lower depositional bench. Krider (1997) reasons lake 4 occurred in the interval 300-500 years ago, using information in Davis (1994). The depositional benches are most extensive near Fitzpatricks camp where they appear to be deltas of Cloverdale Creek. Very shallow water has ponded in low areas of the basin during wet seasons in historical times (Ben Brown, oral comm., 1996).

Sand dunes and windblown sand sheets, now stabilized by vegetation, are located on the lee (northeast) side of the Lake Cloverdale basin (Plate L). These were deposited during the times of lake 1 and 2, or as the lakes were receding and exposing fresh sediment to the wind (e.g. Chadwick and Davis, 1990).

MAP SYMBOL EXPLANATION

CONTACTS AND MISCELLANEOUS SYMBOLS



Boundary of mapping area, and also drainage basin divides except for the northern mapping boundary.

Contact of geomorphic surfaces, dashed where inferred.

Normal fault where material on both sides of trace are faulted, dotted where concealed.

Normal-fault scarp where the geomorphic surface on the down-thrown side is not faulted, rather laps onto the scarp.

? Used with contact to indicate uncertain location, and used with map unit symbol (e.g. V?) to indicate uncertain unit designation.

T=2m Tectonic throw (apparent vertical displacement) on fault.

⊗ S17 Soil pit with identification number.

MEANING OF COMPOUND MAP SYMBOLS

The map symbols for many geomorphic surfaces consist of a single letter, and the remainder consist of more letters and/or may contain a number. The first, or single, letter indicates the landform origin (A, H, W, L), but for alluvial fan and stream terrace surfaces a symbol indicating age (V, O, M, Y) in addition to fluvial origin (A) is substituted. The origin (or origin and age) implies the position of the surface in the landscape, its form, and may convey the soil development or composition of its substrate. The second letter indicates the composition of the substrate, if not already implied, or a regional-variant or special feature of the substrate or surface form. Thus, the symbol Hr indicates a hillslope surface (H) on rhyolite bedrock (r). The symbol Wd indicates a surface of stabilized sand dunes in contrast to stabilized sheets of windblown sand (Ws). The symbol Lb indicates a lake bed in contrast to the surface of other lacustrine (L) landforms.

Compound map symbols, like O6k/pr, imply information in a left-to-right sequence or hierarchy which allows special information to be conveyed for surfaces where additional information was available. In the example, O indicates an "old" alluvial fan surface of late Pleistocene age that has specified soil development, form, and position in the landscape. Numerals, 6 in the example, indicate the position in the flight of terraces (Figure 9) where subdivisions could be identified. If not already implied, composition of the substrate is specified next, or a regional-variant or special feature is indicated. In this example, the special feature k indicates the surface's soil contains more pedogenic calcium carbonate than the type-section soil. Although infrequently used, the slash (/) indicates that the surficial deposit and soil are known to overlie something else at shallow (1-

2 m) depth. In the example, alluvium and soil overlie a pediment (p) cut into rhyolite (r) bedrock.

LANDFORM ORIGIN

The origins of landforms in the study are area include the actions of streams, lakes, wind, and hillslope processes:

A: Alluvial (stream deposited) landforms. Because much of the study area is dominated by alluvial-fan remnants and stream terraces (well preserved depositional surfaces only), the A that would otherwise lead the symbol is omitted and replaced by symbols indicating landform age (**Y**oung, **M**edium, **O**ld, and **V**ery old) because age implies both soil type and position in the landscape.

L: Lacustrine depositional surfaces and erosional shorelines.

W: Surface of windblown depositional landforms.

H: Hillslopes that are eroded or eroding.

ALLUVIAL LANDFORM SURFACES

Alluvial landforms dominate the depositional geomorphology of the Animas Creek valley, with surfaces O and V covering the largest areas. The nature of these surfaces are discussed below from oldest to youngest, with aid of Table 2.

Unit **V** surfaces are the oldest stable surfaces in the area are probably the result of numerous events and therefore a conglomeration of surfaces. V surfaces are in uplands, high on piedmonts at the foot of range fronts. Mostly found in the upper and lower basins, they generally have slopes of $\leq 1°$ and east or west aspects. These surfaces represent the culmination of early to middle Quaternary basin aggradation and were followed by stream incision.

Surface **V** soils have two regional variants denoted by symbols **V** and **Vk**. In the upper basin, **V** soils consist of a ≈10 cm silt loam to clay loam A-horizon, a 30 to 70 cm clay Bt-horizon, and a gravelly silty clay loam to gravelly clay subsoil. In the middle basin the V soils also consist of a 10 to 25 cm loam or clay loam A-horizon, a 20 to 40 cm thick clay or gravelly clay Bt-horizon, but have a gravelly clay to gravelly sandy clay loam subsoil. Stringers or pockets of calcium carbonate may be present at depths > 90 cm. Surface **Vk** soils, in the middle and lower basins, consist of a 10-20 cm limy loam to sandy loam A-horizon, a 30-70 cm gravelly clay to sandy clay loam Bt-horizon, and a gravelly clay loam to sandy loam subsoil with stage III+ carbonate.

Unit **O** surfaces (including **O**, **O6**, and locally **O5** and **Of**) are "old" alluvial fan remnants, abandoned about 100 to 150 ka, that dominate the piedmonts of the study area. They are basin-fill surfaces on upper, middle, and lower piedmonts. In the upper basin they are inset 1-2 m into V surfaces, but in the middle and lower basins they are isolated from V surfaces and are deeply dissected (≤ 40 m) by modern streams. The large pervasive unit O fan surfaces have slopes of ≤ 1° and generally east or west aspects, but less conspicuous small fans (**Of**) lap onto range fronts and are coarse textured with slopes of ≤ 5°.

Surface **O** soils have three regional variants: **O**, **Ok**, and **Ok+**. Surface **O** soils, in all basins, consist of a 10 to 30 cm loam A-horizon with < 5 to 35% gravel, a 35 to 45 cm clay Bt-horizon, and a sandy loam or clay loam subsoil with 20 to 70% gravel, but in the upper basin the subsoil below 100 cm consists of silt loam. Stage II calcium carbonate is generally

TABLE 2

Alluvial landform surfaces organized by age and lateral position on the Animas basin piedmonts. Age decreases downward and organization mimics height of surfaces above valley bottoms (see Figure 9). The letter f indicates the surface of a small and steep alluvial fan at the foot of a range front.

Animas Cr.	**Lower and middle piedmont**	**Upper piedmont &** mountain valleys
Early to middle Pleistocene fan remnants (older top of basin fill)		
	V	**V**
Late Pleistocene fan remnants (youngest top of basin fill)		
	O6	**O & Of**
	O5	
Latest Pleistocene cut terraces (locally fill terraces)		
	M4	**M & Mf**
	M3	
Holocene fill terraces along tributaries		
	Y2	**Yf**
Active landforms		
Ya Animas Cr. floodplain **Yc** cienegas Channels, not mapped	**Y** other floodplains	**Y** **As** alluvial swales

present below the Bt-horizon at depths of > 60 cm. Surface **Ok** soils, in the middle and lower basins, are similar to O soils except calcium carbonate is present in the A-horizon and stage III carbonate is present in the subsoil. Surface **Ok+** soils, located only in the northeast corner of the lower basin (Plate C), are dominated by pedogenic calcium carbonate because their alluvial parent material is limestone. These soils consist of 10 to 30 cm of limy-silt loam over stage IV (or greater?) calcrete. Alluvial hillslopes (Hak) adjacent to Ok+ surfaces have soils similar to Ok+ soils, including exposed calcrete.

Unit **O5** surfaces are the youngest O surfaces and occur as stream terraces inset about 5 m into surface O6. They are in the upland on middle and lower piedmonts, with slopes ≤ 1° and generally east aspects, and were mapped mostly in the middle basin along the Foster and Clanton Draws and Whitmire Creek drainages. Surface O5 soils are nearly indistinguishable with those of O6 surfaces. Therefore, unit O (without numerical postfix) is designated where O5 and O6 are not distinguishable by topographic position, although O implies O6 in most locations because O6 was the result of the larger and more extensive geomorphic event.

Unit **M** (including **M, M4** and **M3**) surfaces are "medium age" or latest Pleistocene stream terraces and small fans. In middle and lower piedmonts they occur as cut terraces inset (below surface O) into alluvial hillslopes flanking streams tributary to Animas Creek. They are up to 6 m above the valley bottoms, and have slopes ≤ 2°. In the upper piedmont, they occur as small alluvial fans (with slopes ≤ 5°) that emanate from range fronts and cover (or rework) older deposits. These surfaces (with probable age of 10 to 30 ka) represent a pause in downcutting and lateral beveling by streams during the most recent ice age, and aggradation of fans by small mountain-front streams. Surfaces **M4** (the older) and **M3** (the younger) converge upstream, and their soils are both variable and nearly indistinguishable from one another. Therefore, unit **M** (without numerical postfix) is designated where surfaces M4 and M3 are not distinguishable by topographic position. Surface **M** soils consist of a 20 to 35 cm loam, sandy loam, or gravelly loam A-horizon and highly variable subsoil. The B-horizons range from gravelly clay loam without carbonate, to gravelly sandy loam with stage II carbonate. An erosional unconformity may be present at shallow depth (≥ 60 cm) beneath which are older sediments and soils, ranging from gravelly clay to gravelly sandy clay loam, with stage I carbonate.

Unit **Y** (including **Y, Y2, Y2f, Ya, Yc** and **As**) surfaces are "young" (late Holocene or active) bottomland stream terraces and floodplains. They are set deeply (≤ 40 m) into lower and middle basin piedmonts, but are incised only 2 m below V and O surfaces in the upper basin. Modern stream beds traverse these surfaces but are not mapable at the 1:24,000 scale. These surfaces have all aspects except south and low gradients (0.2°-2°), but small alluvial fans (**Yf**) emanate from range-fronts with slopes ≤ 5°. Y soils are weakly developed, consisting of 10 to 30 cm thick sandy loam to loamy sand A-horizons, and B-horizons that might be as developed as sandy clay loam and might contain stage I carbonate pebble-coatings or filaments. Buried soils, similar to the surface soil, are commonly found at depth in packages of older Holocene stream sediment.

Unit **Y** surfaces cap deposits (< 3 m thick) representing valley bottom stream-aggradation that started at least by 6 ka and ended several centuries ago (Krider, 1997) or is ongoing. Along the valley axis, the active Animas Creek floodplain surface is designated as unit **Ya** and is aggrading slowly (Krider, 1997). In the middle and lower piedmonts, bottomland along the tributaries of Animas Creek are terraces, incised ≤ 3 m, with surfaces designated as **Y2** or as **Y2f** where tributaries built small fans on the Animas Creek floodplain. At several locations along Animas Creek these fans appear to have impounded cienegas (**Yc**), rare sites of perennial water with marshy vegetation (Davis, 1994). In upper piedmonts, and over large areas of the upper basin, small streams are flanked by active floodplains with surfaces designated as **Y**. In the headwaters of tributaries that drain the piedmont are surfaces designated as alluvial swales (**As**). They are inset less than a few meters below O and V surfaces, and thus are not flanked by alluvial hillslopes (Ha). Alluvial swales are locally incised by gullies, but elsewhere have no stream channels, and have soils typical of the other Y surfaces.

At several upper piedmont locations Holocene streams incompletely reworked M-age deposits, leaving a mosaic of Y and M surfaces that could not be subdivided at the 1:24,000 map scale. These areas are labeled **Y+M** or **M+Y**, with the leading symbol indicating the dominant surface.

TRANSITION TO HILLSLOPES

Landforms that are perhaps both alluvial and hillslope in origin occur at the upper-margins of alluvial piedmonts and foot of bedrock hillslopes. The deposits appear to have been reworked after deposition in the late Quaternary and thus these surfaces may have soils similar to O surfaces.

Am: Surface of mantle of alluvium (and colluvium) appearing as reworked fans with moderate gradients (2-3°) and covering pedimented bedrock.

Hm: Surface of apron of thick (> 40 cm) and moderately steep (3-10°) colluvium (and alluvium?) at the foot of steeper hillslopes.

HILLSLOPES

Hillslopes are eroded and eroding surfaces that generally consist of colluvium-covered bedrock (or sediment), but locally may be exposed bedrock (or sediment). They have any aspect and are steep, commonly 5° to 30°, but slopes >30° and near vertical cliffs occur locally. Hillslopes of bedrock (Table 1) generally have thin (≤ 40 cm) colluvial soils consisting of a 5-10 cm gravelly silt loam to gravelly clay loam AB-horizon, a 10-25 cm B-horizon with 40-70% gravel-sized clasts and interstices filled with clay loam to silty clay, and a subsoil of interlocking stones. Hillslopes in alluvium (Ha), as illustrated on Figure 5, have laterally variable soils because they are transporting both soil derived from the landform at their crests and sediment and soil from the alluvial deposit being exhumed. These surfaces have slopes ranging from 5° to 20°. The symbols used for hillslopes surfaces and their underlying materials are:

Ha: unconsolidated Quaternary alluvium, such as a terrace riser.
Hg: moderately cemented QT gravel.
Hc: indurated Tertiary conglomerate.
Hv: silicic volcaniclastic rock.
Hr: rhyolite.
Hl: latite
Hd: dacite.
Hn: andesite.
Hb: basalt.
Hn-r: mixed andesite, latite, and rhyolite.
Hu: undifferentiated bedrock, but probably silicic volcanics.
Hq: limy sandstone.
He: limestone.

LACUSTRINE LANDFORMS

The upper basin (Figure 8) is topographically closed and the site of prehistoric intermittent lakes that were shallow at ≤ 14 m (≤ 47 ft) deep. We have recognized evidence of four lake periods during and since the last ice age, discussed as lakes 1 through 4. Lake 1 filled to its highstand at 1578 m (5177 ft) at about 18 or 20 ka, and appears to have been contemporaneous with formation of M stream terraces (Krider, 1997). The lacustrine spit and shoreline deposits (surface labeled **Ls**) were primarily formed during this glacial-age high, but were further developed during lake 2. Lake 2 filled to its highstand at 1577 m (5175 ft) in the middle to late Holocene. Both lakes 1 and 2 locally reworked surface O and V fans, and those surfaces are indicated on the maps with **L/O** and **L/V** symbols. Since lake 2, lakes filled to low levels at least twice. Lake 3 filled to the 1573 m (5160 ft) level and formed depositional bench **Ld3**. Lake 4 filled to the 1570 m (5150 ft) level and formed depositional bench **Ld4**. In the lake bed (**Lb**), very shallow water has ponded in the lowest areas during wet seasons in historic times (Ben Brown, oral comm., 1996).

Lb: Lake bottom, consisting of a 10 cm thick silt loam A-horizon and deep silty clay loam subsurface horizons.

Ls: Lake spit and lake-shore depositional berms (that may include an erosional shoreline) consisting of loam to gravelly loam surface soils and more sandy subsurface horizons.

Le: Wave cut shoreline features.

Ld: Lake-shore deltas or depositional benches consisting of homogeneous silt loam.

EOLIAN LANDFORMS

Sand dunes and windblown sand sheets, now stabilized by vegetation, are located on the lee (northeast) side of the Lake Cloverdale basin.

Ws: Sheet of windblown sand, > 20 cm thick, consisting of loamy sand or sandy loam often covering older deposits and soils at shallow (< 1 m) depth.

Wd: Sand dunes consisting of sand to loamy sand and locally cemented with silica.

SPECIAL FEATURES

/p Surficial sediments overlie a pediment carved in bedrock.

k Soil contains more calcium carbonate than type-section soil.

k+ Soil, derived from limestone alluvium, consisting of calcrete.

f Surface has shape of small alluvial fan.

x Deposit is extremely bouldery in texture.

a Not a special feature, but is used to denote hillslope in alluvium (Ha) and used to distinguish the aggrading Animas Creek floodplain (Ya) from the floodplain of other streams (Y) and incised valley bottoms of other streams (Y2).

SOIL DESCRIPTIONS

The following soil descriptions are based on field observations in soil pits, and natural exposures in a few cases, and their locations are summarized in Table 3. Horizon nomenclature and soil structure, consistence, and texture are based on Birkeland (1984) after standards of the Soil Survey (e.g. Soil Survey Staff, 1992). Colors were distinguished using a Munsell® soil color chart. Cobble weathering stages are from Bull

(1991) as adapted from Melton (1965). Carbonate morphology stages are from Machette (1985) as modified from stages originally proposed by Gile et al. (1966). Reheis et al. (1995) suggests that most of the very fine sand, silt, and clay in desert soils may have rained onto the landscape as windblown dust; rather than being stream deposited or being the weathering product of stream deposits, for example. This may well be the case for the A- and Bt-horizons of alluvial fan remnants O and V, for example, in the Animas Creek valley. To avoid excessive interpretation, however, a traditional approach was used in designating the parent material of soil horizons: only clear evidence of stream-deposit packages or erosional unconformities warranted designating a parent material of a subsoil horizon different from overlying horizons.

TABLE 3

Location of soil pits by geomorphic surface and sub-basins (see Figure 8) of the Animas Creek valley.

Geomorphic surface	Basin		
	Upper	Middle	Lower
V	S7, Scs12	S2, S13a	
Vk	—	S13b	S16,
O (& O6)	S6,	S3, S11	S15, S17
O5		S10	
M	S8,	S4, S5, S12	S18
Y	S1,	S26	S19
Lb	S9	—	—
Ls	S27a	—	—
Ld	S27b	—	—
Ws	Scs43	—	—
rock hillslopes	S22, S23	S20, S21, S24, S25	

Soil S1 Geomorphic surface **Y/p**, Holocene floodplain over bedrock; Black Point Quadrangle: NE1/4 SW1/4 sec.9 T33S R21W, along Cloverdale Creek; altitude 5400', slope 0.4° E aspect.

A1 0-10 cm. **Sandy loam to loam**; dark reddish brown (5 YR 3/2) when moist and dark brown (7.5 YR 4/2) when dry; <5% gravel; nonsticky and slightly plastic when wet; soft when dry; weakly developed medium-sized angular-blocky peds; non-effervescent; abrupt smooth lower boundary.

Bw 10-30 cm. **Loam**; dark reddish brown (5 YR 2.5/2) when moist and dark brown (7.5 YR 4/1) when dry; <10% gravel; slightly sticky and slightly plastic when wet; slightly hard when dry; moderately developed coarse-sized columnar peds; non-effervescent; clear smooth lower boundary.

Bt 30-48 cm. **Sandy clay loam**; dark to strong brown (7.5 YR 4/5) when moist and light brown (7.5 YR 6/4) when dry; 10% gravel; sticky and plastic when wet; hard when dry; moderately developed coarse-sized angular-blocky peds; non-effervescent; clear smooth lower boundary.

IIBtg 48-90 cm. **Gravelly clay**; dark brown (10 YR 4/3) when moist and light reddish brown (2.5 YR 6/3) when dry; 25% gravel; sticky and very plastic when wet; hard when dry; strongly developed coarse-sized angular-blocky peds; moderately effervescent; abrupt irregular lower boundary.

IIIR 90+ cm. reddish white (2.5 YR 8/2) when moist and pink (5 YR 7/4) when dry; Rhyolite (locally tuff) bedrock.

Soil S2 Geomorphic surface **V**, Alluvial fan remnant; Clanton Draw Quadrangle: NW1/4 NE1/4 sec.23 T32S R21W, S of Clanton Draw; altitude 5380', slope 2° NE aspect.

Av 0-2 cm. **Gravelly loam**; reddish brown (5 YR 4/4) when moist and light brown (7.5 YR 6/3) when dry; 50% gravel; slightly sticky and slightly plastic when wet; soft when dry; weakly developed platy peds; non-effervescent; abrupt smooth lower boundary.

AB 2-14 cm. **Clay loam**; dark brown (7.5 YR 3/2) when moist and brown (7.5 YR 5/3) when dry; <10% gravel; sticky and plastic when wet; friable when moist and slightly hard when dry; moderately developed fine-sized angular-blocky peds; non-effervescent; abrupt smooth lower boundary.

B1t 14-36 cm. **Gravelly clay**; dark reddish brown (5 YR 3/4) moist; 25% gravel; very sticky and very plastic when wet; extremely firm when moist and very hard when dry; strongly developed medium-sized to coarse-sized columnar peds; many prominent clay films with slickensides on ped faces; 0.5 cm open space between columns when soil is dry; non-effervescent; clear smooth lower boundary.

B2t 36-50+ cm. **Gravelly clay**; dark reddish brown (5 YR 3/4) moist; 40% gravel; extremely firm when moist and extremely hard when dry; strongly developed very coarse sized angular-blocky peds; non-effervescent.

Soil S3 Geomorphic surface **O6**, Alluvial fan remnant; Clanton Draw Quadrangle: SE1/4 sec.8 T32S R20W, along Geronimo Trail; altitude 5190', slope 2° E aspect.

A1 0-5 cm. **Gravelly loam**; dark brown (7.5 YR 3.5/4) when moist and brown (7.5 YR 5/4) when dry; 35% gravel; slightly sticky and slightly plastic when wet; slightly hard when dry; moderately developed medium-sized platy peds; non-effervescent; abrupt smooth lower boundary.

A2 5-20 cm. **Gravelly clay loam**; dark brown (7.5 YR 3/4) when moist and brown (7.5 YR 5/4) when dry; 20% gravel; sticky and plastic when wet; hard when dry; moderately developed very coarse sized subangular-blocky peds; non-effervescent; abrupt smooth lower boundary.

Bt 20-55 cm. **Clay**; dark brown (7.5 YR 3/4) when moist and dark brown (7.5 YR 4/4) when dry; 5% gravel; very sticky and very plastic when wet; very hard when dry; strongly developed medium-sized prismatic peds; non-effervescent, clear wavy lower boundary.

Btox 55-90 cm. **Very gravelly clay**; yellowish red (5 YR 4/6) when moist and yellowish red (5 YR 5/6) when dry; 60% gravel; very sticky and very plastic when wet; weakly coherent when dry; massive structure; very slight effervescence, carbonate stage I; gradual wavy lower boundary.

Btox2 90-130 cm. **Very gravelly clay loam**; yellowish red (5 YR 4/6) when moist and yellowish red (5 YR 5/8) when dry; 60% gravel; slightly sticky and plastic when wet; weakly coherent when dry; massive structure; very slight effervescence, carbonate stage I; cobble weathering stage I; gradual wavy lower boundary.

Bk 135-165+ cm. **Very gravelly sandy loam**; reddish yellow (5 YR 5.5/6) when moist and pink (5 YR 7/4) when dry; 70% gravel; non-sticky and slightly plastic when wet; weakly coherent when dry; massive structure; moderately effervescent, carbonate stage II+.

Soil S4 Geomorphic surface **M4**, Inset stream terrace; Animas Peak NE Quadrangle: SE1/4 SE1/4 sec.2 T31S R20W, 1 mi. S of Indian Cr. mouth; altitude 5010', slope 5° W aspect.

A 0-20 cm. **Loam**; dark brown (7.5 YR 3/4) when moist and brown (7.5 YR 4.5/4) when dry; 5-10% gravel; slightly sticky and slightly plastic when wet; hard when dry; moderately developed very coarse sized subangular-blocky peds; non-effervescent; abrupt wavy lower boundary.

Bt 20-60 cm. **Very gravelly clay loam**; dark brown (7.5 YR 3/4) when moist and brown (7.5 YR 5/4) when dry; 60% gravel; sticky and plastic when wet; slightly hard when dry; massive structure to weakly developed very fine sized angular-blocky peds; non-effervescent; abrupt smooth erosional unconformity at lower boundary.

IIBtb 60-65 cm. **Gravelly clay**; dark reddish brown (5 YR 3/4) when moist and reddish brown (5 YR 4/4) when dry; 30% gravel; very sticky and very plastic when wet; very hard when dry; moderately developed fine-sized platy peds; non-effervescent; clear smooth lower boundary.

IIBtox1 65-115 cm. **Very gravelly sandy clay loam**; yellowish red (5 YR 4/6) when moist and yellowish red (5 YR 5/6) when dry; 60% gravel; sticky and plastic when wet; hard when dry; massive structure; moderately effervescent, carbonate stage I; gradual smooth lower boundary.

IIBtox2 115-150+ cm. **Gravelly sandy clay loam**; yellowish red (5 YR 4/7) when moist and yellowish red (5 YR 5/6) when dry; massive structure; moderately effervescent, carbonate stage I.

Soil S5 Geomorphic surface **M3**, Inset stream terrace; Animas Peak NE Quadrangle: SE1/4 sec.2 T31S R20W, 1 mi. S of Indian Cr. mouth; altitude 4950', slope 2° W aspect.

A 0-25 cm. **Gravelly loam**; dark brown (7.5 YR 3/4) when moist and brown (7.5 YR 4.5/4) when dry; 35% gravel; slightly sticky and slightly plastic when wet; slightly hard when dry; moderately developed very coarse sized subangular-blocky peds; non-effervescent; abrupt smooth lower boundary.

Bt 25-70 cm. **Gravelly clay loam**; dark brown (7.5 YR 3/4) when moist and dark brown (7.5 YR 4/4) when dry; 50% gravel; sticky and plastic when wet; slightly hard when dry; moderately developed fine-sized subangular-blocky peds; non-effervescent; abrupt smooth erosional lower boundary.

IIBtb 70-110 cm. **Gravelly clay**; yellowish red (5 YR 4/6) when moist and yellowish red (5 YR 5/7) when dry; 25% gravel; very sticky and very plastic when wet; hard when dry; moderately-developed medium-sized prismatic peds; moderately effervescent, carbonate stage I; clear wavy lower boundary.

IIBt2b 110-155+ cm. **Gravelly clay**; yellowish red (5 YR 4/6) when moist and reddish yellow (5 YR 5.5/6) when dry; 30% gravel; sticky and very plastic when wet; hard when dry; massive structure to weakly developed medium-sized angular-blocky peds; moderately effervescent, carbonate stage I.

Soil S6 Geomorphic surface **O**, Inset stream terrace; Black Point Quadrangle: W edge SW1/4 sec.20 T33S R20W, along Cloverdale road; altitude 5215', slope 0.3° E aspect.

A 0-30 cm. **Silty clay loam**; dark brown (7.5 YR 3/4) when moist and light brown (7.5 YR 6.5/5) when dry; 5% gravel; sticky and plastic when wet; soft when dry; granular to weakly-developed coarse-sized subangular-blocky peds; non-effervescent; abrupt smooth lower boundary.

Bt 30-75 cm. **Gravelly clay**; dark reddish brown (5 YR 3.5/4) when moist and reddish brown (5 YR 4.5/5) when dry; 25% gravel; very sticky and very plastic when wet; very hard when dry; strongly developed medium-sized prismatic peds; moderately effervescent; clear wavy lower boundary.

Bst2 75-95 cm. **Gravelly sandy clay loam**; yellowish red (5 YR 4/7) when moist and yellowish red (5 YR 5/6) when dry; 40% gravel; sticky and plastic when wet; hard when dry; massive structure; strong effervescence, carbonate stage I+ pebble coatings, abrupt smooth unconformity lower boundary.

IIB 95-150+ cm. **Silt loam**; yellowish red (5 YR 5/7) when moist and yellowish red (5 YR 5/6) when dry; <5% gravel; slightly sticky and slightly plastic when wet; very hard when dry; strongly developed medium-sized prismatic peds; non-effervescent.

Soil S7 Geomorphic surface **V**, Alluvial fan remnant; Black Point Quadrangle: W edge W1/2 sec.20 T33S R20W, along Cloverdale road; altitude 5218', slope 0.4° E aspect.

A 0-13 cm. **Silt loam**; dark reddish brown (5 YR 3/2) when moist and dark reddish gray (5 YR 4/2) when dry; 5% gravel; slightly sticky and slightly plastic when wet; very friable when moist and soft when dry; weakly developed fine-sized subangular-blocky peds; non-effervescent; abrupt smooth lower boundary.

Bt1 13-45 cm. **Silty clay**; dark reddish brown (5 YR 3/3) when moist and dark reddish gray (5 YR 4/2) when dry; 5-10% gravel; very sticky and plastic when wet; very hard when dry; moderately developed very coarse sized angular-blocky peds; slightly effervescent; clear smooth lower boundary.

Bt2 45-110 cm. **Gravelly clay**; reddish brown (5 YR 4/4) when moist and dark reddish gray (5 YR 4.5/1.5) when dry; 20% gravel; very sticky and very plastic when wet; extremely firm when moist; moderately developed coarse-sized prismatic peds; moderately effervescent; clear smooth lower boundary.

Btk 110-180+ cm. **Gravelly silty clay loam**; yellowish red (5 YR 5/6) when moist and reddish yellow (5 YR 6/6) when dry; 20% gravel; sticky and plastic when wet; very firm when moist; massive structure; slightly effervescent but vertical stringers (3-5 cm. wide) of stage III carbonate effervesce violently and occupy 5-10% of soil volume; cobble weathering stage I.

Soil S8 Geomorphic surface **M?**, Inset fan remnant; Fitzpatricks Quadrangle: SW1/4 sec.32 T33S R19W, S of San Luis Pass road near windmill; altitude 5170', slope 1° W aspect.

A 0-17 cm. **Silty clay loam**; dark brown (7.5 YR 3.5/2) when moist and brown (7.5 YR 5.5/2) when dry; 5% gravel; sticky and plastic when wet; soft when dry; weakly-developed to moderately developed fine-sized to medium-sized subangular-blocky peds; non-effervescent; abrupt smooth lower boundary.

B1 17-49 cm. **Silty clay loam**; dark brown (7.5 YR 3/2) when moist and brown (7.5 YR 5.5/2) when dry; 5% gravel; sticky and plastic when wet; hard when dry; moderately developed coarse-sized subangular-blocky peds; non-effervescent; clear wavy lower boundary probably an erosional unconformity.

IIBt 49-115 cm. **Silty clay**; dark reddish brown (5 YR 3/2) when moist and reddish brown (5 YR 4.5/3) when dry; 5% gravel; very sticky and plastic when wet; very firm when moist and very hard when dry; moderately developed medium-sized prismatic peds; non-effervescent; clear wavy lower boundary.

IIIC 115-200+ cm. dark brown (7.5 YR 3.5/4) when moist and light brown (7.5 YR 6/4) when dry; 40% gravel; loose when dry; massive to single-grain structure; carbonate stage I pebble coatings.

Soil S9 Geomorphic surface **Lb**, Dry lake bed; Fitzpatricks Quadrangle: S edge NE1/4 sec.1 T34S R20W, on dirt track SW of windmill and pit 8; altitude 5130', slope 0°.

A 0-13 cm. **Silt loam**; dark grayish brown (10 YR 4/2) when moist and grayish brown (10 YR 5/2) when dry; 1% gravel; slightly sticky and plastic when wet; very friable when moist and soft when dry; coarse-sized granular peds; non-effervescent; abrupt smooth lower boundary.

BC 13-75 cm. **Silty clay loam**; dark grayish brown (10 YR 4/2) when moist and grayish brown (10 YR 5/2) when dry; <5% gravel; very sticky and plastic when wet; extremely firm when moist and hard to very hard when dry; moderately developed medium-sized prismatic peds; non-effervescent; gradual smooth lower boundary.

CB 75-180+ cm. **Silty clay loam**; weak red (2.5 YR 4.5/2) when moist and weak red (2.5 YR 5.5/2) when dry; <5% gravel; very sticky and plastic when wet; very firm when moist and hard when dry; moderately developed medium-sized prismatic peds; non-effervescent.

Soil S10 Geomorphic surface **O5**, Alluvial fan remnant; Clanton Draw Quadrangle: SW1/4 SE1/4 T32S R20W, N of Foster Draw; altitude 5190', slope 0.4° E aspect.

Av 0-1 cm. **Sandy loam**; dark brown (7.5 YR 3/4) when moist and brown (7.5 YR 5.5/4) when dry; 5% gravel; nonsticky and slightly plastic when wet; loose to soft when dry; single-grain structure to weakly developed fine-sized platy peds; non-effervescent; abrupt smooth lower boundary.

A 1-28 cm. **Sandy loam**; dark brown (7.5 YR 3/4) when moist and brown (7.5 YR 5.5/4) when dry; 10% gravel; slightly sticky and slightly plastic when wet; very friable when moist; weakly developed fine-sized subangular-blocky peds; non-effervescent; abrupt smooth lower boundary.

Bx 28-70 cm. **Loam**; dark brown (7.5 YR 4/5) when moist and brown (7.5 YR 5.5/4) when dry; 15% gravel; slightly sticky and slightly plastic when wet; hard when dry; moderately developed coarse-sized angular-blocky peds; non-effervescent; cobble weathering stage 0; clear irregular lower boundary, probably an erosional unconformity.

IIBts 70-170 cm. **Clay loam**; strong brown (7.5 YR 4/6) when moist and reddish yellow (7.5 YR 6/6) when dry; sticky and plastic when wet; hard when dry; massive structure; non-effervescent; cobble weathering stage III; diffuse wavy lower boundary.

IIC 170-210+ cm. **Silt loam**; brown (7.5 YR 5.5/4) when moist and pink (7.5 YR 7.5/4) when dry; nonsticky and nonplastic when wet; slightly hard when dry; massive to single-grain structure; non-effervescent; cobble weathering stage II.

Soil S11 Geomorphic surface **O6**, Alluvial fan remnant; Clanton Draw Quadrangle: SW1/4 sec.13 T32S R21W, along Geronimo Trail; altitude 5330', slope 0.5° E aspect.

Av 0-1 cm. **Loam**; brown to dark brown (7.5 YR 4/3) when moist and pink to reddish yellow (7.5 YR 7/5) when dry; 10% gravel; slightly sticky and slightly plastic when wet; soft when dry; weakly developed fine-sized platy peds; non-effervescent; abrupt smooth lower boundary.

A 1-15 cm. **Gravelly silt loam**; dark brown (7.5 YR 3/4) when moist and light brown to brown (7.5 YR 5.5/4) when dry; 25% gravel; slightly sticky and slightly plastic when wet; very friable when moist; weakly developed medium-sized subangular-blocky peds; non-effervescent; abrupt smooth lower boundary.

Bt 15-60 cm. **Clay**; dark brown (7.5 YR 3/4) when moist and brown (7.5 YR 5/3) when dry; 15% gravel; very sticky and very plastic when wet; hard when dry; strongly developed coarse-sized prismatic peds; non-effervescent, but carbonate stage II coatings on pebbles at lower boundary; abrupt wavy lower boundary.

Bts 60-220+ cm. **Gravelly silty clay loam**; yellowish red (5 YR 5/6) when moist and yellowish red (5 YR 5.5/8) when dry; 50% gravel; sticky and plastic when wet; slightly hard when dry; massive structure; slightly effervescent, carbonate stage I coatings on some pebbles; cobble weathering stage II; abrupt to gradual boundaries where it interfingers with Bk.

Bk 60-220+ cm. **Silty clay loam**; reddish yellow (7.5 YR 7.5/6) when moist and pink (7.5 YR 8/4) when dry; slightly sticky and slightly plastic when wet; hard when dry; massive structure; violently effervescent, carbonate stage III; interfingers with Bts.

Soil S12 Geomorphic surface **M3**, Inset stream terrace; Clanton Draw Quadrangle: SW1/4 NE1/4 sec.9 T32S R20W, near Gray Ranch Office; altitude 5105', slope 0.6° E aspect.

A 0-35 cm. **Sandy loam**; dark brown (7.5 YR 3.5/2) when moist and pinkish gray (7.5 YR 6/2) when dry; 10% gravel; nonsticky and slightly plastic when wet; very friable when moist and soft when dry; weakly developed fine subangular-blocky peds; non-effervescent; gradual smooth lower boundary.

AB 35-65 cm. **Gravelly sandy loam**; dark brown (7.5 YR 4/3) when moist and brown (7.5 YR 5/2) when dry; 50% gravel; nonsticky and slightly plastic when wet; slightly hard when dry; weakly developed coarse-sized subangular-blocky structure; non-effervescent; clear wavy lower boundary.

Bk 65-95 cm. **Gravelly sandy loam**; brown (7.5 YR 5/4) when moist and pink (7.5 YR 7.5/4) when dry; 50% gravel; nonsticky and slightly plastic when wet; very hard when dry; massive structure; strongly to violently effervescent, carbonate stage II+; gradual wavy lower boundary.

Cox 95-170+ cm. **Very gravelly loamy sand**; strong brown (7.5 YR 4.5/6) when moist and reddish yellow (7.5 YR 5.5/6) when dry; 60% gravel; nonsticky and nonplastic when wet; massive structure; moderately effervescent, carbonate stage I; cobble weathering stage 0.

Soil S13a Geomorphic surface **V?**, Alluvial fan remnant; Clanton Draw Quadrangle: SW1/4 SW1/4 sec.21 T31S R20W, mesa S of Bercham Draw; altitude 5150', slope 1° E aspect.

AB 0-20 cm. **Loam**; dark brown (7.5 YR 3/4) when moist and reddish yellow (7.5 YR 6/7) when dry; 15% gravel; slightly sticky and slightly plastic when wet; soft when dry; moderately developed medium-sized subangular-blocky peds; non-effervescent; clear wavy lower boundary.

Bt 20-65 cm. **Clay**; yellowish red (5 YR 4/7) moist; 5-10% gravel; very sticky and very plastic when wet; very hard when dry; strongly developed medium-sized prismatic peds; slightly effervescent at base; clear wavy lower boundary.

Btk 65-120+ cm. **Gravelly clay loam**; yellowish red (5 YR 5/8) moist; reddish yellow (5 YR 6/8) when dry; 45% gravel; sticky and plastic when wet; slightly hard to hard when dry; massive structure to moderately developed fine-sized prismatic peds; slightly to violently effervescent, pockets of carbonate stage II+ that are 30% of soil volume.

Soil S13b Geomorphic surface **Vk**, Alluvial fan remnant, Clanton Draw Quadrangle: E edge NE1/4 sec.24 T31S R21W, W of Howe Camp, N of Bercham; altitude 5318', slope 0.5° SE aspect.

AB 0-25 cm. **Loam**; dark brown (7.5 YR 3/4) when moist and reddish yellow (7.5 YR 6/6) when dry; 5% gravel; sticky and slightly plastic when wet; very friable when moist and soft when dry; weakly developed medium-sized subangular-blocky peds; non-effervescent; clear wavy lower boundary.

Bt 25-50 cm. **Gravelly clay**; dark reddish brown to yellowish red (5 YR 3.5/5) when moist and reddish brown (5 YR 4.5/3) when dry; 25% gravel; very sticky and very plastic when wet; hard when dry; strongly developed medium-sized prismatic peds; non-effervescent; clear wavy lower boundary.

Bt2 50-100 cm. **Gravelly sandy clay loam**; yellowish red (5 YR 4/6) when moist and yellowish red (5 YR 5.5/6) when dry; 30% gravel; sticky and plastic when wet; loose to slightly hard when dry; massive structure; slightly effervescent, but 10% of soil volume has stage III carbonate; gradual lower boundary.

Bk 100-200+ cm. 30% gravel; slightly hard to extremely hard when dry; massive structure; violently effervescent, carbonate stage III+ in 20% of soil volume.

Soil S14 Geomorphic surface **O**, Alluvial fan remnant; Clanton Draw Quadrangle: E edge NW¼ sec.21 T31S R20W, W of Howe Camp, N of Bercham Creek; altitude 5090', slope 0.8° E aspect.

A 0-10 cm. **Sandy loam**; dark brown (7.5 YR 3/4) when moist and brown (7.5 YR 5/4) when dry; 15% gravel; nonsticky and nonplastic when wet; soft when dry; moderately developed fine-sized platy peds; non-effervescent; abrupt smooth lower boundary.

AB 10-28 cm. **Loam**; dark brown (7.5 YR 3.5/4) when moist and strong brown (7.5 YR 4.5/6) when dry; 15% gravel; slightly sticky and slightly plastic when wet; friable when moist and slightly hard when dry; weakly developed coarse-sized subangular-blocky peds; non-effervescent; abrupt wavy lower boundary.

Bt 28-55 cm. **Gravelly clay**; reddish brown (5 YR 4/4) when moist and yellowish red (5 YR 5/7) when dry; 20% gravel; very sticky and very plastic when wet; hard to very hard when dry; strongly developed medium-sized prismatic structure; non-effervescent; clear smooth lower boundary.

Bt2k 55-165+ cm. **Gravelly sandy clay loam**; yellowish red (5 YR 5/8) when moist and reddish yellow (5 YR 6/6) when dry; 50% gravel; sticky and plastic when wet; soft when dry; massive structure; slightly to violently effervescent with stage II+ carbonate in 20% of soil volume.

Soil S15 Geomorphic surface **O**, Alluvial fan remnant; Tank Mountain Quadrangle: center sec.19 T29S R19W, along Wright Road; altitude 4735', slope 0.5° NE aspect.

A 0-10 cm. **Loam**; dark brown (7.5 YR 3.5/4) when moist and reddish yellow (7.5 YR 6.5/6) moist; <5% gravel; slightly sticky and slightly plastic when wet; soft when dry; granular peds; non-effervescent; abrupt smooth lower boundary.

B1t 10-25 cm. **Clay loam**; reddish brown (5 YR 4/4) when moist and yellowish red (5 YR 4.5/6) when dry; 10% gravel; sticky and plastic when wet; slightly hard when dry; weakly developed medium-sized subangular-blocky peds; non-effervescent; abrupt smooth lower boundary.

B2ts 25-70 cm. **Clay**; dark red (2.5 YR 3/6) when moist and red (2.5 YR 4/6) when dry; 15% gravel; very sticky and very plastic when wet; hard when dry; strongly developed medium-sized prismatic peds; slightly effervescent; gradual wavy lower boundary.

B3k 70-100 cm. **Gravelly loam**; yellowish red (5 YR 4/6) when moist and reddish yellow (5 YR 6.5/6) when dry; 30% gravel; slightly sticky and plastic when wet; hard when dry; massive structure; violently effervescent, carbonate stage II+; gradual wavy lower boundary.

B4k 100-145 cm. **Gravelly sandy loam**; yellowish red (5 YR 4/6) when moist and reddish yellow (5 YR 6.5/6) when dry; 25% gravel; nonsticky and nonplastic when wet; hard when dry; massive structure; moderately to strongly effervescent, carbonate stage I+; gradual wavy lower boundary.

Cox 145-210+ cm. **Gravelly sandy loam**; yellowish red (5 YR 4.5/6) when moist and reddish yellow (5 YR 6/6) when dry; 30% gravel; nonsticky and nonplastic when wet; slightly hard to hard when dry; massive to single-grain structure; slightly effervescent.

Soil S16 Geomorphic surface **Vk**, Alluvial fan remnant; Tank Mountain Quad Quadrangle: NE1/4 sec.26 T29S R20W, along Wright Road; altitude 4850', slope 0.8° E aspect.

A 0-10 cm. **Sandy loam**; brown to dark brown (7.5 YR 4/4) when moist and brown (7.5 YR 5/4) when dry; <5% gravel; nonsticky and slightly plastic when wet; soft when dry; weakly developed medium-sized subangular-blocky peds; strongly effervescent, carbonate stage 0; abrupt wavy lower boundary.

Btk 10-45 cm. **Sandy clay loam**; yellowish red (5 YR 4/6) when moist and reddish yellow (5 YR 6/7) when dry; 10% gravel; sticky and plastic when wet; hard when dry; strongly developed medium-sized prismatic peds; strongly effervescent, carbonate stage I+; abrupt wavy lower boundary.

B1kt 45-90 cm. **Sandy loam**; reddish yellow (7.5 YR 7.5/6) when moist and pink (7.5 YR 8/4) when dry; <5% gravel; slightly sticky and plastic when wet; hard to very hard when dry; massive structure; violently effervescent, carbonate stage III+; gradual wavy lower boundary.

B2k 90-170+ cm. **Loamy sand**; yellowish red (5 YR 5/6) when moist and reddish yellow (5 YR 6/6) when dry; 15% gravel; nonsticky and nonplastic when wet; hard when dry; massive structure; strongly to violently effervescent, mixed carbonate stages II and III.

Soil S17 Geomorphic surface **O6**, Alluvial fan remnant; Tank Mountain Quad Quadrangle: N edge SE1/4 sec.7 T29S R19W, S of Big Creek; altitude 4705', slope 0.6° E aspect.

A 0-7 cm. **Loam**; dark brown (7.5 YR 3/4) when moist and light brown (7.5 YR 6/4) when dry; 5% gravel; slightly sticky and slightly plastic when wet; very friable when moist and loose to soft when dry; massive structure to weakly developed fine-sized platy peds; non-effervescent; abrupt smooth lower boundary.

Bt1 7-27 cm. **Clay loam**; reddish brown to dark reddish brown (5 YR 3.5/4) moist; 10% gravel; sticky and plastic when wet; friable when moist; weakly developed medium-sized subangular-blocky peds; slightly effervescent; abrupt wavy lower boundary.

Bt2k 27-62 cm. **Sandy clay**; red to dark red (2.5 YR 3.5/6) moist; 5% gravel; very sticky and very plastic when wet; hard when dry; moderately developed medium-sized prismatic peds; strongly effervescent, carbonate stage I; clear wavy lower boundary.

Bkt 62-89 cm. **Silty clay loam**; yellowish red (5 YR 4.5/6) when moist and reddish yellow (5 YR 6.5/7) when dry; 10-20% gravel; sticky and plastic when wet; hard when dry; moderately developed fine-sized subangular-blocky peds; violently effervescent, carbonate stage II+, gradual wavy lower boundary.

Bk 89-159 cm. **Silt loam**; yellowish red (5 YR 4/6) when moist and reddish yellow (5 YR 5.5/7) when dry; 5-10% gravel; slightly sticky and slightly plastic when wet; slightly hard to hard when dry; massive structure; moderately effervescent, carbonate stage I; gradual wavy lower boundary.

CBk 159-180 cm. **Loamy sand**; strong brown (7.5 YR 5/6) when moist and light brown (7.5 YR 6.5/4) when dry; nonsticky and nonplastic when wet; slightly hard when dry; massive structure; moderately effervescent, carbonate stage I.

Soil S18 Geomorphic surface **M**, Inset stream terrace; Animas Peak NE Quadrangle: center E1/2 sec.7 T30S R19W, at mouth of Double Adobe Creek; altitude 4810', slope 1° NW aspect.

Av 0-1 cm. **Loam**; brown to dark brown (7.5 YR 4/4) when moist and light brown (7.5 YR 6/4) when dry; 5% gravel; slightly sticky and slightly plastic when wet; soft when dry; weakly developed fine-sized platy peds; non-effervescent, abrupt smooth lower boundary.

A 1-30 cm. **Loam**; dark brown (7.5 YR 3/4) when moist and brown (7.5 YR 4.5/4) when dry; 10% gravel; slightly sticky and slightly plastic when wet; slightly hard when dry; weakly developed coarse-sized subangular-blocky structure; non-effervescent; abrupt smooth lower boundary.

B1st 30-65 cm. **Gravelly sandy clay loam**; reddish brown (5 YR 4/4) when moist and yellowish red (5 YR 5/6) when dry; 50% gravel; sticky and plastic when wet; slightly hard to hard when dry; moderately developed medium-sized subangular-blocky peds; non-effervescent; gradual wavy lower boundary possibly an erosional unconformity.

B2skt 65-130 cm. **Very gravelly sandy clay loam**; reddish brown (5 YR 4/4) when moist and yellowish red (5 YR 5/6) when dry; 60% gravel; sticky and plastic when wet; hard when dry; moderately developed medium-sized subangular-blocky peds; carbonate stage I; gradual wavy lower boundary.

B3sk 130-185+ cm. **Very gravelly sandy clay loam**; red (2.4 YR 4/7) when moist and red (2.5 YR 5/8) when dry; 60% gravel; slightly sticky and slightly plastic when wet; hard when dry; massive structure; moderately effervescent, carbonate stage I; cobble weathering stage 0.

Soil S19 Geomorphic surface **Y2f**, Inset Holocene fan; Animas Peak NE Quadrangle: NW corner SW1/4 sec.7 T30S R19W, at mouth of Miner Canyon; altitude 4790', slope 1° SE aspect.

A 0-30 cm. **Gravelly loamy sand**; dark brown (7.5 YR 3.5/2) when moist and brown (7.5 YR 5.5/2) when dry; 25% gravel; nonsticky and nonplastic when wet; very friable when moist and soft when dry; weakly developed fine-sized subangular-blocky peds; non-effervescent; abrupt wavy contact.

Bk1 30-65 cm. **Gravelly loamy sand**; dark brown (7.5 YR 3.5/2) when moist and brown (7.5 YR 5/2) when dry; 40% gravel; nonsticky and nonplastic when wet; soft when dry; weakly developed medium-sized subangular-blocky peds; non-effervescent matrix but carbonate stage I pebble coatings; gradual smooth lower boundary.

Bk2 65-135 cm. **Gravelly loamy sand**; brown (7.5 YR 4.5/2) when moist and brown to pinkish gray (7.5 YR 5.5/2) when dry; 40% gravel; nonsticky and nonplastic when wet; loose when dry; massive structure; non-effervescent matrix but carbonate stage I pebble coatings; abrupt smooth unconformity lower boundary.

IIBk3 135-160+ cm. **Silt loam**; dark brown (7.5 YR 3.5/2) when moist and pinkish gray (7.5 YR 6/2) when dry; <2% gravel; slightly sticky and slightly plastic when wet; loose when dry; massive structure; carbonate stage I filaments.

Soil S20 Geomorphic surface **Hb**, Hillslope of basalt bedrock; Fitzpatricks Quadrangle: NW1/4 SE1/4 sec.29 T32S R19W, N of Red Hill W of Cornelius Tank; altitude 5660', slope 7° S80°W aspect.

AB 0-10 cm. **Gravelly silt loam**; dark reddish brown (5 YR 3/2) when moist and reddish brown (5 YR 5/3) when dry; 50% gravel; sticky and slightly plastic when wet; very friable when moist and soft to slightly hard when dry; granular to moderately developed very fine sized subangular-blocky peds; non-effervescent; clear wavy lower boundary.

B 10-20 cm. **Very gravelly silty clay loam**; dark reddish brown (5 YR 3/2) when moist and reddish brown (5 YR 4/3) when dry; 70% gravel; very sticky and plastic when wet; very friable when moist and weakly-developed fine-sized angular-blocky peds; non-effervescent; cobble weathering stage III, clear wavy lower boundary.

C 20-30+ cm. **Interlocking basalt fragments.**

Soil S21 Geomorphic surface **Hr**, Hillslope of rhyolite bedrock; Fitzpatricks Quadrangle: center SE1/4 sec.29 T32S R19W, N of Red Hill W of Cornelius Tank; altitude 5660', slope 6° S80°W aspect.

A 0-2 cm. **Gravelly clay loam**; dark brown (7.5 YR 3/2) when moist and brown to dark brown (7.5 YR 4/2) when dry; 30% gravel; sticky and plastic when wet; friable when moist and soft when dry; weakly developed medium-sized subangular-blocky peds; non-effervescent; unweathered stones; abrupt wavy lower boundary.

AB 2-12 cm. **Gravelly clay loam**; dark reddish brown (5 YR 3/2) when moist and dark reddish gray (5 YR 4/2) when dry; 40% gravel; sticky and plastic when wet; friable to firm when moist and slightly hard when dry; weakly developed medium-sized angular-blocky peds; non-effervescent; clear wavy lower boundary.

B 12-27 cm. **Gravelly, clay loam to silty clay loam**; dark reddish brown (5 YR 3/2) when moist and dark reddish gray (5 YR 4/2) when dry; 50% gravel; sticky and plastic when wet; friable to firm when moist and hard when dry; weakly developed medium-sized angular-blocky peds; non-effervescent; cobble weathering stage II, clear wavy lower boundary

CB 27-35+ cm. **Very gravelly clay**; 70+% gravel.

Soil S22 Geomorphic surface **Hb**, Hillslope of basalt bedrock; Fitzpatricks Quadrangle: S side SE1/4 sec.27 T33S R19W, NW of San Luis Pass, W of Miner Tank; altitude 5420', slope 5° S60°W aspect.

AB 0-5 cm. **Gravelly silty clay loam**; dark reddish brown (5 YR 3/3) when moist and reddish gray (5 YR 5/2) when dry; 40% gravel; sticky and plastic when wet; soft to slightly hard when dry; granular to weakly developed fine-sized angular-blocky peds; slight effervescence; cobble weathering stage I-; clear wavy lower boundary.

B 5-15 cm. **Very gravelly clay loam**; dark reddish brown (5 YR 3/2) when moist and dark reddish gray (5 YR 4/2) when dry; 70% gravel; sticky to very sticky and plastic when wet to very plastic when wet; hard when dry; weakly developed medium-sized subangular-blocky peds; strong effervescence, carbonate stage II pebble coatings; cobble weathering stage II; clear wavy lower boundary.

C 15-25+ cm. **Interlocking basalt fragments**; 90% gravel.

Soil S23 Geomorphic surface **Hr**, Hillslope of rhyolite bedrock; Fitzpatricks Quadrangle: W side SE¼ sec.27 T33S R19W, NW of San Luis Pass, W of Miner Tank; altitude 5420', slope 5° S60°W aspect.

A 0-3 cm. **Gravelly silty clay loam**; very dark gray (5 YR 3/1) when moist and dark gray (5 YR 4/1) when dry; 50% gravel; sticky and plastic when wet; soft when dry; granular to moderately developed medium-sized subangular-blocky peds; non-effervescent; cobble weathering stage I-; abrupt smooth lower boundary.

B1 3-8 cm. **Gravelly clay loam**; very dark gray (5 YR 3/1) when moist and dark gray (5 YR 4/1) when dry; 20% gravel; sticky and plastic when wet; friable when moist and slightly hard to hard when dry; weakly developed medium-sized subangular-blocky peds, non-effervescent; abrupt wavy lower boundary.

B2t 8-30 cm. **Clay loam**; very dark gray (5 YR 3/1) when moist and dark gray (5 YR 4/1) when dry; 10% gravel; sticky and plastic when wet; friable when moist and hard when dry; massive structure; non-effervescent; cobble weathering stage II+; clear wavy lower boundary.

C 30-40+ cm. **Interlocking rhyolite fragments**; 95% gravel.

Soil S24 Geomorphic surface **Hn**, Hillslope of andesite bedrock; Animas Peak Quadrangle: NW corner NW¼ sec.6 T32S R19W, N of Last Chance Draw; altitude 5680', slope 13° S85°W aspect.

AB 0-12 cm. **Gravelly clay loam**; dark reddish brown (5 YR 3/2) when moist and dark brown (7.5 YR 3/2) when dry; 30% gravel (95% surface cover), sticky and plastic when wet; soft to slightly hard when dry; moderately developed medium-sized subangular-blocky peds; non-effervescent; clear smooth lower boundary.

B 12-35 cm. **Gravelly silty clay**; dark reddish brown (5 YR 3/2) moist; 40% gravel; very sticky and very plastic when wet; friable when moist and hard when dry; weakly developed coarse-sized subangular-blocky peds; non-effervescent; clear wavy lower boundary.

C 35-45+ cm. **Interlocking andesite fragments,** 95% gravel.

Soil S25 Geomorphic surface **Hl**, Hillslope of latite bedrock; Animas Peak Quadrangle: center NW1/4 sec.19 T31S R19E, S of Walker Tank; altitude 5660', slope 13° S80°W aspect.

A 0-8 cm. **Gravelly loam**; dark reddish brown (5 YR 3/2) when moist and brown to dark brown (7.5 YR 4/2) when dry; 30% gravel; slightly sticky and slightly plastic when wet; slightly hard when dry, moderately developed fine-sized subangular-blocky peds; non-effervescent; clear smooth lower boundary.

B 8-27 cm. **Very gravelly silty loam**; dark reddish brown (5 YR 3/2) when moist and reddish brown (5 YR 4/3) when dry; 55% gravel; slightly sticky and plastic when wet; slightly hard when dry, weakly developed fine-sized subangular-blocky peds; non-effervescent; clear wavy lower boundary.

C 27-35+ cm. **Interlocking latite fragments**, 95% gravel.

Soil S26 Geomorphic surface **Y2**, Inset Holocene fill terrace; Animas Peak Quadrangle: W side SW1/4 sec.10 T32S R20W, stream bank E of Animas Foundation office; altitude 5100', slope 1° W aspect. Age estimates and description of depositional units below modified from Krider (1997).

Unit 5 0-27 cm. **Gravelly sandy loam**; dark brown (7.5 YR 4/2); 30% gravel; nonsticky and slightly plastic when wet; slightly hard when dry; weakly developed large columnar peds; non-effervescent. No bedding or sedimentary structures preserved. Contains charcoal with radiocarbon age of 878 ±49 years B.P.

Unit 4 27-47 cm. **Sandy loam**; brown (7.5 YR 5/2); nonsticky and slightly plastic when wet; slightly hard when dry; weakly developed large columnar peds in upper 10 cm; non-effervescent. Upper portion contains 5-10% gravel; bottom 5 cm contains 25% gravel. Upward-fining sequence contains little other bedding or sedimentary structures. Contains charcoal with radiocarbon age of 1,416 ±68 years B.P.

Unit 3 47-69 cm. **Loam**; brown (7.5 YR 5/4); 5% gravel; nonsticky and slightly plastic when wet; hard when dry; weakly developed large columnar peds; non-effervescent.

Unit 2 69-130 cm. **Loam**; dark brown (7.5 YR 4/2); 5% gravel; slightly sticky and slightly plastic when wet; slightly hard when dry; weakly developed large columnar peds; slight effervescence.

Unit 1 130+350+ cm. **Very gravelly loam**; light reddish brown (5 YR 6/4); slightly sticky and slightly plastic when wet; slightly hard when dry; weakly developed large columnar peds in upper 20 cm, massive structure below; slight effervescence. Unit generally fines upward and consists of cobbles (60%) in matrix of interbedded lenticular sand and gravel packages. Contains charcoal with radiocarbon age of 5,283 ±68 years B.P.

Site S27 Geomorphic surface **Ls**, Lake shoreline depositional berm, and **Ld**, Lake shoreline depositional bench; Fitzpatricks Quadrangle: center SE¼ sec.24 T33S R20W, trench in lake berm next to San Luis Pass road; altitude 5160', slope 1°-11° SW aspect. Age estimates, lake chronology, and description of soils and deposits below modified from Krider (1997).

Soil 27A Lake spit sediment (0-90 cm) deposited during lake 2 time (middle to late Holocene) overlying lake spit sediment (90-190+ cm) deposited during lake 1 time (18-20 ka).

A 0-7 cm. **Loam**; grayish brown (10 YR 5/2) when dry; <10% gravel (discoidal beach pebbles), slightly sticky and slightly plastic when wet; slightly hard when dry; moderately developed fine-sized subangular-blocky peds; non-effervescent; clear smooth lower boundary.

B 7-35 cm. **Loam**; pale brown (10 YR 6/3) when dry; 10% gravel; slightly sticky and slightly plastic when wet; hard when dry; moderately developed coarse-sized subangular-blocky peds; non-effervescent; clear smooth lower boundary.

C 35-90 cm. **Gravelly sand**; pinkish gray (7.5 YR 7/2) when dry; 25-50% gravel (imbricated, discoidal beach pebbles), nonsticky and nonplastic when wet; loose when dry; massive structure; non-effervescent; sharp wavy erosional contact.

IIBtb 90-150 cm. **Sandy clay loam**; dark brown (7.5 YR 4/4) moist; pinkish gray (7.5 YR 6/2) when dry; 1% gravel; sticky and plastic when wet; very firm when moist and very hard when dry; moderately developed coarse-sized prismatic peds with many prominent clay films on ped faces; carbonate stage 0; clear wavy lower boundary. Contains carbonized wood with radiocarbon age (on residue after pretreatment) of 4,115 ±102 years B.P., but this is anomalously young. Krider (1997) obtained radiocarbon ages of 18,000 to 20,000 years for this unit at a different site.

IIBkb 150-190+ cm. **Silt**; pinkish gray (7.5 YR 6/2) when dry; 1% gravel (discontinuous lenses of discoidal beach pebbles), nonsticky and nonplastic when wet; loose (moist and dry); massive structure; carbonate stage I+ to II; locally cemented by subhorizontal, silica-cement stringers (1-5 cm thick).

Soil 27B lake shoreline depositional bench at the foot of the highstand spit (description above) formed during lake 3 time (latest Holocene).

A 0-15 cm. **Silt loam**; light brownish gray (10 YR 6/2) when dry; ≤3% gravel; slightly sticky and slightly plastic when wet; friable when moist and very hard when dry; strongly developed fine-sized angular-blocky peds; carbonate stage 0; clear smooth lower boundary.

B 15-85 cm. **Silt loam**; light gray (10 YR 7/2) when dry; 0% gravel; slightly sticky and slightly plastic when wet; friable when moist and very hard when dry; moderately developed very coarse sized subangular-blocky peds; carbonate stage 0. Contains charcoal fleck with radiocarbon age of 237 ±43 years B.P., but Krider (1987) believes the deposit may be as old as 1,000 years.

C 85+ cm. **Silt loam**; light gray (10 YR 7/2) when dry; 0% gravel; slightly sticky and slightly plastic when wet; friable when moist and very hard when dry; massive structure; carbonate stage 0.

Soil Scs12 Geomorphic surface **V**, Alluvial fan remnant; Black Point Quadrangle: SW corner sec.32 T32S R20W; altitude 5228', slope 0.3° E aspect. Soil description from Cox (1973, p. 12).

A 0-10 cm. **Clay loam**; dark brown (7.5 YR 3/2) when moist and dark grayish brown (10 YR 4/2) when dry; sticky and plastic when wet; friable when moist and slightly hard when dry; moderately developed medium-sized granular structure; noncalcareous; clear smooth lower boundary.

B21t 10-23 cm. **Clay**; very dark brown (10 YR 2/2) moist; very dark grayish brown (10 YR 3/2) when dry; very sticky and very plastic when wet; firm when moist and very hard when dry; weakly developed coarse-sized prismatic peds and moderately developed medium-sized subangular-blocky peds; common, moderately thick clay films on peds with few indistinct slickensides; noncalcareous; mildly alkaline; gradual smooth lower boundary.

B22t 23-46 cm. **Clay**; very dark brown (10 YR 2/2) when moist and very dark grayish brown (10 YR 3/2) when dry; very sticky and very plastic when wet; firm when moist and very hard when dry; weakly developed very coarse sized prismatic peds and moderately developed coarse-sized and very coarse sized subangular-blocky peds; common, moderately thick clay films on peds with few indistinct slickensides; slightly calcareous; mildly alkaline; clear irregular lower boundary.

B3 46-91 cm. **Clay**; dark brown (7.5 YR 3/2) when moist and dark grayish brown (10 YR 4/2) when dry; very sticky and very plastic when wet; firm when moist and very hard when dry; weakly developed very coarse sized prismatic peds and weakly developed very coarse sized subangular-blocky peds; strongly calcareous; moderately alkaline; clear wavy lower boundary.

Cca 91-182+ cm. **Gravelly clay**; mottled reddish brown (5 YR 5/3), light reddish brown (2.5 YR 6/4) and light gray (10 YR 7/2); 10-30% gravel; sticky and plastic when wet; firm when moist and very hard when dry; massive structure with pockets of moderately developed medium-sized subangular-blocky peds; common, medium-sized, prominent, black iron concretions and stains; common, fine, distinct lime masses; strongly calcareous, moderately alkaline.

Soil Scs43 Geomorphic surface **Ws/M**, Sheet of windblown sand overlaying an M soil, that may overlie an O soil; Fitzpatricks Quadrangle: center sec.2 T33S R20W; altitude 5170', slope 0.4° W aspect. Soil description from Cox (1973, p. 43). Note several of the stated hues are inconsistent with the stated colors.

A11 0-5 cm. **Loamy sand**; dark brown (10 YR 3/3) when moist and pale brown (10 YR 6/3) when dry; nonsticky and nonplastic when wet; very friable when moist and soft when dry; massive structure; noncalcareous; mildly alkaline; clear lower boundary.

A12 2-25 cm. **Loamy sand**; dark brown (10 YR 3/3) when moist and pale brown (10 YR 6/3) when dry; nonsticky and nonplastic when wet; very friable when moist and slightly hard when dry; weakly developed coarse-sized subangular-blocky peds; noncalcareous; mildly alkaline; abrupt lower boundary.

C 25-51 cm. **Loamy sand**; brown (10 YR 4/3) when moist and pale brown (10 YR 6/3) when dry; nonsticky and nonplastic when wet; very friable when moist and slightly hard when dry; massive structure; noncalcareous; mildly alkaline; abrupt lower boundary.

IIA2b 51-56 cm. **Sandy loam**; grayish brown (2.5 YR 5/2) when moist and white (2.5 YR 8/2) when dry; nonsticky and nonplastic when wet; friable when moist and very hard when dry; weakly developed thick platy peds; weakly cemented by silica; noncalcareous; mildly alkaline; clear lower boundary.

IIB2tb 56-86 cm. **Sandy clay**; highly mottled grayish brown, dark grayish brown, and very dark grayish brown (2.5 Y 5/2, 4/2, 3/2) when moist and white, light brownish gray, and dark grayish brown (2.5 Y 8/2, 6/2, 4/2) when dry; sticky and plastic when wet; firm when moist and very hard when dry; weakly developed medium-sized prismatic peds and moderately developed coarse-sized subangular-blocky peds; weakly developed thin platy peds on caps of prisms; noncalcareous; mildly alkaline; clear lower boundary.

IICb 86-102 cm. **Sandy loam**; grayish brown (2.5 Y 5/2) when moist and light gray (2.5 Y 7/2); nonsticky and nonplastic when wet; firm when moist and very hard when dry; massive structure; slightly cemented by silica; noncalcareous; mildly alkaline; clear lower boundary.

IIIB2b 102-152+ cm. **Heavy clay loam**; reddish brown (5 Y 4/4) when moist and light reddish brown (5 YR 6/4) dry with common, fine, prominent mottles of brown (10 YR 5/3) when moist and very pale brown (10 YR 7/3) when dry; sticky and plastic when wet; friable when moist and very hard when dry; moderately developed medium-sized subangular-blocky peds; noncalcareous; mildly alkaline.

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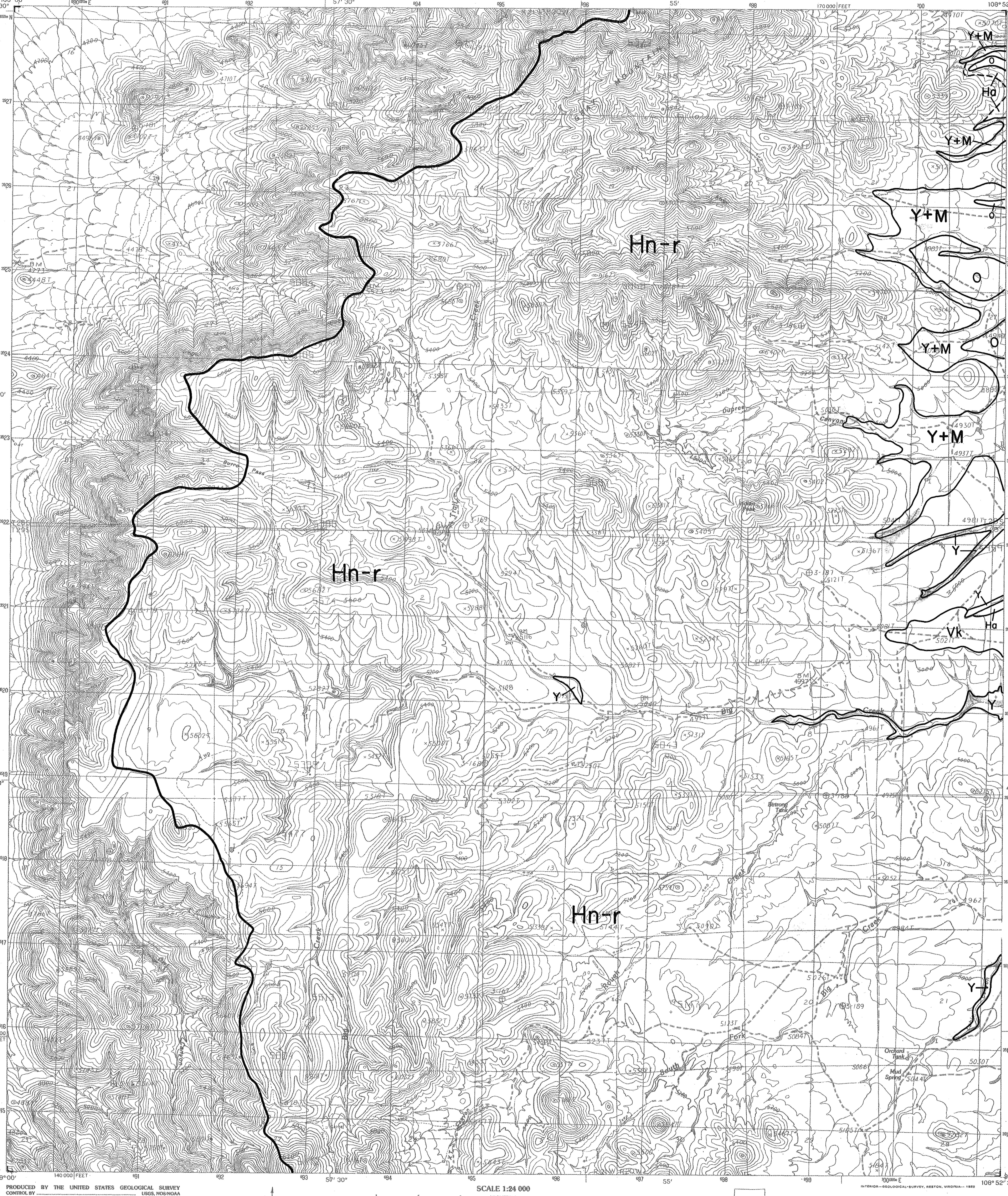
UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

Vincent and Krider, 1997: PLATE 429-A

New Mexico Bureau of Mines and Mineral Resources
Open-File Report 429

INDIAN PEAK QUADRANGLE
NEW MEXICO–HIDALGO CO.
7.5 MINUTE SERIES (TOPOGRAPHIC)



PRODUCED BY THE UNITED STATES GEOLOGICAL SURVEY
CONTROL BY .... USGS, NOS/NOAA
COMPILED FROM AERIAL PHOTOGRAPHS TAKEN 1976
FIELD CHECKED .... 1977 MAP EDITED........ 1982
PROJECTION .... TRANSVERSE MERCATOR
GRID: 1000-METER UNIVERSAL TRANSVERSE MERCATOR .... ZONE 12
10,000-FOOT STATE GRID TICKS .... NEW MEXICO, WEST ZONE
UTM GRID DECLINATION .... 1°05' EAST
1982 MAGNETIC NORTH DECLINATION .... 12° EAST
VERTICAL DATUM .... NATIONAL GEODETIC VERTICAL DATUM OF 1929
HORIZONTAL DATUM .... 1927 NORTH AMERICAN DATUM

To place on the predicted North American Datum of 1983, move the projection lines as shown by dashed corner ticks
(9 meters south and 58 meters east)
There may be private inholdings within the boundaries of any Federal and State Reservations shown on this map

NORTH

PROVISIONAL MAP
Produced from original manuscript drawings. Information shown as of date of field check. 3

SCALE 1:24 000

KILOMETERS 1 .5 0 1 2
METERS 1000 0 1000 2000
MILES 1 .5 0 1
FEET 1000 0 1000 2000 3000 4000 5000 6000 7000 8000 9000 10 000

CONTOUR INTERVAL 40 FEET

To convert meters to feet multiply by 3.2808
To convert feet to meters multiply by .3048

THIS MAP COMPLIES WITH NATIONAL MAP ACCURACY STANDARDS
FOR SALE BY U.S. GEOLOGICAL SURVEY, DENVER, COLORADO, 80225
OR RESTON, VIRGINIA 22092

NEW MEXICO
QUADRANGLE LOCATION

1	2	3	1 Portal NE 2 Antelope Pass 3 Animas 4 Rodeo 5 Tank Mountain 6 Skull Canyon 7 Mount Baldy 8 Animas Peak NE
4		5	
6	7	8	

ADJOINING 7.5 QUADRANGLE NAMES

INTERIOR—GEOLOGICAL SURVEY, RESTON, VIRGINIA—1983

ROAD LEGEND

Improved Road
Unimproved Road
Trail
Interstate Route U.S. Route State Route

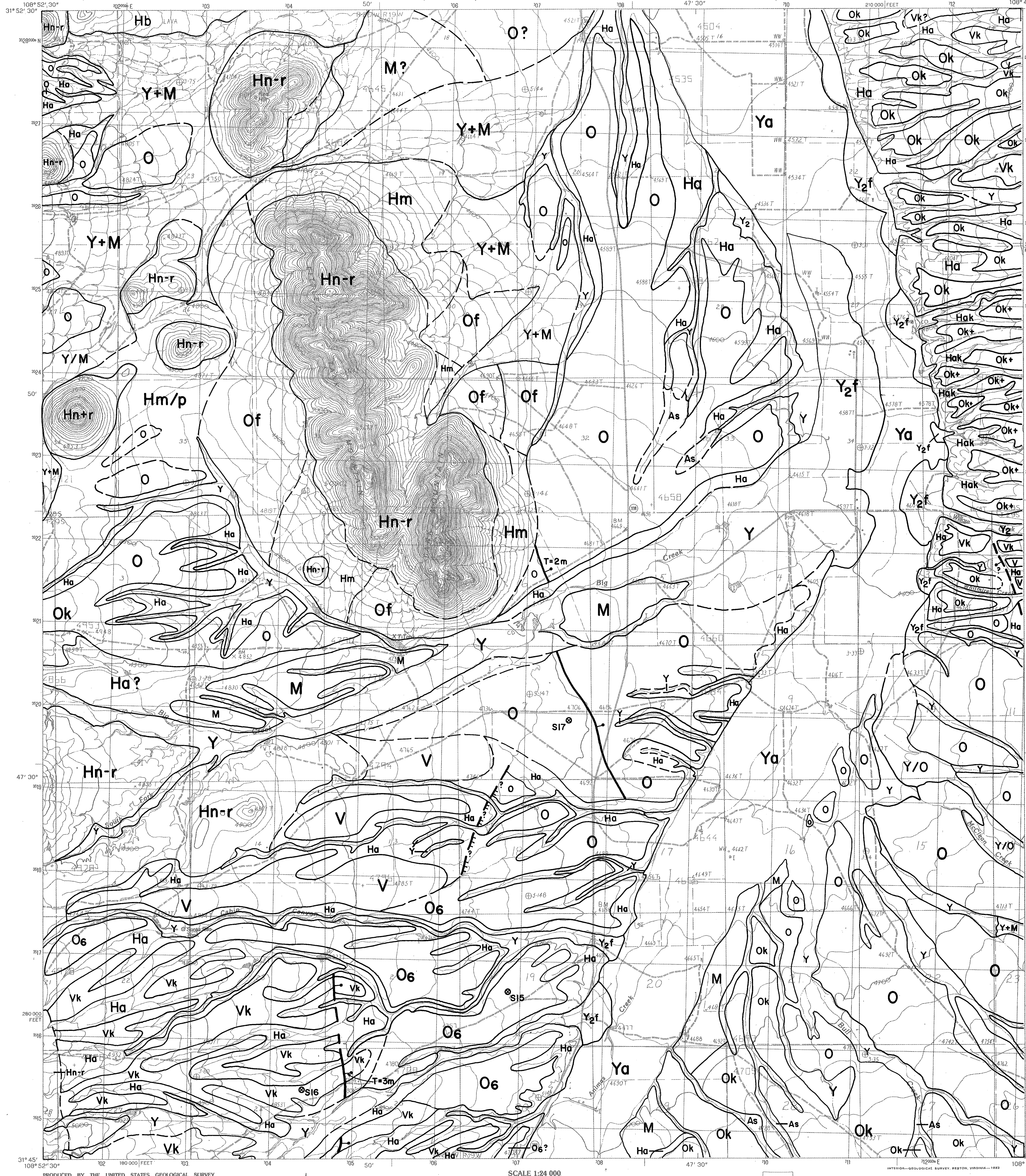
INDIAN PEAK, NEW MEXICO

PROVISIONAL EDITION 1982

31108-G8-TF-024

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

TANK MOUNTAIN QUADRANGLE
NEW MEXICO–HIDALGO CO.
7.5 MINUTE SERIES (TOPOGRAPHIC)



PRODUCED BY THE UNITED STATES GEOLOGICAL SURVEY	
CONTROL BY	USGS, NOS/NOAA
COMPILED FROM AERIAL PHOTOGRAPHS TAKEN	1976
FIELD CHECKED	1977
MAP EDITED	1982
PROJECTION	TRANSVERSE MERCATOR
GRID: 1000-METER UNIVERSAL TRANSVERSE MERCATOR	ZONE 12
10,000-FOOT STATE GRID TICKS	NEW MEXICO, WEST ZONE
UTM GRID DECLINATION	1°09′ EAST
1982 MAGNETIC NORTH DECLINATION	11°30′ EAST
VERTICAL DATUM	NATIONAL GEODETIC VERTICAL DATUM OF 1929
HORIZONTAL DATUM	1927 NORTH AMERICAN DATUM

To place on the predicted North American Datum of 1983, move the projection lines as shown by dashed corner ticks (9 meters south and 57 meters east)

There may be private inholdings within the boundaries of any Federal and State Reservations shown on this map

NORTH

PROVISIONAL MAP
Produced from original manuscript drawings. Information shown as of date of field check. 3

SCALE 1:24 000

KILOMETERS 1 .5 0 1 2
METERS 1000 0 1000 2000
MILES 1 .5 0 1
FEET 1000 0 1000 2000 3000 4000 5000 6000 7000 8000 9000 10 000

CONTOUR INTERVAL 20 FEET

To convert meters to feet multiply by 3.2808
To convert feet to meters multiply by .3048

THIS MAP COMPLIES WITH NATIONAL MAP ACCURACY STANDARDS
FOR SALE BY U.S. GEOLOGICAL SURVEY, DENVER, COLORADO, 80225
OR RESTON, VIRGINIA 22092

NEW MEXICO
QUADRANGLE LOCATION

1	2	3	1 Antelope Pass 2 Animas 3 Beacon Hill 4 Indian Peak 5 Whitmire Pass 6 Mount Baldy 7 Animas Peak 8 Gillespie Mountain
4		5	
6	7	8	

ADJOINING 7.5 QUADRANGLE NAMES

INTERIOR—GEOLOGICAL SURVEY, RESTON, VIRGINIA—1982

ROAD LEGEND

Improved Road
Unimproved Road
Trail
Interstate Route U.S. Route State Route

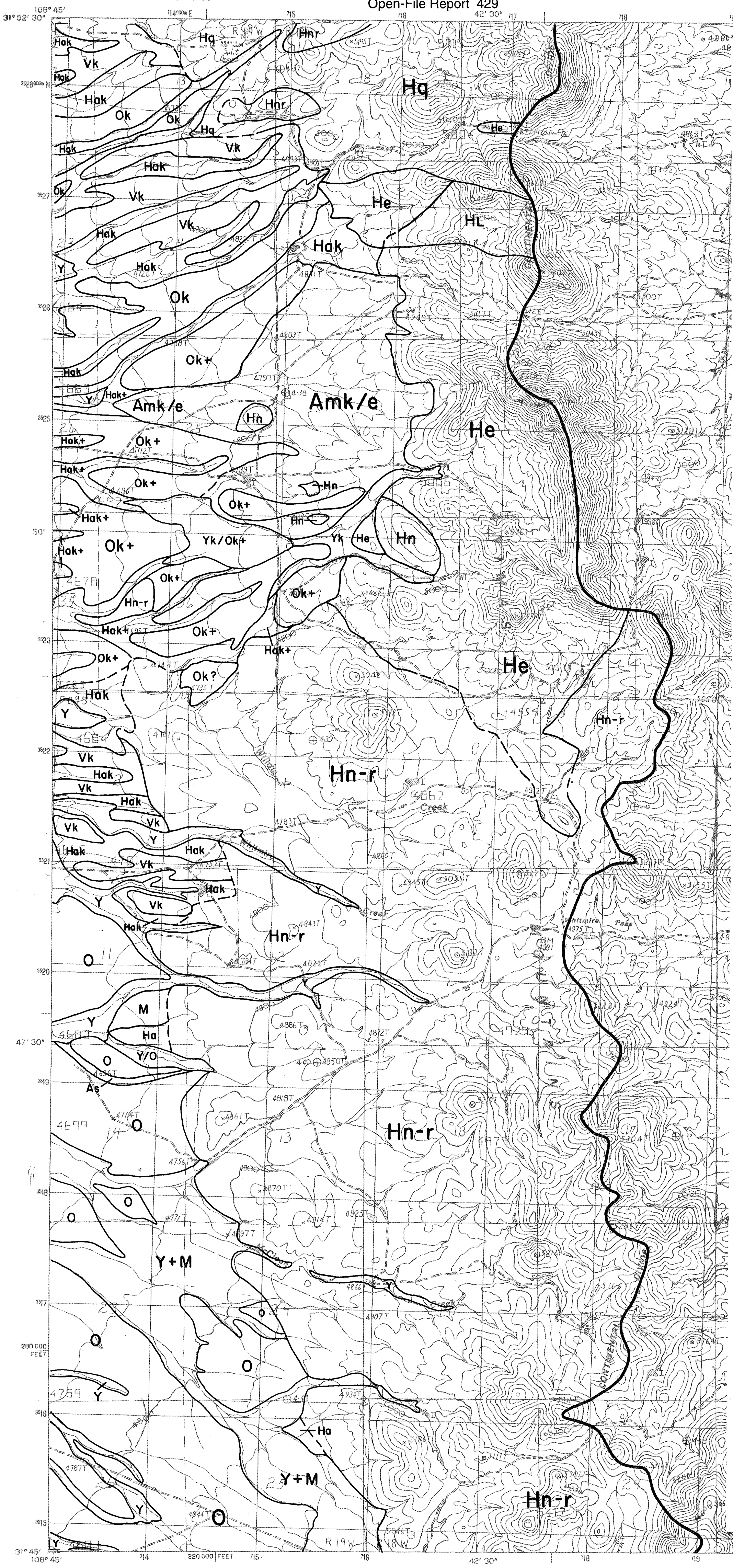
TANK MOUNTAIN, NEW MEXICO
PROVISIONAL EDITION 1982
31108-G7-TF-024

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

Vincent and Krider, 1997: PLATE 429-C

New Mexico Bureau of Mines and Mineral Resources
Open-File Report 429

WHITMIRE PASS QUADRANGLE
NEW MEXICO–HIDALGO CO.
7.5 MINUTE SERIES (TOPOGRAPHIC)



MAP SYMBOL EXPLANATION

MAP UNIT CONTACTS AND MISCELLANEOUS SYMBOLS

Boundary of mapping area, and also drainage basin divides except for the northern mapping boundary.

Contact of geomorphic surfaces, dashed where inferred.

Normal fault where material on both sides of trace are faulted, dotted where concealed.

Normal-fault scarp where the geomorphic surface on the down-thrown side is not faulted, but instead laps onto the scarp.

? Used with contacts to indicate uncertain location, used with map unit symbol (e.g. V?) to indicate uncertain unit designation.

T=2m Throw, apparent vertical displacement, on fault.

⊗ S17 Soil pit location and identification number.

MEANING OF COMPOUND MAP SYMBOLS

Map symbols for geomorphic surfaces, like O6k/pr, imply information in a left-to-right sequence or hierarchy. The landform origin is first, with age used for stream terraces. In the example above, O6 indicates an alluvial fan surface of late-Pleistocene age that has specified soil development, form, and position in the landscape. If not already inferred, composition of the substrate is specified next, or a regional variant or special feature is indicated. The special feature k indicates the soil also contains more calcium carbonate then the type-section soil. Although infrequently used, the slash (/) indicates that the surface deposit and soil are known to overlie something else at shallow depth. In the example, alluvium and soil overlie a pediment (p) cut into rhyolite bedrock (r).

LANDFORM ORIGIN

The origin of landforms in the study area include the actions of streams, lakes and wind, and hillslope processes:

A: Alluvial fan remnants and stream terraces (well-preserved
Y depositional surfaces only). The A that would
M otherwise lead the symbol is omitted for alluvial
O surfaces where additional information on age
V (**Y**oung, **M**edium, **O**ld, and **V**ery old) can be inferred.

L: Lacustrine depositional landforms and erosional shorelines.

W: Wind-blown depositional landforms.

H: Hillslopes that are eroded or eroding.

ALLUVIAL LANDFORMS

Y: Holocene floodplains or fill terraces.

Y2a: Animas Creek floodplain.

Yc: Cienegas along major creeks.

As: Alluvial swales.

Y2: Holocene fill terraces in bottom of tributary drainages.

M: Latest Pleistocene (early Holocene?) inset terraces. Terrace M3 is younger than terrace M4.

O: Late Pleistocene alluvial fan remnants. Remnant O6 is the top of basin fill and the younger O5 surface is inset into it.

V: Early to middle Pleistocene alluvial fan remnants.

TRANSITION TO HILLSLOPES

Landforms transitional between Alluvial and Hillslope in origin.

Am: Mantle of alluvium (and colluvium) spanning considerable range in age (probably includes O) that has low gradient and covers pedimented bedrock.

Hm: Apron of thick and moderately steep colluvium (and alluvium?) at the foot of steeper hillslopes covered by thin colluvium.

HILLSLOPES

Hillslopes generally consist of colluvium-covered bedrock (or sediment), but locally may be exposed bedrock (or sediment).

Ha: Unconsolidated late Quaternary alluvium, such as a terrace riser.

Hg: Moderately cemented QT gravel.

Hc: Indurated Tertiary conglomerates.

Hv: Silicic volcaniclastic rocks.

Hr: Rhyolite.

Hl: Latite

Hd: Dacite.

Hn: Andesite.

Hb: Basalt.

Hn-r: Mixed andesite, latite, and rhyolite.

Hu: Undifferentiated bedrock, but probably silicic volcanics.

Hq: Limy sandstone.

He: Limestone.

LACUSTRINE LANDFORMS

Lb: Lake bottom (now dry).

Ls: Lake spit and lake-shore depositional berms (that may include an erosional shoreline) formed by latest Pleistocene lake 1 (level >5175' and <5180') and modified by early Holocene lake 2 (level at 5175'), or formed by lake 2.

Le: Wave-cut shoreline features.

Ld: Lake-shore deltas or depositional benches formed by middle to late Holocene lakes. Ld3 was formed by lake 3 at level 5160', and Ld4 was formed by the younger lake 4 at level 5150'.

EOLIAN LANDFORMS

Ws: Sheet of wind-blown sand.

Wd: Stabilized sand dunes.

SPECIAL FEATURES

/p Surficial sediments overlie a pediment carved in bedrock.

k Soil contains more calcium carbonate then type-section soil.

k+ Soil derived from limestone alluvium consists of calcrete.

f Surface has shape of small alluvial fan.

x Deposits extremely bouldery in texture.

a Not a special feature, but is used to denote hillslope in alluvium (Ha) and used to distinguish the aggrading Animas Creek floodplain (Y2a) from incised valley bottom of side streams (Y2).

PRODUCED BY THE UNITED STATES GEOLOGICAL SURVEY
CONTROL BY .... USGS, NOS/NOAA
COMPILED FROM AERIAL PHOTOGRAPHS TAKEN 1976
FIELD CHECKED .... 1977 MAP EDITED 1982
PROJECTION .... TRANSVERSE MERCATOR
GRID: 1000-METER UNIVERSAL TRANSVERSE MERCATOR .... ZONE 12
10,000-FOOT STATE GRID TICKS .... NEW MEXICO, WEST ZONE
UTM GRID DECLINATION .... 1°13' EAST
1982 MAGNETIC NORTH DECLINATION .... 11°30' EAST
VERTICAL DATUM .... NATIONAL GEODETIC VERTICAL DATUM OF 1929
HORIZONTAL DATUM .... 1927 NORTH AMERICAN DATUM

To place on the predicted North American Datum of 1983, move the projection lines as shown by dashed corner ticks (9 meters south and 57 meters east)

There may be private inholdings within the boundaries of any Federal and State Reservations shown on this map

PROVISIONAL MAP
Produced from original manuscript drawings. Information shown as of date of field check. 3

SCALE 1:24 000

CONTOUR INTERVAL 40 FEET

To convert meters to feet multiply by 3.2808
To convert feet to meters multiply by .3048

THIS MAP COMPLIES WITH NATIONAL MAP ACCURACY STANDARDS
FOR SALE BY U.S. GEOLOGICAL SURVEY, DENVER, COLORADO, 80225
OR RESTON, VIRGINIA 22092

NEW MEXICO
QUADRANGLE LOCATION

1	2	3
4		5
6	7	8

1 Animas
2 Beacon Hill
3 Playas Lake North
4 Tank Mountain
5 Playas Lake South
6 Animas Peak NE
7 Gillespie Mountain
8 Walnut Wells NE

ADJOINING 7.5' QUADRANGLE NAMES

ROAD LEGEND
Improved Road
Unimproved Road
Trail
Interstate Route U.S. Route State Route

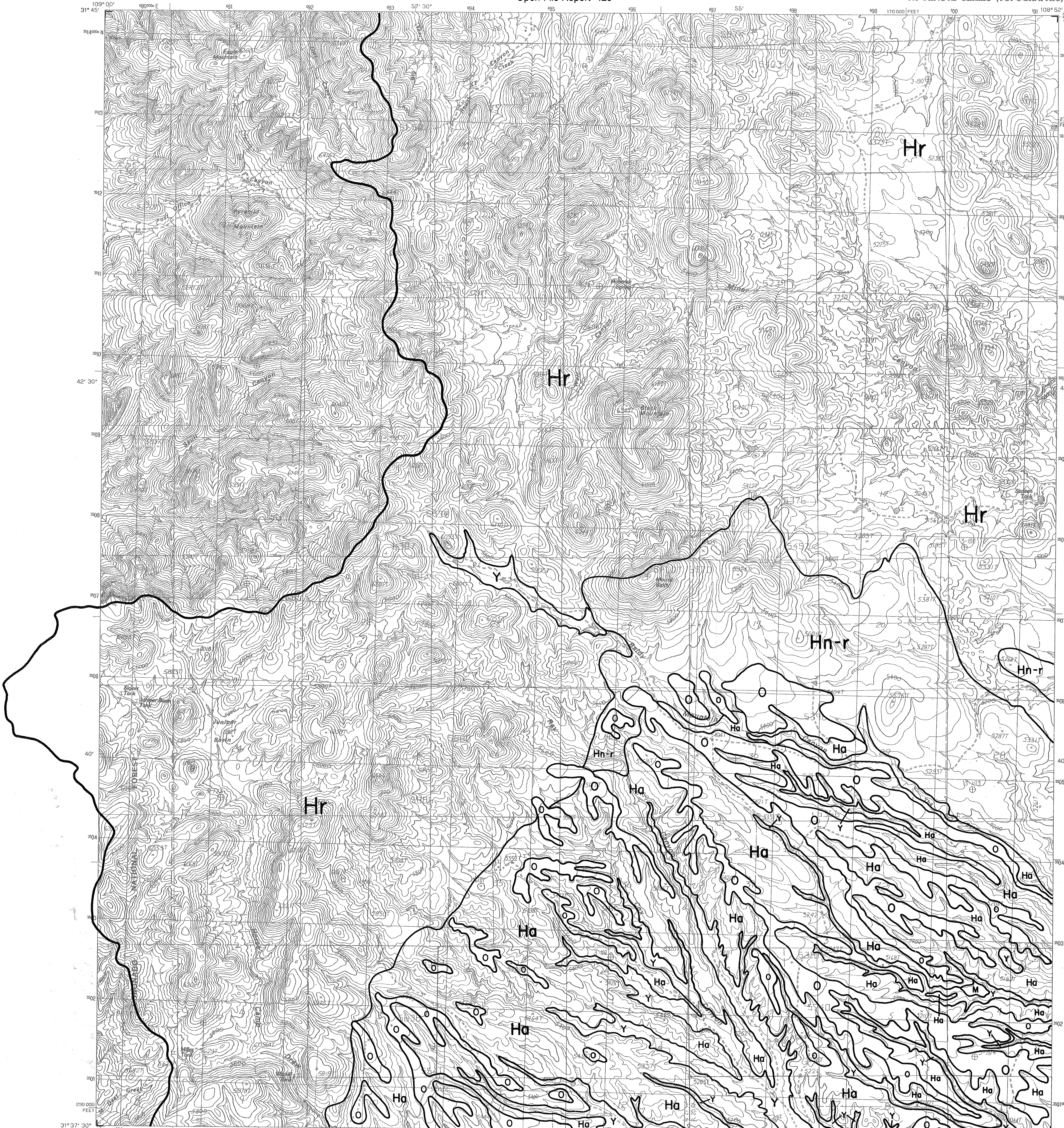
WHITMIRE PASS, NEW MEXICO
PROVISIONAL EDITION 1982
31108-G6-TF-024

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

Vincent and Krider, 1997: PLATE 429-D

New Mexico Bureau of Mines and Mineral Resources
Open-File Report 429

MOUNT BALDY QUADRANGLE
NEW MEXICO–HIDALGO CO.
7.5 MINUTE SERIES (TOPOGRAPHIC)



PRODUCED BY THE UNITED STATES GEOLOGICAL SURVEY
CONTROL BY .... USGS, NOS/NOAA
COMPILED FROM AERIAL PHOTOGRAPHS TAKEN 1976
FIELD CHECKED .... 1977 MAP EDITED........ 1982
PROJECTION .... TRANSVERSE MERCATOR
GRID: 1000-METER UNIVERSAL TRANSVERSE MERCATOR .... ZONE 12
10,000-FOOT STATE GRID TICKS .... NEW MEXICO, WEST ZONE
UTM GRID DECLINATION .... 1°05' EAST
1982 MAGNETIC NORTH DECLINATION .... 12°EAST
VERTICAL DATUM .... NATIONAL GEODETIC VERTICAL DATUM OF 1929
HORIZONTAL DATUM .... 1927 NORTH AMERICAN DATUM

To place on the predicted North American Datum of 1983, move the projection lines as shown by dashed corner ticks (10 meters south and 58 meters east)

There may be private inholdings within the boundaries of any Federal and State Reservations shown on this map

NORTH

SCALE 1:24 000

KILOMETERS · METERS · MILES · FEET

CONTOUR INTERVAL 40 FEET

To convert meters to feet multiply by 3.2808
To convert feet to meters multiply by .3048

THIS MAP COMPLIES WITH NATIONAL MAP ACCURACY STANDARDS
FOR SALE BY U.S. GEOLOGICAL SURVEY, DENVER, COLORADO, 80225
OR RESTON, VIRGINIA 22092

PROVISIONAL MAP
Produced from original manuscript drawings. Information shown as of date of field check. 3

NEW MEXICO

QUADRANGLE LOCATION

1	2	3	1 Rodeo 2 Indian Peak 3 Tank Mountain
4		5	4 Skull Canyon 5 Animas Peak NE
6	7	8	6 Skeleton Canyon 7 Clanton Draw 8 Animas Peak

ADJOINING 7.5 QUADRANGLE NAMES

INTERIOR—GEOLOGICAL SURVEY, RESTON, VIRGINIA—1982

ROAD LEGEND

Improved Road
Unimproved Road
Trail

Interstate Route · U.S. Route · State Route

MOUNT BALDY, NEW MEXICO

PROVISIONAL EDITION 1982

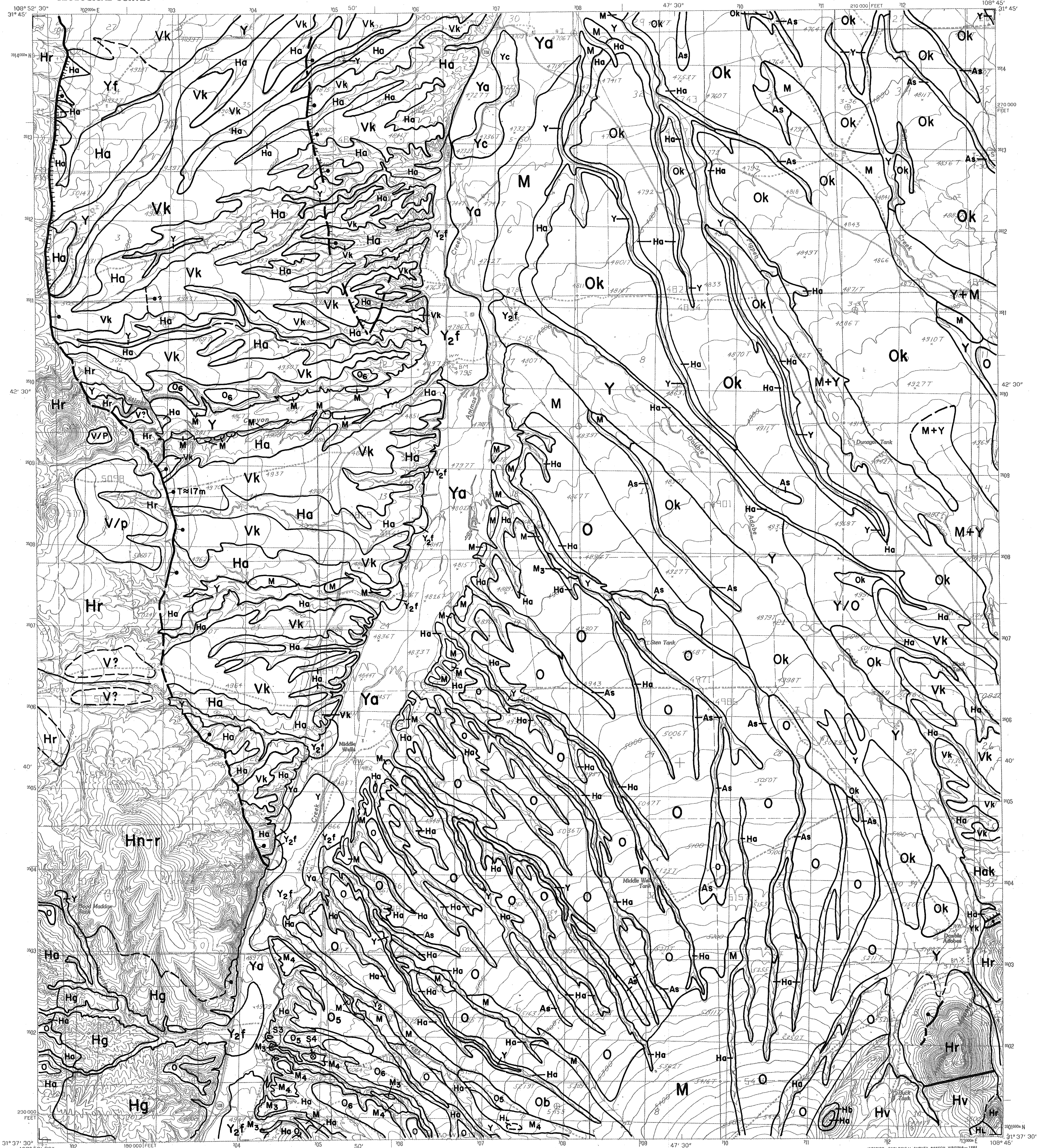
31108-F8-TF-024

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

Vincent and Krider, 1997: PLATE 429-E

New Mexico Bureau of Mines and Mineral Resources
Open-File Report 429

ANIMAS PEAK NE QUADRANGLE
NEW MEXICO–HIDALGO CO.
7.5 MINUTE SERIES (TOPOGRAPHIC)



INTERIOR—GEOLOGICAL SURVEY, RESTON, VIRGINIA—1982

PRODUCED BY THE UNITED STATES GEOLOGICAL SURVEY
CONTROL BY .... USGS, NOS/NOAA
COMPILED FROM AERIAL PHOTOGRAPHS TAKEN 1976
FIELD CHECKED .... 1977 MAP EDITED 1982
PROJECTION .... TRANSVERSE MERCATOR
GRID: 1000-METER UNIVERSAL TRANSVERSE MERCATOR .... ZONE 12
10,000-FOOT STATE GRID TICKS .... NEW MEXICO, WEST ZONE
UTM GRID DECLINATION .... 1°05' EAST
1982 MAGNETIC NORTH DECLINATION .... 12° EAST
VERTICAL DATUM .... NATIONAL GEODETIC VERTICAL DATUM OF 1929
HORIZONTAL DATUM .... 1927 NORTH AMERICAN DATUM

To place on the predicted North American Datum of 1983, move the projection lines as shown by dashed corner ticks (10 meters south and 57 meters east)

There may be private inholdings within the boundaries of any Federal and State Reservations shown on this map

NORTH

PROVISIONAL MAP
Produced from original manuscript drawings. Information shown as of date of field check. 3

SCALE 1:24 000

KILOMETERS 1 .5 0 1 2
METERS 1000 0 1000 2000
MILES 1 .5 0 1
FEET 1000 0 1000 2000 3000 4000 5000 6000 7000 8000 9000 10 000

CONTOUR INTERVAL 20 FEET

To convert meters to feet multiply by 3.2808
To convert feet to meters multiply by .3048

THIS MAP COMPLIES WITH NATIONAL MAP ACCURACY STANDARDS
FOR SALE BY U.S. GEOLOGICAL SURVEY, DENVER, COLORADO, 80225
OR RESTON, VIRGINIA 22092

NEW MEXICO

QUADRANGLE LOCATION

1	2	3	1 Indian Peak 2 Tank Mountain 3 Whitmire Pass 4 Mount Baldy 5 Gillespie Mountain 6 Clanton Draw 7 Animas Peak 8 Center Peak
4		5	
6	7	8	

ADJOINING 7.5 QUADRANGLE NAMES

ROAD LEGEND

Improved Road ....
Unimproved Road ....
Trail ....
Interstate Route U.S. Route State Route

ANIMAS PEAK NE, NEW MEXICO

PROVISIONAL EDITION 1982

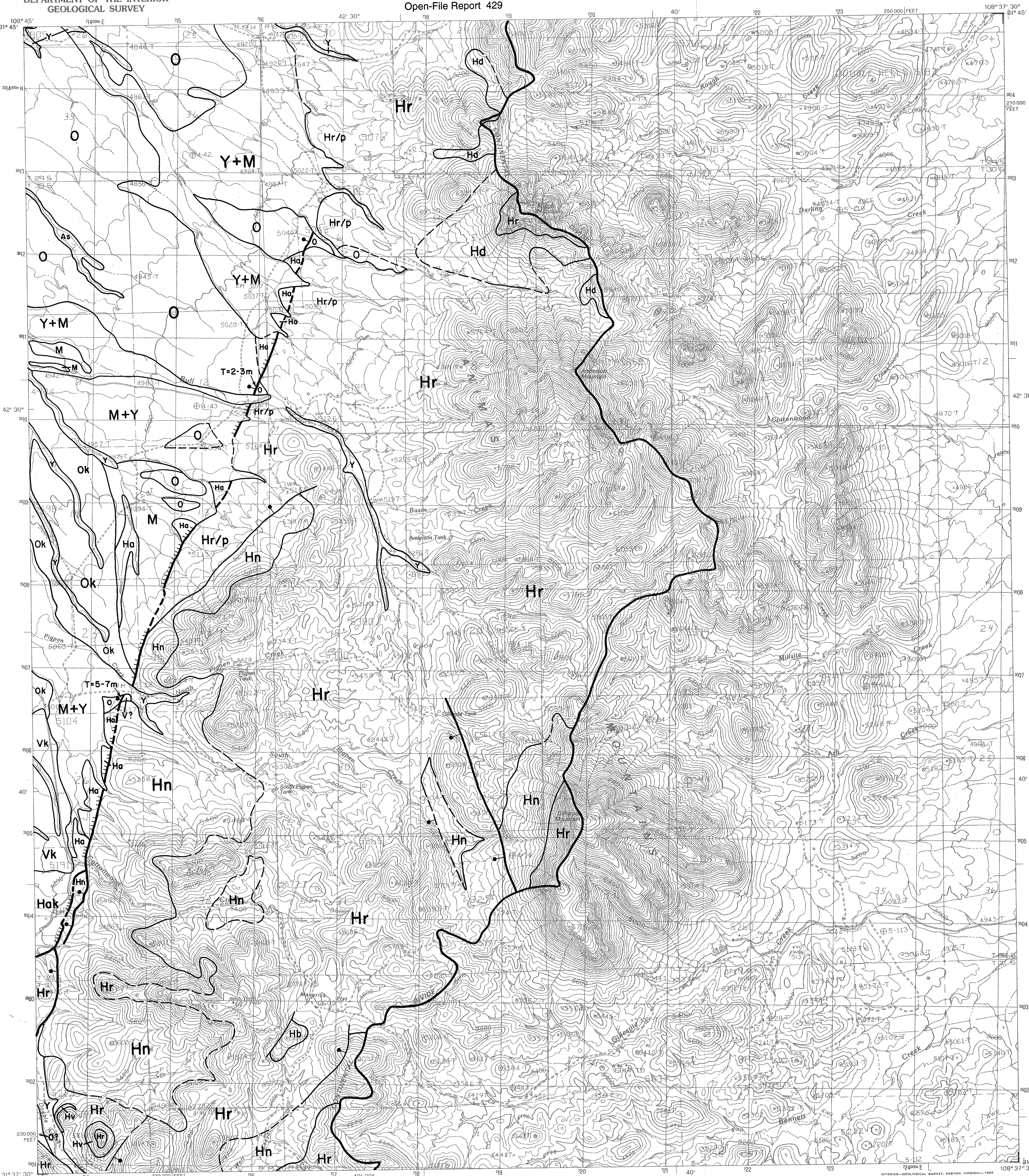
31108-F7-TF-024

Vincent and Krider, 1997: PLATE 429-F

New Mexico Bureau of Mines and Mineral Resources
Open-File Report 429

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

GILLESPIE MOUNTAIN QUADRANGLE
NEW MEXICO–HIDALGO CO.
7.5 MINUTE SERIES (TOPOGRAPHIC)



PRODUCED BY THE UNITED STATES GEOLOGICAL SURVEY
CONTROL BY .... USGS, NOS/NOAA
COMPILED FROM AERIAL PHOTOGRAPHS TAKEN 1976
FIELD CHECKED .... 1977 MAP EDITED 1982
PROJECTION .... TRANSVERSE MERCATOR
GRID: 1000-METER UNIVERSAL TRANSVERSE MERCATOR .... ZONE 12
10,000-FOOT STATE GRID TICKS .... NEW MEXICO, WEST ZONE
UTM GRID DECLINATION .... 1°13′ EAST
1982 MAGNETIC NORTH DECLINATION .... 11°30′ EAST
VERTICAL DATUM .... NATIONAL GEODETIC VERTICAL DATUM OF 1929
HORIZONTAL DATUM .... 1927 NORTH AMERICAN DATUM

To place on the predicted North American Datum of 1983, move the projection lines as shown by dashed corner ticks (10 meters south and 57 meters east)

There may be private inholdings within the boundaries of any Federal and State Reservations shown on this map

NORTH

PROVISIONAL MAP

Produced from original manuscript drawings. Information shown as of date of field check. 3

SCALE 1:24 000

KILOMETERS · METERS · MILES · FEET

CONTOUR INTERVAL 40 FEET

To convert meters to feet multiply by 3.2808
To convert feet to meters multiply by .3048

THIS MAP COMPLIES WITH NATIONAL MAP ACCURACY STANDARDS
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OR RESTON, VIRGINIA 22092

NEW MEXICO

QUADRANGLE LOCATION

1	2	3	1 Tank Mountain
4		5	2 Whitmire Pass
6	7	8	3 Playas Lake South

4 Animas Peak NE
5 Walnut Wells NE
6 Animas Peak
7 Center Peak
8 Horse Mountain

ADJOINING 7.5 QUADRANGLE NAMES

ROAD LEGEND

Improved Road
Unimproved Road
Trail

Interstate Route · U.S. Route · State Route

GILLESPIE MOUNTAIN, NEW MEXICO

PROVISIONAL EDITION 1982

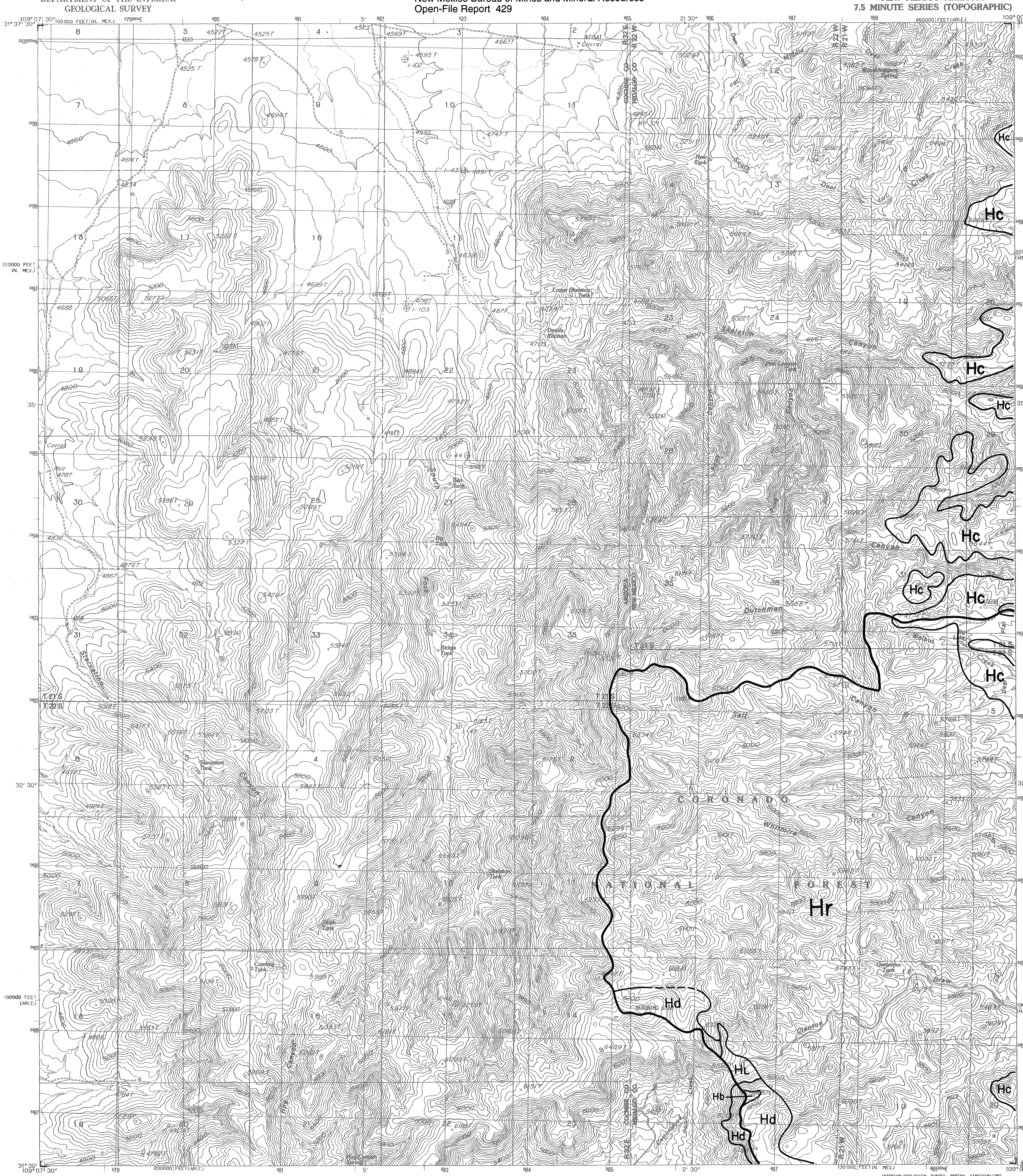
31108-F6-TF-024

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

Vincent and Krider, 1997: PLATE 429-G

New Mexico Bureau of Mines and Mineral Resources
Open-File Report 429

SKELETON CANYON QUADRANGLE
NEW MEXICO–ARIZONA
7.5 MINUTE SERIES (TOPOGRAPHIC)



PRODUCED BY THE UNITED STATES GEOLOGICAL SURVEY
CONTROL BY .... USGS, NOS/NOAA
COMPILED FROM AERIAL PHOTOGRAPHS TAKEN 1982
FIELD CHECKED .... 1983 MAP EDITED 1987
PROJECTION .... TRANSVERSE MERCATOR
GRID: 1000-METER UNIVERSAL TRANSVERSE MERCATOR .... ZONE 12
10,000-FOOT STATE GRID TICKS .... ARIZONA, EAST ZONE
NEW MEXICO, WEST ZONE
UTM GRID DECLINATION .... 1°01' EAST
1987 MAGNETIC NORTH DECLINATION .... 11°30' EAST
VERTICAL DATUM .... NATIONAL GEODETIC VERTICAL DATUM OF 1929
HORIZONTAL DATUM .... 1927 NORTH AMERICAN DATUM

To place on the predicted North American Datum of 1983, move the projection lines as shown by dashed corner ticks (10 meters south and 58 meters east)

There may be private inholdings within the boundaries of any Federal and State Reservations shown on this map

Where omitted, land lines have not been established

All marginal data and lettering generated and positioned by automated type placement procedures

No distinction made between houses, barns, and other buildings

NORTH

PROVISIONAL MAP
Produced from original manuscript drawings. Information shown as of date of photography. 1

SCALE 1:24 000

CONTOUR INTERVAL 40 FEET

THIS MAP COMPLIES WITH NATIONAL MAP ACCURACY STANDARDS
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OR RESTON, VIRGINIA 22092

NEW MEXICO

QUADRANGLE LOCATION

1	2	3	1 Apache 2 Skull Canyon 3 Mount Baldy 4 Paramore Crater 5 Clanton Draw 6 Lazy J Ranch 7 Guadalupe Spring 8 Black Point
4		5	
6	7	8	

ADJOINING 7.5' QUADRANGLE NAMES

INTERIOR–GEOLOGICAL SURVEY, RESTON, VIRGINIA–1987

ROAD LEGEND

Improved Road ....
Unimproved Road ....
Trail ....

Interstate Route U.S. Route State Route

SKELETON CANYON, N. MEX.–ARIZ.

PROVISIONAL EDITION 1987

31109-E1-TF-024

SKELETON CANYON

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

Vincent and Krider, 1997: PLATE 429-H

New Mexico Bureau of Mines and Mineral Resources
Open-File Report 429

CLANTON DRAW QUADRANGLE
NEW MEXICO–HIDALGO CO.
7.5 MINUTE SERIES (TOPOGRAPHIC)

PRODUCED BY THE UNITED STATES GEOLOGICAL SURVEY
CONTROL BY .... USGS, NOS/NOAA
COMPILED FROM AERIAL PHOTOGRAPHS TAKEN 1976
FIELD CHECKED .... 1977 MAP EDITED 1982
PROJECTION .... TRANSVERSE MERCATOR
GRID: 1000-METER UNIVERSAL TRANSVERSE MERCATOR .... ZONE 12
10,000-FOOT STATE GRID TICKS .... NEW MEXICO, WEST ZONE
UTM GRID DECLINATION .... 1°05′ EAST
1982 MAGNETIC NORTH DECLINATION .... 12° EAST
VERTICAL DATUM .... NATIONAL GEODETIC VERTICAL DATUM OF 1929
HORIZONTAL DATUM .... 1927 NORTH AMERICAN DATUM

To place on the predicted North American Datum of 1983, move the projection lines as shown by dashed corner ticks (10 meters south and 58 meters east)

There may be private inholdings within the boundaries of any Federal and State Reservations shown on this map

PROVISIONAL MAP
Produced from original manuscript drawings. Information shown as of date of field check.

SCALE 1:24 000

CONTOUR INTERVAL 20 FEET

To convert meters to feet multiply by 3.2808
To convert feet to meters multiply by .3048

THIS MAP COMPLIES WITH NATIONAL MAP ACCURACY STANDARDS
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OR RESTON, VIRGINIA 22092

QUADRANGLE LOCATION

1	2	3
4		5
6	7	8

1 Skull Canyon
2 Mount Baldy
3 Animas Peak NE
4 Skeleton Canyon
5 Animas Peak
6 Guadalupe Spring
7 Black Point
8 Fitzpatricks

ADJOINING 7.5' QUADRANGLE NAMES

ROAD LEGEND

Improved Road
Unimproved Road
Trail

Interstate Route U.S. Route State Route

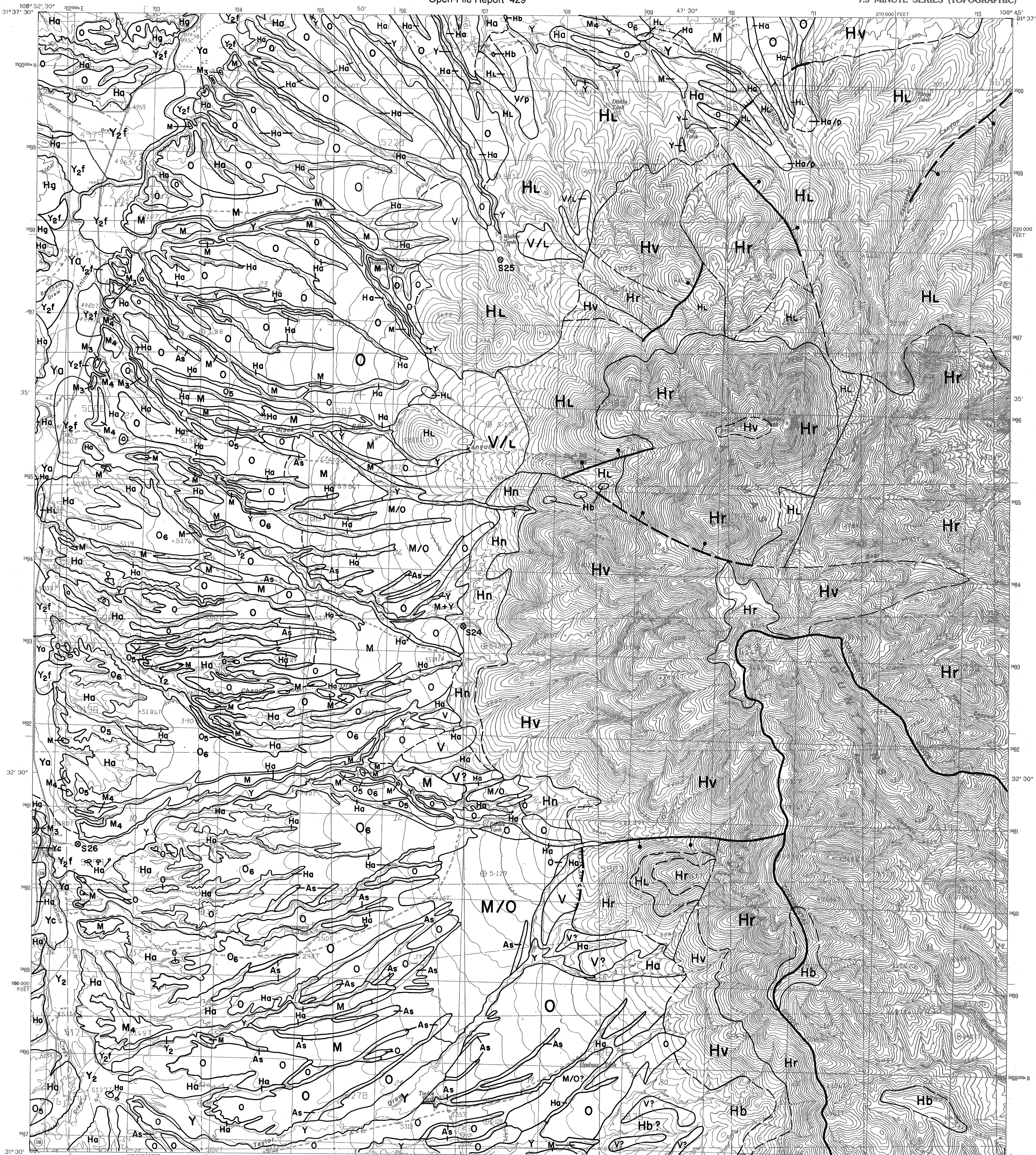
CLANTON DRAW, NEW MEXICO
PROVISIONAL EDITION 1982
31108-E8-TF-024

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

Vincent and Krider, 1997: PLATE 429-I

New Mexico Bureau of Mines and Mineral Resources
Open-File Report 429

ANIMAS PEAK QUADRANGLE
NEW MEXICO–HIDALGO CO.
7.5 MINUTE SERIES (TOPOGRAPHIC)



PRODUCED BY THE UNITED STATES GEOLOGICAL SURVEY
CONTROL BY .... USGS, NOS/NOAA
COMPILED FROM AERIAL PHOTOGRAPHS TAKEN 1976
FIELD CHECKED .... 1977 MAP EDITED 1982
PROJECTION .... TRANSVERSE MERCATOR
GRID: 1000-METER UNIVERSAL TRANSVERSE MERCATOR .... ZONE 12
10,000-FOOT STATE GRID TICKS .... NEW MEXICO, WEST ZONE
UTM GRID DECLINATION .... 1°05' EAST
1982 MAGNETIC NORTH DECLINATION .... 12° EAST
VERTICAL DATUM .... NATIONAL GEODETIC VERTICAL DATUM OF 1929
HORIZONTAL DATUM .... 1927 NORTH AMERICAN DATUM

To place on the predicted North American Datum of 1983, move the projection lines as shown by dashed corner ticks (10 meters south and 57 meters east)

There may be private inholdings within the boundaries of any Federal and State Reservations shown on this map

NORTH

PROVISIONAL MAP
Produced from original manuscript drawings. Information shown as of date of field check. 3

SCALE 1:24 000

KILOMETERS: 1 .5 0 1 2
METERS: 1000 0 1000 2000
MILES: 1 .5 0 1
FEET: 1000 0 1000 2000 3000 4000 5000 6000 7000 8000 9000 10 000

CONTOUR INTERVAL 40 FEET

To convert meters to feet multiply by 3.2808
To convert feet to meters multiply by .3048

THIS MAP COMPLIES WITH NATIONAL MAP ACCURACY STANDARDS
FOR SALE BY U.S. GEOLOGICAL SURVEY, DENVER, COLORADO, 80225
OR RESTON, VIRGINIA 22092

NEW MEXICO
QUADRANGLE LOCATION

1	2	3
4		5
6	7	8

1 Mount Baldy
2 Animas Peak NE
3 Gillespie Mountain
4 Clanton Draw
5 Center Peak
6 Black Point
7 Fitzpatricks
8 San Luis Pass

ADJOINING 7.5 QUADRANGLE NAMES

INTERIOR—GEOLOGICAL SURVEY, RESTON, VIRGINIA—1982

ROAD LEGEND

Improved Road ....
Unimproved Road ....
Trail ....
Interstate Route U.S. Route State Route

ANIMAS PK

ANIMAS PEAK, NEW MEXICO

PROVISIONAL EDITION 1982

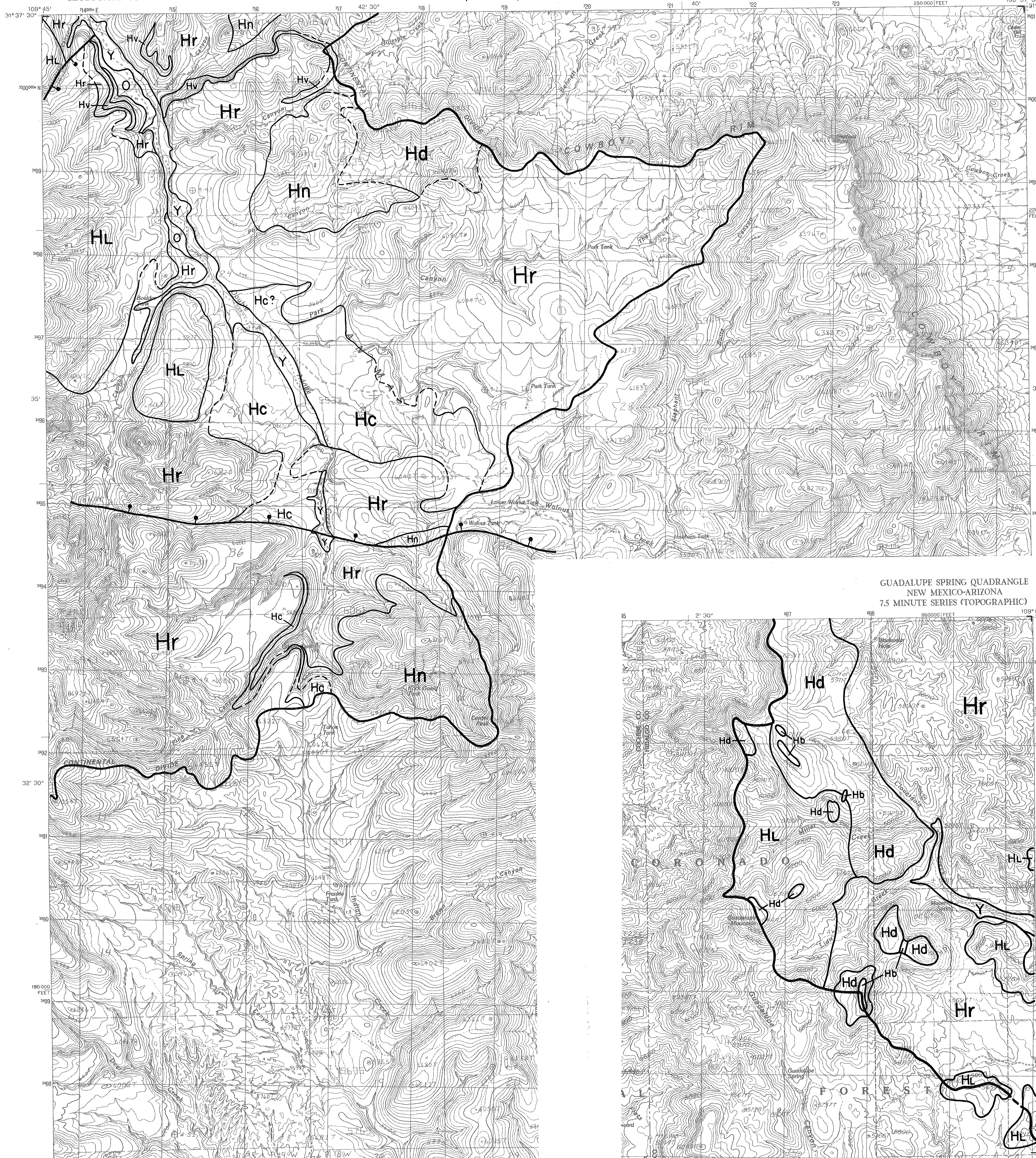
31108-E7-TF-024

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

Vincent and Krider, 1997: PLATE 429-J

New Mexico Bureau of Mines and Mineral Resources
Open-File Report 429

CENTER PEAK QUADRANGLE
NEW MEXICO–HIDALGO CO.
7.5 MINUTE SERIES (TOPOGRAPHIC)



GUADALUPE SPRING QUADRANGLE
NEW MEXICO-ARIZONA
7.5 MINUTE SERIES (TOPOGRAPHIC)

PRODUCED BY THE UNITED STATES GEOLOGICAL SURVEY
CONTROL BY .... USGS, NOS/NOAA
COMPILED FROM AERIAL PHOTOGRAPHS TAKEN 1976
FIELD CHECKED .... 1977 MAP EDITED 1982
PROJECTION .... TRANSVERSE MERCATOR
GRID: 1000-METER UNIVERSAL TRANSVERSE MERCATOR .... ZONE 12
10,000-FOOT STATE GRID TICKS .... NEW MEXICO, WEST ZONE
UTM GRID DECLINATION .... 1°13′ EAST
1982 MAGNETIC NORTH DECLINATION .... 11°30′ EAST
VERTICAL DATUM .... NATIONAL GEODETIC VERTICAL DATUM OF 1929
HORIZONTAL DATUM .... 1927 NORTH AMERICAN DATUM
To place on the predicted North American Datum of 1983, move the projection lines as shown by dashed corner ticks (10 meters south and 57 meters east)
There may be private inholdings within the boundaries of any Federal and State Reservations shown on this map

NORTH

SCAL

CONTOUR INTE

PROVISIONAL MAP
Produced from original manuscript drawings. Information shown as of date of field check. 3

To convert meters to
To convert feet to m

THIS MAP COMPLIES WITH NA
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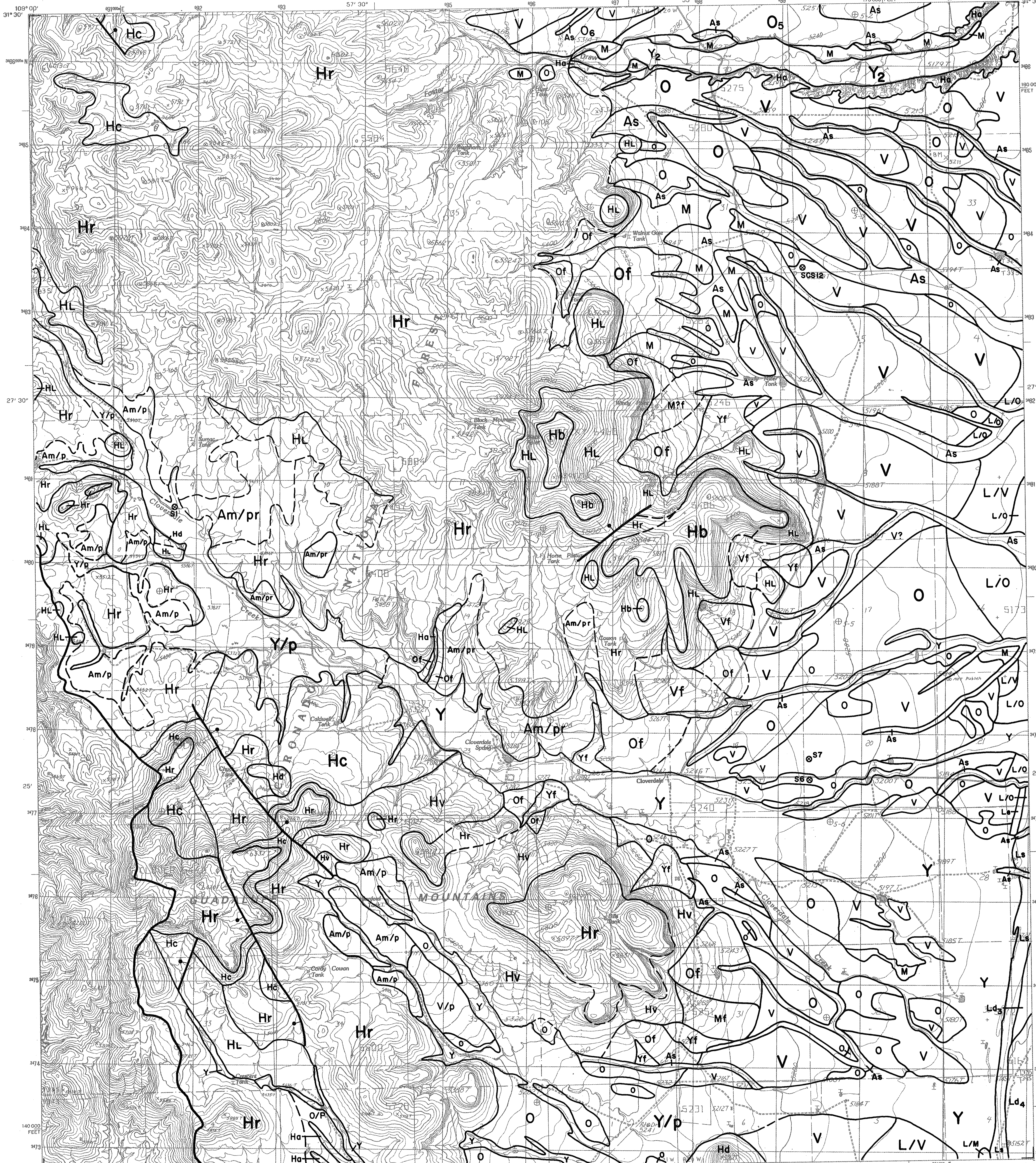
OR RESTO

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

Vincent and Krider, 1997: PLATE 429-K

New Mexico Bureau of Mines and Mineral Resources
Open-File Report 429

BLACK POINT QUADRANGLE
NEW MEXICO–HIDALGO CO.
7.5 MINUTE SERIES (TOPOGRAPHIC)



PRODUCED BY THE UNITED STATES GEOLOGICAL SURVEY
CONTROL BY .... USGS, NOS/NOAA
COMPILED FROM AERIAL PHOTOGRAPHS TAKEN 1976
FIELD CHECKED .... 1977 MAP EDITED 1982
PROJECTION .... TRANSVERSE MERCATOR
GRID: 1000-METER UNIVERSAL TRANSVERSE MERCATOR .... ZONE 12
10,000-FOOT STATE GRID TICKS .... NEW MEXICO, WEST ZONE
UTM GRID DECLINATION .... 1°05' EAST
1982 MAGNETIC NORTH DECLINATION .... 11°30' EAST
VERTICAL DATUM .... NATIONAL GEODETIC VERTICAL DATUM OF 1929
HORIZONTAL DATUM .... 1927 NORTH AMERICAN DATUM

To place on the predicted North American Datum of 1983, move the projection lines as shown by dashed corner ticks (10 meters south and 58 meters east)

There may be private inholdings within the boundaries of any Federal and State Reservations shown on this map

NORTH

PROVISIONAL MAP
Produced from original manuscript drawings. Information shown as of date of field check.
3

SCALE 1:24 000

1 .5 0 KILOMETERS 1 2
1000 0 METERS 1000 2000
1 .5 0 MILES 1
1000 0 1000 2000 3000 4000 5000 6000 7000 8000 9000 10 000 FEET

CONTOUR INTERVAL 10 AND 40 FEET

To convert meters to feet multiply by 3.2808
To convert feet to meters multiply by .3048

40 ft. contours
10 ft.

THIS MAP COMPLIES WITH NATIONAL MAP ACCURACY STANDARDS
FOR SALE BY U.S. GEOLOGICAL SURVEY, DENVER, COLORADO, 80225
OR RESTON, VIRGINIA 22092

NEW MEXICO
QUADRANGLE LOCATION

1	2	3	1 Skeleton Canyon 2 Clanton Draw 3 Animas Peak 4 Guadalupe Spring 5 Fitzpatricks 6 Guadalupe Canyon 7 Guadalupe Pass 8 Lang Canyon
4		5	
6	7	8	

ADJOINING 7.5' QUADRANGLE NAMES

ROAD LEGEND

Improved Road
Unimproved Road
Trail
Interstate Route U.S. Route State Route

BLACK POINT, NEW MEXICO

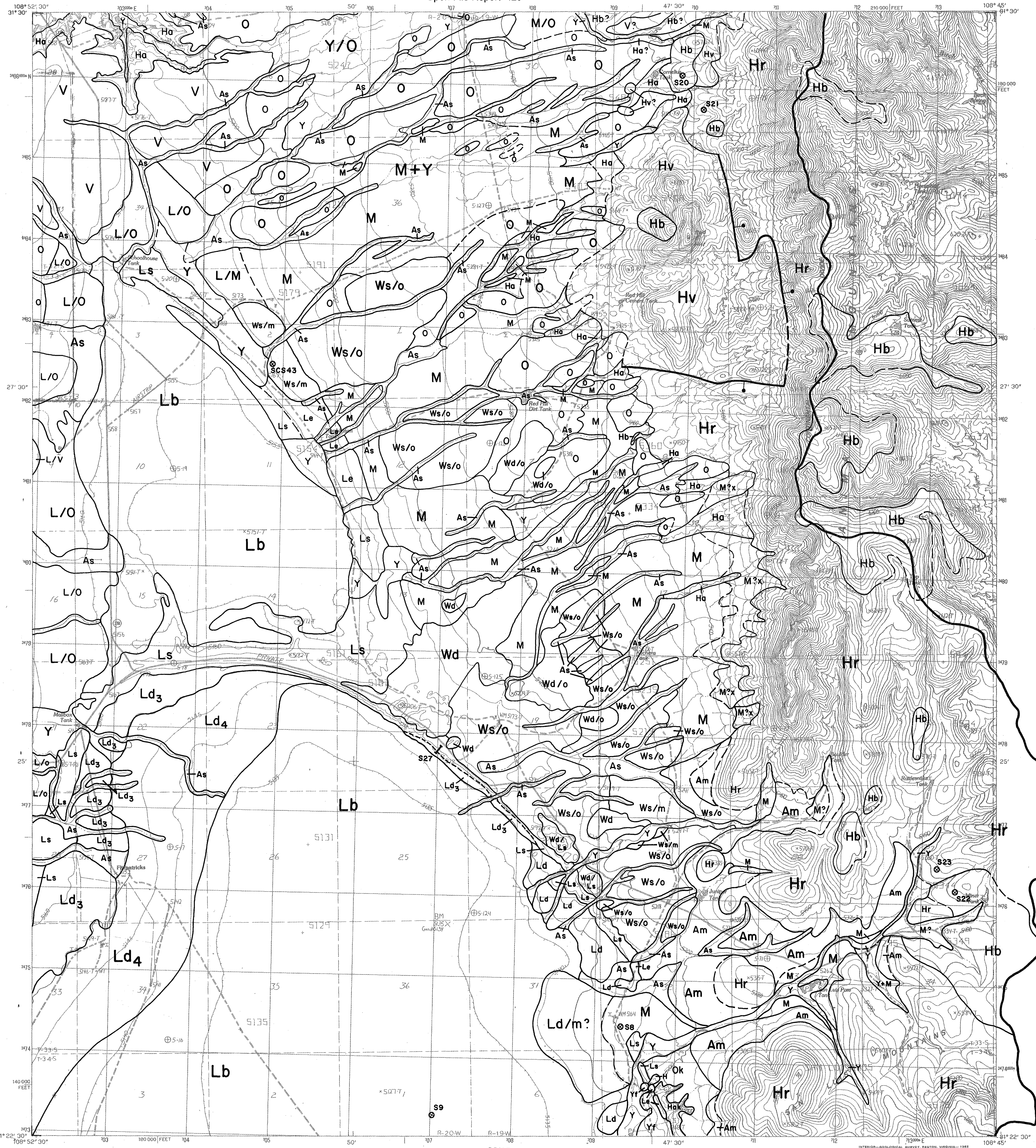
PROVISIONAL EDITION 1982

31108-D8-TF-024

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

Vincent and Krider, 1997: PLATE 429-L
New Mexico Bureau of Mines and Mineral Resources
Open-File Report 429

FITZPATRICKS QUADRANGLE
NEW MEXICO–HIDALGO CO.
7.5 MINUTE SERIES (TOPOGRAPHIC)



SCALE 1:24 000

CONTOUR INTERVAL 10 AND 40 FEET
DASHED LINES REPRESENT 5-FOOT CONTOURS

To convert meters to feet multiply by 3.2808
To convert feet to meters multiply by .3048

THIS MAP COMPLIES WITH NATIONAL MAP ACCURACY STANDARDS
FOR SALE BY U.S. GEOLOGICAL SURVEY, DENVER, COLORADO, 80225
OR RESTON, VIRGINIA 22092

PRODUCED BY THE UNITED STATES GEOLOGICAL SURVEY
CONTROL BY .... USGS,NOS/NOAA
COMPILED FROM AERIAL PHOTOGRAPHS TAKEN 1976
FIELD CHECKED .... 1977 MAP EDITED 1982
PROJECTION .... TRANSVERSE MERCATOR
GRID: 1000-METER UNIVERSAL TRANSVERSE MERCATOR .... ZONE 12
10,000-FOOT STATE GRID TICKS .... NEW MEXICO, WEST ZONE
UTM GRID DECLINATION .... 1°08' EAST
1982 MAGNETIC NORTH DECLINATION .... 11°30' EAST
VERTICAL DATUM .... NATIONAL GEODETIC VERTICAL DATUM OF 1929
HORIZONTAL DATUM .... 1927 NORTH AMERICAN DATUM
To place on the predicted North American Datum of 1983, move the projection lines as shown by dashed corner ticks
(10 meters south and 57 meters east)
There may be private inholdings within the boundaries of any Federal and State Reservations shown on this map

PROVISIONAL MAP
Produced from original manuscript drawings. Information shown as of date of field check.
3

QUADRANGLE LOCATION

1	2	3	1 Clanton Draw 2 Animas Peak 3 Center Peak 4 Black Point 5 San Luis Pass 6 Guadalupe Pass 7 Lang Canyon 8 Whitewater Creek
4		5	
6	7	8	

ADJOINING 7.5 QUADRANGLE NAMES

ROAD LEGEND

Improved Road
Unimproved Road
Trail
Interstate Route U.S. Route State Route

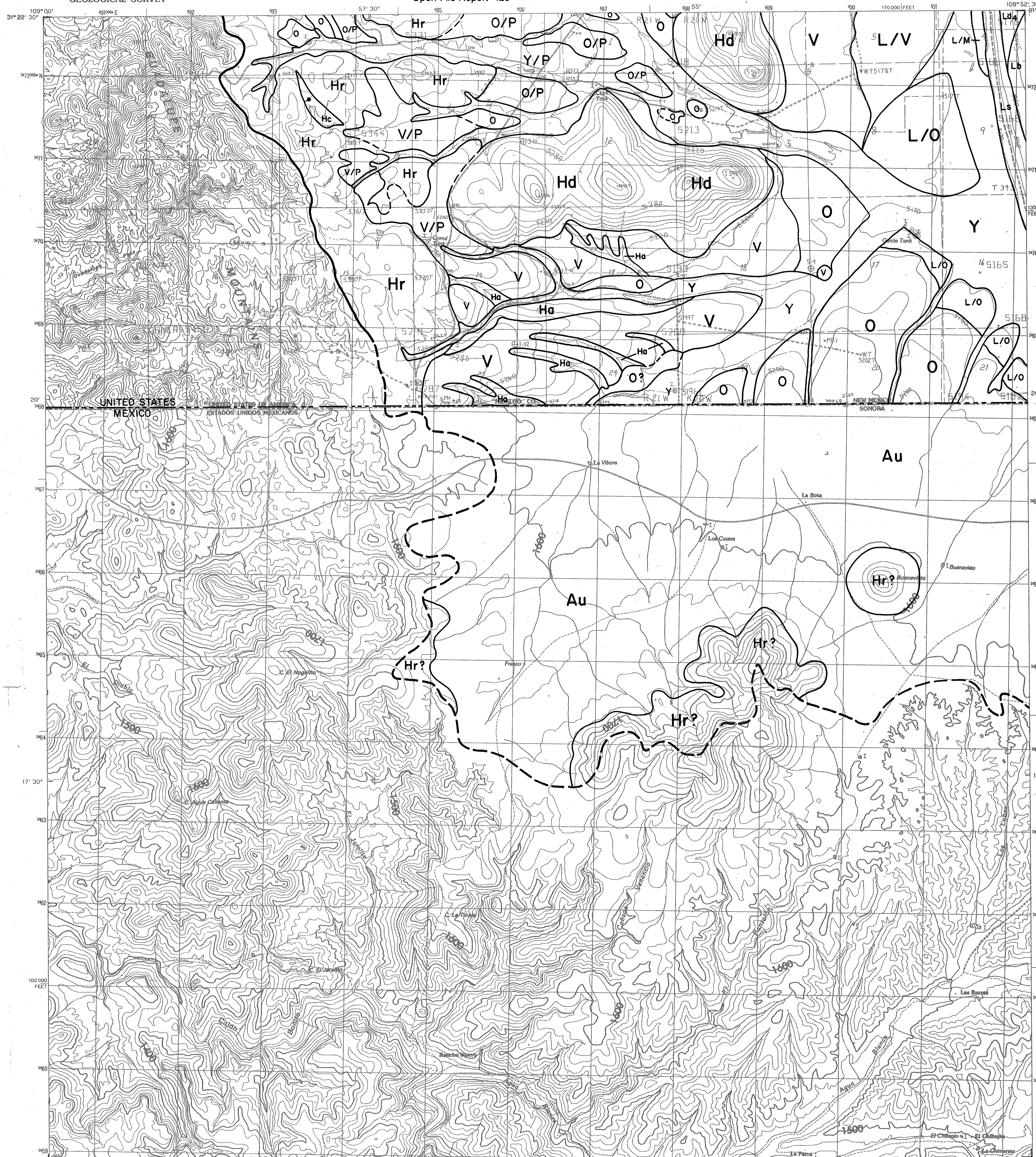
FITZPATRICKS, NEW MEXICO
PROVISIONAL EDITION 1982
31108-D7-TF-024

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

Vincent and Krider, 1997: PLATE 429-M

New Mexico Bureau of Mines and Mineral Resources
Open-File Report 429

GUADALUPE PASS QUADRANGLE
NEW MEXICO–SONORA
7.5 MINUTE SERIES (TOPOGRAPHIC)



INTERIOR—GEOLOGICAL SURVEY, RESTON, VIRGINIA—1983

PRODUCED BY THE UNITED STATES GEOLOGICAL SURVEY
CONTROL BY .... USGS, NOS/NOAA, IBC, AND DGG
COMPILED FROM AERIAL PHOTOGRAPHS TAKEN 1976
FIELD CHECKED .... 1977 MAP EDITED 1983
PROJECTION .... TRANSVERSE MERCATOR
GRID: 1000-METER UNIVERSAL TRANSVERSE MERCATOR .... ZONE 12
10,000-FOOT STATE GRID TICKS .... NEW MEXICO, WEST ZONE
UTM GRID DECLINATION .... 1°04′ EAST
1983 MAGNETIC NORTH DECLINATION .... 11°30′ EAST
VERTICAL DATUM .... NATIONAL GEODETIC VERTICAL DATUM OF 1929
HORIZONTAL DATUM .... 1927 NORTH AMERICAN DATUM

To place on the predicted North American Datum of 1983, move the projection lines as shown by dashed corner ticks (11 meters south and 58 meters east)

There may be private inholdings within the boundaries of any Federal and State Reservations shown on this map

Mexico portion copied from DGG 1:50,000-scale map, Rancho Nuevo H12B37, dated 1981

NORTH

PROVISIONAL MAP
Produced from original manuscript drawings. Information shown as of date of field check. 3

SCALE 1:24 000

KILOMETERS · METERS · MILES · FEET

CONTOUR INTERVAL 10 AND 40 FEET IN THE UNITED STATES
DOTTED LINES REPRESENT 5-FOOT CONTOURS
CONTOUR INTERVAL 20 METERS IN MEXICO
To convert meters to feet multiply by 3.2808
To convert feet to meters multiply by .3048

THE U.S. PORTION OF THIS MAP COMPLIES WITH NATIONAL MAP ACCURACY STANDARDS
FOR SALE BY U.S. GEOLOGICAL SURVEY, DENVER, COLORADO 80225, OR RESTON, VIRGINIA 22092
AND BY CENTRO DE ASESORIA Y VENTA DE INFORMACIÓN ESTADISTICA Y CARTOGRÁFICA
BALDERAS #71, MEZZANINE, MEXICO 1, D.F.
A FOLDER DESCRIBING U.S. TOPOGRAPHIC MAPS AND SYMBOLS IS AVAILABLE FROM USGS

NEW MEXICO
QUADRANGLE LOCATION

40 ft. contours / 10 ft. contours

ADJOINING 7.5 QUADRANGLE NAMES
1 Guadalupe Spring
2 Black Point
3 Fitzpatricks
4 Guadalupe Canyon
5 Lang Canyon
6
7
8

ROAD LEGEND
Improved Road
Unimproved Road
Trail
Interstate Route · U.S. Route · State Route

GUADALUPE PASS, N. MEX.–SON.

PROVISIONAL EDITION 1983

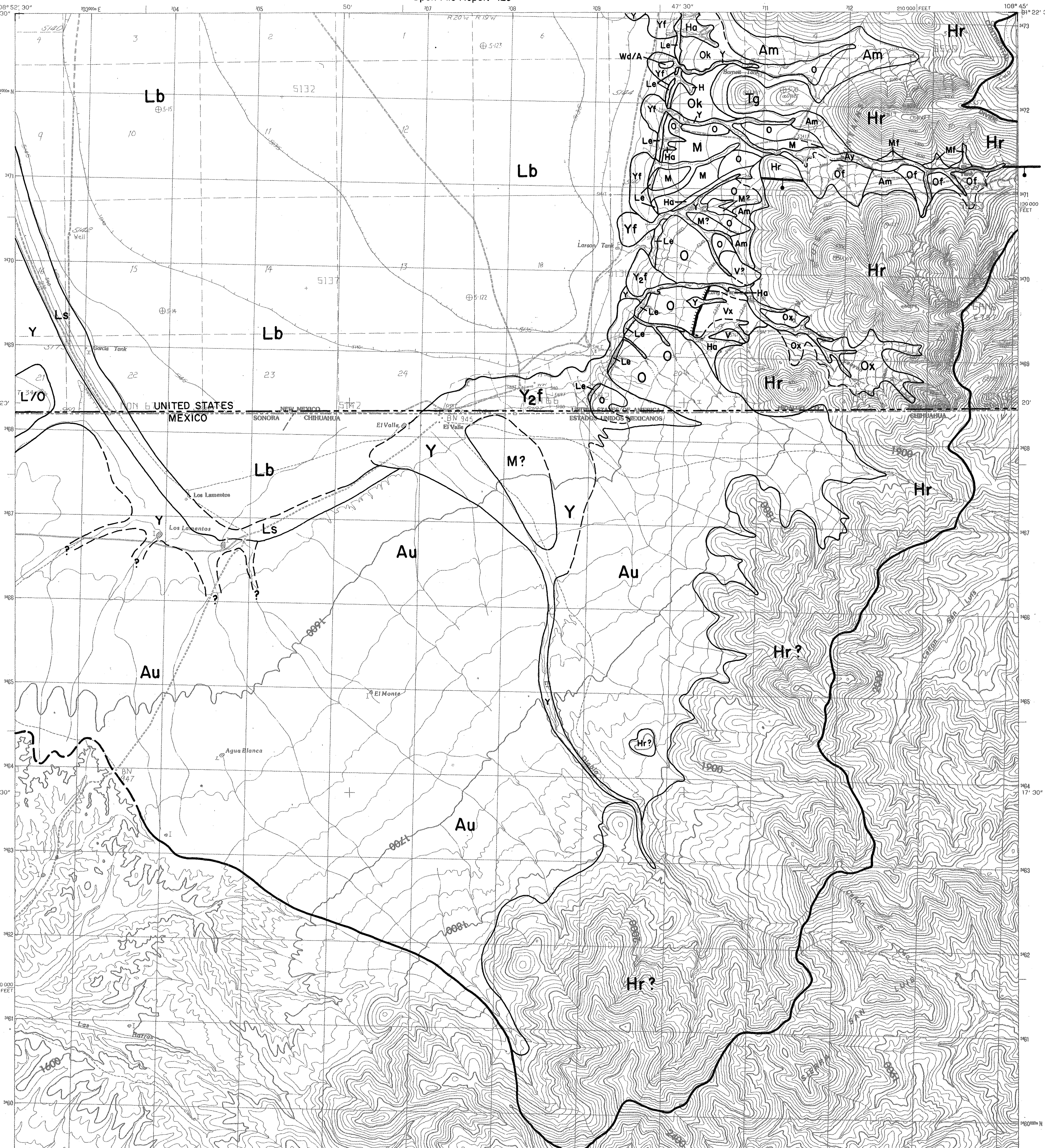
31108-C8-TF-024

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

Vincent and Krider, 1997: PLATE 429-N

New Mexico Bureau of Mines and Mineral Resources
Open-File Report 429

LANG CANYON QUADRANGLE
NEW MEXICO–SONORA–CHIHUAHUA
7.5 MINUTE SERIES (TOPOGRAPHIC)



PRODUCED BY THE UNITED STATES GEOLOGICAL SURVEY
CONTROL BY .... USGS, NOS/NOAA, IBC, AND DGG
COMPILED FROM AERIAL PHOTOGRAPHS TAKEN 1976
FIELD CHECKED .... 1977 MAP EDITED 1983
PROJECTION .... TRANSVERSE MERCATOR
GRID: 1000-METER UNIVERSAL TRANSVERSE MERCATOR .... ZONE 12
10,000-FOOT STATE GRID TICKS .... NEW MEXICO, WEST ZONE
UTM GRID DECLINATION .... 1°08′ EAST
1983 MAGNETIC NORTH DECLINATION .... 11°30′ EAST
VERTICAL DATUM .... NATIONAL GEODETIC VERTICAL DATUM OF 1929
HORIZONTAL DATUM .... 1927 NORTH AMERICAN DATUM

To place on the predicted North American Datum of 1983, move the projection lines as shown by dashed corner ticks (11 meters south and 57 meters east)

There may be private inholdings within the boundaries of any Federal and State Reservations shown on this map

Mexico portion copied from DGG 1:50,000-scale map, Rancho Nuevo H12B37, dated 1981

NORTH

SCALE 1:24 000

KILOMETERS · METERS · MILES · FEET

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PROVISIONAL MAP
Produced from original manuscript drawings. Information shown as of date of field check.

10 ft. contours · 40 ft.

NEW MEXICO
QUADRANGLE LOCATION

1	2	3
4		5
6	7	8

1 Black Point
2 Fitzpatricks
3 San Luis Pass
4 Guadalupe Pass
5 Whitewater Creek
6
7
8

ADJOINING 7.5' QUADRANGLE NAMES

INTERIOR—GEOLOGICAL SURVEY, RESTON, VIRGINIA—1983

ROAD LEGEND
Improved Road
Unimproved Road
Trail
Interstate Route · U.S. Route · State Route

LANG CANYON, N. MEX.–SON.–CHIH.
PROVISIONAL EDITION 1983
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