Characterization and Interpretation of Soils and Geologic Formations with Carbonates, Gypsum, and Other Soluble Salts

Toyah Basin and Culberson Gypsum Plain

Pre-meeting tour
Soil Science Society of America
Pecos, Texas
October 2-5, 2008

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Thursday, October 2, 2008: First Day – Travel to Pecos

3:00-5:30 pm: Arrive Midland International Airport
3:45pm: First van departs for Pecos
6:15 pm: Second van departs for Pecos
6:00 pm: Dinner
8:00 pm: Orientation meeting, Alpine Lodge Restaurant meeting room

Friday, October 3, 2008: Second Day – Soils and Landscapes of the Toyah Basin

6:00-7:00 am: Breakfast (provided)
7:30 am: Tour departs Swiss Clock Inn
5:30 pm: Tour returns to Swiss Clock Inn

Saturday, October 4, 2008: Third Day – Soils and Landscapes of the Culberson Gypsum Plain

6:00-7:00 am: Breakfast (provided)
7:00 am: Tour departs Swiss Clock Inn
7:00 pm: Tour returns to Swiss Clock Inn

Sunday, October 5, 2008: Fourth Day – Travel to Houston

6:00-7:00 am: Breakfast (provided)
7:00 am: First van departs for Midland International Airport
9:00 am: Last van departs for Midland International Airport

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Landowners

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Hugh Box: lessee of Blue Goose Ranch

Soil Survey Details

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Juan Herrero
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Alan Stahnke
Jo Parsley
Gary Harris
Rusty Dowell
Josh Boxell

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Soil-Forming Factors of the Tour Area

Soil scientists utilize the 5-factor model of soil formation presented by Jenny (1941) to formulate and test landscape models.

$$S, V = f\,(P, R, T, C, O, \ldots)$$

where dependent variables S = soil, V = vegetation, are a function of P = parent material, R = relief, T = time, C = climate, and O = organisms. The factors parent material, relief (landforms), and organisms (vegetation) can be observed in the field, but time and climate must be inferred. By relating the factors associated with a particular kind of soil, its occurrence can be predicted from visible surface features.

Parent Material

Bedrock

The main gyprock strata that outcrop in Culberson, Reeves, and Eddy counties are the Castile, Salado, and Rustler Formations (Figure 1). These formations represent the final late-Permian deposits filling the Delaware Basin. The Castile Formation is the largest and thickest evaporite deposit in the United States; it's among the largest and thickest in the world (Johnson, Gonzales, and Dean 1989). The outcrop of the Castile measures nearly 100 km (60 mi) south to north, 12 to 40 km (7.5 to 25 mi) east to west, and 300 to 500 m (980 to 1640 ft) thick. According to well log API-015-43222, the Amoco Federal "BQ" #1 well located in New Mexico 15 km (9 miles) north of Stop 6 penetrated 460 m (1500 ft) of Castile anhydrite. The UNM Phillips #1 well, 25 km (15 miles) south of Stop 6, passed through 126 m (415 ft) of Salado and 311 m (1020 ft) of Castile (Table 1). At the Pokorny sulfur prospect, about 7 km (4.5 mi) northwest of Stop 6, the Castile ranges from 275 to 335 m (900 to 1100 feet) thick (Klemmick 1993).

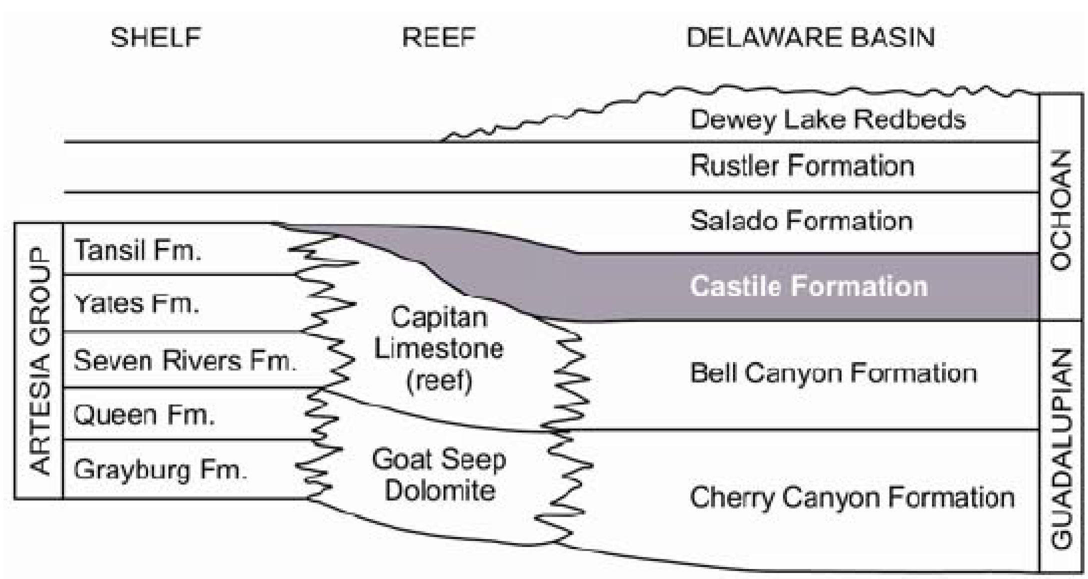

Figure 1. Permian strata of the Delaware Basin, including spatial relationships among shelf, reef, and basin facies. Note the stratigraphic position of the Castile Formation (shaded area) (adapted from Scholle et al. 2007).

The Castile Formation consists of banded anhydrite and halite, with minor amounts of calcite, dolomite, and sandstone. Anderson et al. (1972) subdivided the Castile into eight informal members: Basal limestone, up to 1 m (3 ft) thick; Anhydrite I, ranging from 57 to 107 m (187 to 351 ft) thick; Halite I, pure halite ranging up to150 m (495 ft) thick; Anhydrite II, 27 to 45 m (90 to 150 ft) thick; Halite II, halite with 5 thin anhydrite beds, up to 70 m (230 ft) thick; Anhydrite III, 85 to 92 m (280 to 300 ft) thick; Halite III, interbedded halite and anhydrite, 60 to 120 m (200 to 400 ft) thick; Anhydrite IV, anhydrite and some interbedded halite, 90 to 180 m (300 to 600 ft) thick. The halite units have been removed by dissolution from the western part of the Gypsum Plain. In their place is a much thinner anhydrite breccia. It is difficult to distinguish the anhydrite members in areas where the halite beds are absent.

Table 1. Thickness of individual members of the Castile Formation within UNM Phillips #1 well (modified from Anderson et al. 1972).

Formation Member	**Thickness (m)**	**Number of Varve Couplets**	**Average Thickness of Calcite-Anhydrite Varve Couplets (cm)**
Salado	126.60	35,422	0.36
Castile			
Anhydrite IV	98.42	54,187	0.18
Halite III	27.48	17,879	0.16
Anhydrite III	95.54	46.592	0.21
Halite II	8.01	1,758	0.45
Anhydrite II	27.38	14,414	0.19
Halite I	3.30	1,063	0.31
Anhydrite I	50.92	38,397	0.13
Basal Limestone	0.28	600	0.04

The defining characteristic of the Castile Formation is the alternating millimeter-thick strata of anhydrite and calcite (Anderson et al. 1972). In hand specimen, the laminae consist of regularly alternating white anhydrite layers and darker layers containing calcite and organic matter. The darker calcite and organic-matter strata represent periodic, perhaps annual, freshening of the water and the development of plankton blooms. The light colored anhydrite layers were deposited under restricted, more saline conditions (Kirkland et al. 2000; Kirkland 2003). About 220,000 calcite-evaporite cycles have been counted in the Castile Formation (Anderson et al. 1972). The layers are remarkably laterally continuous; individual laminae have been traced for more than 110 km (70 miles) (Anderson et al. 1972; Anderson and Kirkland 1966).

The name of the Castile Formation comes from the Spanish word for the castle-like structures that occur throughout the Gypsum Plain (Plate 1). These tepee-shaped hills, which are locally known as castiles, are held up by bio-epigenetic limestone characterized by calcite pseudomorphs after gypsum. Biogenic limestone is more resistant to weathering and erosion than the gypsum around it and therefore stands out in relief. The limestone retains the laminated fabric of the precursor gypsum. It is believed to have formed by sulfate-reducing bacteria metabolizing hydrocarbons (leaking from the underlying Bell Canyon Formation) and calcium sulfate (Kirkland and Evans 1976). The reaction produced calcium carbonate and hydrogen sulfide. H_2S can be detected leaking from karst holes at several places on the Gypsum Plain (Hill 1996).

In favorable situations, hydrogen sulfide was altered to native sulfur by reacting with oxidizing groundwater. The Castile Formation hosts several economic sulfur deposits. From the 1960's to the 1990's, sulfur prospecting and production were important activities in Culberson County. Until the middle 1990's, substantial quantities of elemental sulfur were produced from the Michigan Sulfur Mine, which was located in northeastern Culberson County about 65 km (40 mi) northwest of Pecos.

Lying above the Castile, the Salado Formation consists mainly of massive halite with accessory beds of anhydrite, polyhalite, potassium salts, and red sandy clay layers. Halite and other extremely soluble components of the Salado do not generally outcrop, but thick deposits remain in the subsurface. Except in areas held up by the Rustler Formation, most of the Salado has been removed by erosion. East of Carlsbad, the Salado is mined extensively for potash minerals, and its deeply buried halite beds host an active transuranic radioactive waste repository, the Waste Isolation Pilot Plant (WIPP) (Scholle et al. 2007). Stein et al. (1989) noted the presence of smectite, corrensite, feldspar, and quartz within silicate-containing strata of the Salado.

Overlying the Salado and Castile Formations is the Rustler Formation. The five members are recognized within the Rustler Formation; anhydrite is a major component within the 3-non dolomitic members: Los Medanos, halite, mudstone, and anhydrite, 25 to 50 m (80 to 165 ft) thick; Culebra Dolomite, 6 to 9 m (20 to 30 ft) thick; Tamarisk member, anhydrite halite, and mudstone, 35 to 55 m (115 to 180 ft) thick; Magenta Dolomite, 6 to 8 m (20 to 25 ft) thick; Forty-Niner member, anhydrite halite, and mudstone, 18 to 20 m (50 to 65 ft) thick (Vine 1963, Powers et al. 2006).

In New Mexico, gyprock strata are intercalated between dolomite and redbed formations deposited on the Northwest Shelf flanking the Delaware Basin (Kelley 1971, Table 2). These are the Abo and Yeso Formations, the Fourmile Draw member of the San Andres Formation, and the Artesia Group (consisting of the Tansill, Yates, Seven Rivers, Queen, and Grayburg Formations).

As mentioned earlier, the Castile Formation is the largest and thickest evaporite deposit in the United States. A total of 250,000 ha are underlain by gyprock of the Salado and Castile Formations. About three-fourths of that total (190,000 ha) is in Texas (Table 3). In Texas, the Castile and Salado Formations are mapped in a single unit covering more than 170,000 ha. East of the Rustler Hills in Culberson and Reeves Counties, a unit called "gypsum of the Rustler, Salado, and Castile Formations, undivided" accounts for an 18,800 additional ha. In New Mexico, the Castile and Salado Formations were mapped separately; their combined extent in Eddy County is about 60,000 ha. The Rustler Formation covers more than 125,000 ha in Texas and New Mexico, with slightly more than half (71,000 ha) in Culberson and Reeves Counties, Texas.

Table 2. Permian stratigraphy of the Delaware Basin (adapted from Kelley 1971).

System	Series	Group	Formation	Reef facies	Basin facies	Thickness	Lithology
PERMIAN	Ochoan Series		Dewey Lake Formation			200-250	Sandstone, siltstone; orange-brown; commonly laminated
			Rustler Formation: Upper Member			150-200	Dolomite, gypsum, mudstone, white, red-brown, green, gray, deep orange; Magenta dolomite at base
			Lower Member			100-250	Dolomite, gypsum, mudstone, sandstone; white, red-brown, gray, green; salt in subsurface; Culebra dolomite at base.
			Salado Formation			0-2,500	Gypsum, mudstone, thin local dolomite; white, red, brown, green, deep orange; breccia residue at surface, thick salt, potash in subsurface
			Castile Formation Upper Member* (surface)			1,000±	Gypsum (anhydrite), salt; white, gray
			Lower Member (surface)			1,000±	Laminated gypsum (anhydrite) and limestone, laminated limestone, laminated gypsum; gray, black, white
	Guadalupian Series	Artesia Group	Tansill Formation	Capitan Ls.†	Bell Canyon Fm.*	200-300	Dolomite and siltstone (south); dolomite, gypsum, and anhydrite (north); Ocotillo siltstone tongue near exposed top
			Yates Formation			250-350	Siltstone, sandstone, dolomite, limestone and gypsum (south); gypsum, siltstone and thin dolomite (north)
			Seven Rivers Formation			450-600	Dolomite, siltstone (south); gypsum and siltstone (north)
			Queen Formation	Goat Seep Do.†	Cherry Canyon Fm.*	200-400	Dolomite and sandstone (south); gypsum, red mudstone, dolomite (north); Shattuck member near top
			Grayburg Formation			250-450	Dolomite and sandstone (south); gypsum, mudstone, dolomite (north)
			San Andres Formation: Fourmile Draw Member			0-700	Dolomite, gypsum, reddish mudstone; sandstone locally at top; thin-bedded
			Bonney Canyon Member			0-300	Dolomite, local limestone; gray, light-gray, local black; thin-bedded
	Leonardian Series		Rio Bonito Member			250-350	Dolomite, limestone, sandstone (Glorieta); gray, brownish gray; thick-bedded
			Yeso Formation			0-1,400	Sandstone, siltstone, dolomite, gypsum; tan, red-yellow, gray, white

* Delware basin facies only
† Reef facies only

Table 3. Area (in ha) of gyprock-bearing formations in the Delaware Basin, Culberson County, Texas, and Eddy County, New Mexico.

Formation	**Texas**	**New Mexico**	**Total**
Pgrc*	18,800		18,800
Rustler	71,182	56,433	127,615
Salado	170,885	30,204	231,603
Castile		30,514	
Total	260,867	117,151	378,018

* Gypsum of Rustler, Castile, and Salado Formations, undivided

Gypsum Deposits in Basins

Gypsite is defined as an earthy variety of gypsum containing dirt and sand, found only in arid regions as an efflorescence deposit occurring over the ledge outcrop of gypsum or of a gypsum-bearing stratum (Jackson 1997). Quaternary-age gypsite deposits occur within several tectonic or solutional basins located in West Texas and New Mexico. Perhaps best known of these is the White Sands deposit, namesake for White Sands National Monument, and White Sands Missile Range, within the Tularosa Basin between Las Cruces and Alamogordo, New Mexico. Gypsum derived from Permian-age gyprock exposed in the surrounding highlands is deposited within lacustrine environments of the basin floor. Wind action deflates and transports gypsum sand from lakefloors to the lee side of lakes where it is deposited.

Other closed basins in New Mexico that contain lacustrine and/or eolian gypsum deposits include the Jornada del Muerto Basin north of Las Cruces, the Salt Basin between El Paso and Carlsbad, and the Estancia Basin east of Albuquerque. Toyah Lake near Pecos, Texas, and numerous small basins east of the Pecos River in Ward, Ector, Crane, Reagan, Upton, and Glasscock counties also contain gypsite.

Silicate-Rich Surficial Deposits

Anderson et al. (1972) estimated the quartz content of the Castile gyprock at less than 0.1%, so surface veneers of silicate material almost certainly originated from other sources (Table 4). Much of the Gypsum Plain has a thin (1 to 3 cm) discontinuous cover (about 15% cover) of silicate dominated material overlying hypergypsic materials. Silicate-rich sediments thicker than 50 cm, restricted to topographic lows, are thought to represent Tertiary(?)- and Pleistocene-age terrace deposits. Streams that left these deposits originated in the Delaware Mountains and Foothills and flowed eastward across the Gypsum Plain, in a pattern similar to that of present-day streams. In contrast to present streams however, the Tertiary(?) and Pleistocene drainage channels were not deeply incised below the surrounding terrain.

Table 4. Potential sources of silicate-rich materials found on the Gypsum Plain.

Source	**Reference**
Dissolution of Castile Formation gyprock without loss of silicates	
Thin sandstone marker beds within Castile Formation (Stop 7)	Madsen 1984
Clastic-rich strata within remnants of Salado Formation above the Castile	Stein et al. 1989
Siltstone / mudstone members of Rustler Formation remnants above the Castile	Vine 1963
Sand / conglomerate of Cretaceous-age Cox Formation remnants above the Castile	Miller 1963
Alluvium derived from Bell Canyon / Cherry Canyon outcrops west of Castile	
Eolian deposition of materials derived from the Salt Basin and perhaps the Rio Grande	

Relief

Elevation of the Gypsum Plain ranges from about 915 m (3000 ft) along the Delaware River to 1375 m (4500 ft) in the southwest. Relief on the plain is undulating to rolling in most areas, though rugged terrains exist adjacent to incised drainageways and solution subsidence troughs. Significant scarps mark the western boundary of the Gypsum Plain where the underlying Bell Canyon Formation has been preferentially eroded and along the eastern boundary where the Rustler Hills rise above the Castile Formation.

Tectonic stretching of western North America beginning during the Miocene resulted in the pull-apart grabens of the Basin and Range Province. Salt Basin, immediately west of the Delaware and Guadalupe Mountains is the easternmost tectonic basin. At that time, rocks of the Ochoan Group were tilted at an easterly to northeasterly dip at 3 to 5 degrees (Olive 1957).

Consequent streams originating west of the Gypsum Plain pass through a limited number of gaps in the western boundary scarp. The Black River and Delaware River have their source in the Guadalupe Mountains; Virginia Draw, Emory Draw, and Cottonwood Creek head in the Delaware Mountains. These streams cross the western escarpment, flow eastward across the Gypsum Plain, then pass into the Rustler Hills through just a few gaps in the eastern boundary scarp between the units. Numerous smaller consequent tributaries with headwaters on the Gypsum Plain drain into the Pecos River. Obsequent streams flowing westward from the Castile Formation are minor in extent and have relatively small catchments.

Thirteen landform classes have been recognized on the Gypsum Plain (Table 5), each hosting a characteristic suite of soils. Soils shallow-to-bedrock occur on landforms with more than 8% slope. Elcor formed in gyprock residuum, whereas Bissett soils developed in carbonates. Petrogypsic horizons of the Hollebeke, Cavewell, Pokorny, and Joberanch soils formed in alluvial and residual gypsite and occur on slopes of 2 to 8 percent. The age of petrogypsic-mantled landforms is estimated to be Pleistocene. Silicate-rich soils that contain less than 40 percent gypsum are restricted to topographically low landforms with less than 2 percent slope.

Time

Except where soil age is zero on geomorphic surfaces undergoing erosion or deposition at the moment, soil age cannot be directly observed. However, soil age can be inferred from landforms and soil properties. Application of geomorphologic principles can provide relative ages of different landforms and of the soils on them. In addition, the presence of features like petrogypsic horizons suggests a long history of weathering.

Besides areas that are characterized by rugged relief (i.e., gypsum breaks, gullies, erosion balloons, and margins of solution subsidence troughs), much of the Gypsum Plain landsurface is believed to date to the Pleistocene (Table 5). Hawley (1993) wrote that the Delaware and Black Rivers may date back to late-Miocene time. One particular summit just north of Seven L Peak near the western margin of the Gypsum Plain suggests great antiquity. It is an undissected karst-pitted platform remnant, presumably formed over alluvial gypsite, resting at an elevation of 1285 m (4215 ft). To the west 4.5 km (3 mi) the present-day channel of intermittent Wild Horse Draw flows at 1210 m (3970 ft) elevation. Since deposition of alluvial gypsite, enough time has passed for stream incision to slice completely through the Castile and into the underlying Bell Canyon formation, lowering base level about 75 m (250 ft).

Table 5. Landform classes of the Gypsum Plain.

Landform Class	Slope Gradient (%)	Characteristic Component	Diagnostic Horizons	Note	Estimated Geomorphic Age
biogenic limestone knob	8 to 40	Bissett Rock Outcrop	calcic lithic	Castiles	Holocene
alluvial fan below remnant Rustler Hills	1 to5	Owlhills*	gypsic		Pleistocene / Holocene
undissected karst-pitted platform remnant	0 to 2	Pokorny* Joberanch*	hypergypsic petrogypsic	gypsite terrace	Pliocene?-Pleistocene
gullied gypsite terrace	10 to 30	Pokorny* Hollomex	hypergypsic petrogypsic		Holocene
smooth gypsite-mantled hillslope	1 to 8	Cavewell* Hollebeke*	hypergypsic petrogypsic lithic	most extensive landform class	Pleistocene
gyprock break, gully, and erosion balloon	8 to 40	Elcor* Rock Outcrop	lithic		Holocene
solution-subsidence trough floors	0 to 2	Dillyhunt*, Joberanch*	gypsic petrogypsic	result from dissolution of halite	Pleistocene
solution-subsidence trough margin	5 to 16	Elcor*, Hollebeke*	petrogypsic lithic	east-west orientation	Holocene
karst sinkhole		Rock Outcrop	lithic		Holocene
U-shaped drainageway	0 to 2	Neimahr*, Dillyhunt*	lithic, gypsic	swale	Pleistocene
broad abandoned stream terrace	0 to 2	Dillyhunt*, Joberanch*	gypsic petrogypsic		Pleistocene
narrow floodplain	0 to 2	Walkerwells*	gypsic		Holocene
narrow terrace	2 to 8	Monahans	gypsic		Holocene

* Proposed soil series

Climate

The climate of the Reeves-Eddy-Culberson County area is continental arid (Figures 2 and 3). Summers are hot and winters are cool. Though winter days are warm, freezing temperatures occur most nights. Precipitation is limited, and mostly falls during the warm season; plants must tolerate long periods of dry soil conditions.

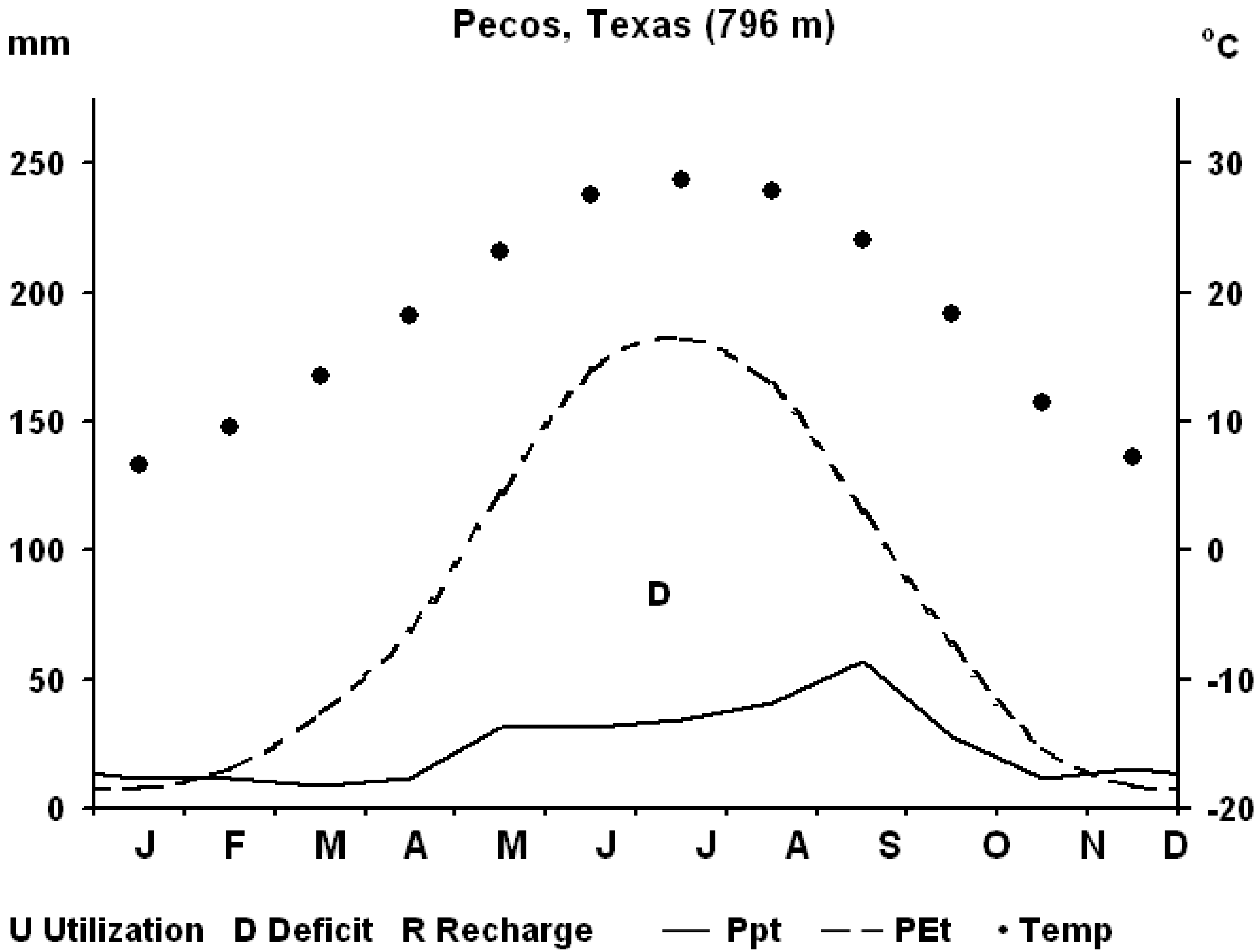

Figure 2. Soil climate diagram for Pecos, Texas.

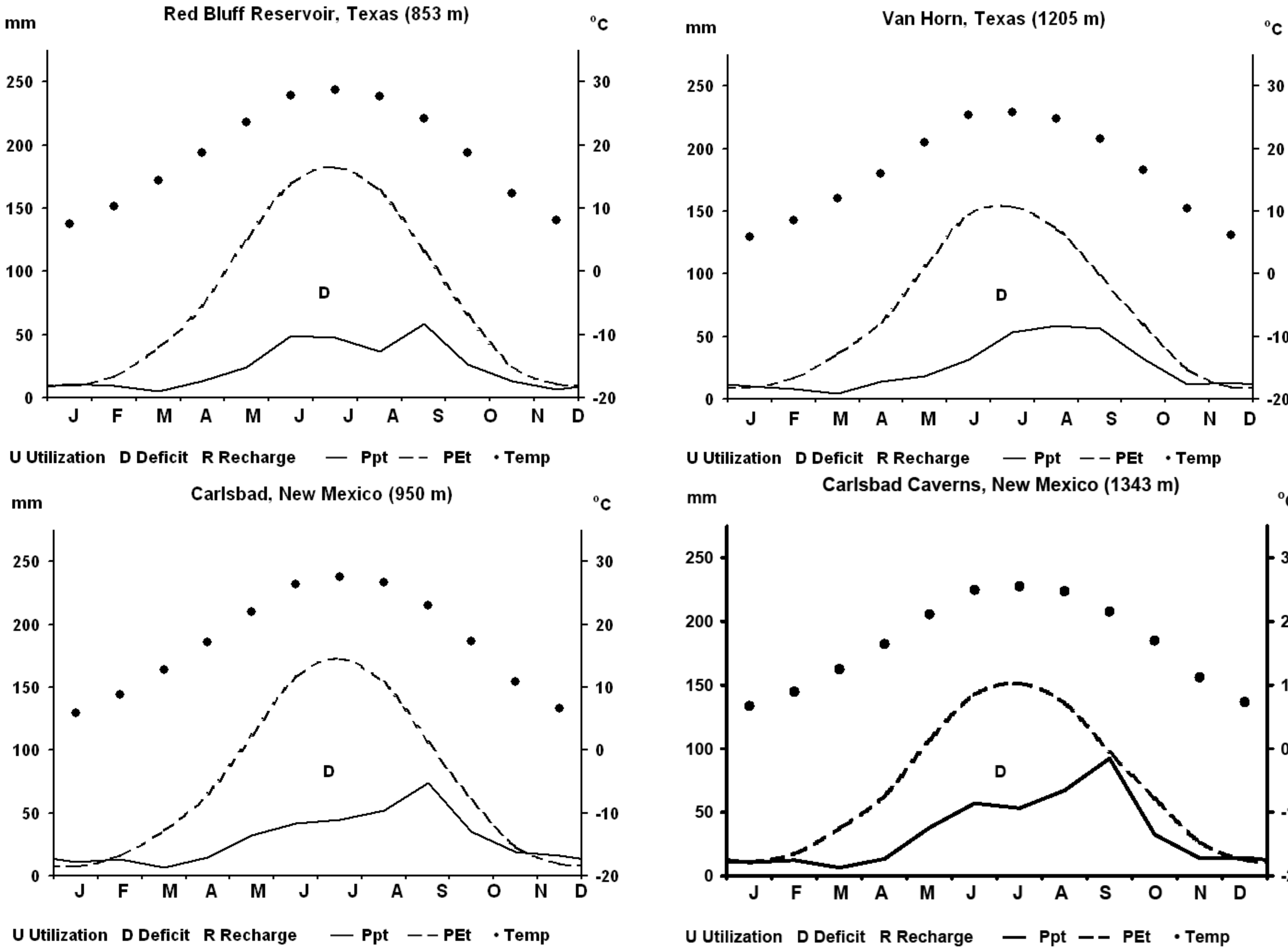

Figure 3. Soil climate diagrams for Red Bluff Reservoir, Van Horn, Carlsbad, and Carlsbad Caverns.

Five cooperative meteorological observation stations with long-term records occur in or near the tour area (Table 6). Stations at Pecos, Red Bluff Reservoir, and Carlsbad occur near the Pecos River axis. Mean annual precipitation ranges from 294 mm (11.57 in) at Pecos to 413 mm (16.26 in) at Carlsbad Caverns. Carlsbad and Carlsbad Caverns are near the Guadalupe Ridge and Reef Escarpment, where enhanced orographic precipitation is evident. Van Horn is within a bolson; the higher elevation there partially compensates for the rain shadow cast by the surrounding mountains.

Table 6. Climate summary for stations in the Reeves-Eddy-Culberson county tour area.

Station	Elev (m)	MAAT (C)	Days w/ high > 37.8 C	Days w/ low < 0 C	FFP (days)	MAP (mm)	pET (mm)	PPt def (mm)	Days w/ > 25 mm precip
Pecos	795	18.0	50.6	75.2	225	294	977	682	2.0
Red Bluff Reservoir	853	18.5	44.3	70.5	218	301	997	696	3.2
Carlsbad	950	17.1	19.5	80.4	214	359	919	560	3.1
Carlsbad Caverns	1343	16.5	5.3	51.2	222	413	863	450	3.5
Van Horn	1205	16.2	13.9	76.8	215	311	856	544	1.9

Elev = Elevation; MAAT = Mean annual air temperature; FFP = Frost-free period; MAP = Mean annual precipitation; pET = Potential evapo-transpiration; PPt def = Precipitation deficit

From November through April, alternating northwesterly, northeasterly and southwesterly winds blow, often strongly, bringing in modified air masses: maritime polar, continental polar and continental tropical, respectively. Polar maritime air masses from the Pacific lose moisture as they pass over the Sierra Nevada and Rocky Mountains. The common attribute of these air masses is that they are dry. The dewpoint temperature during the cool season is normally less than -6.5 C (20 F). The months from November through March each receive less than 11 mm (0.45 in) precipitation. March is typically the driest month of the year.

During the period of May to June, winds switch to a southeasterly direction and maritime tropical air masses bearing moisture from the Gulf of Mexico begin to penetrate to West Texas. The summer monsoon usually starts in early July when dewpoints increase to 10 C (50 F). The months of July through September receive about half of the annual precipitation total. Afternoon convectional thunderstorm cells of limited extent drop brief bursts of intense rainfall. Most storm totals are less than 12.5 mm (0.5 in). On average, only two to three days per year receive more than 25 mm (1.0 in) of rainfall. Precipitation during August and September is enhanced by tropical cyclone remnants from the Gulf of Mexico and Pacific Ocean.

Summer temperatures at the three stations along the Pecos River; Pecos, Red Bluff Reservoir and Carlsbad are hot. At Pecos, about 50 days per year reach a maximum temperature of 38 C (100 F). The hottest months of the year are May and June. Higher humidity and the accompanying cloud cover during July and August result in slightly cooler temperatures. The average freeze-free period is from 215 to 225 days long, extending from early- to mid-April through early

November. Freezing temperatures occur during about half of the nights between first freeze and last freeze.

Evapo-transpiration exceeds precipitation during 11 to 12 months of the year (Figures 2 and 3). Only during December and January does precipitation meet or exceed potential water loss. Annual precipitation deficit ranges from nearly 700 mm (27.5 in) at Pecos and Red Bluff Reservoir to about 450 mm (17.7 in) at Carlsbad Caverns.

The soil moisture regime is considered typic aridic at lower elevations along the Pecos River, gradually increasing to ustic aridic on the Culberson Plateau. A summary of six years of soil temperature monitoring confirms that Pecos, and by inference the surrounding area, has a thermic soil temperature.

Organisms

Gypsophiles form unique plant communities on the Gypsum Plain. These are plant species adapted to the arid climate and unique chemical and physical properties of hypergypsic soils. The chemical limitations that gypsophiles must tolerate include 1) unbalanced ion concentration, with excess sulfur and calcium, and 2) low retention of nutrients such as phosphorous, potassium, and nitrogen by the soil. These limitations may prevent establishment of non-gypsophile species. Alternatively, surface crusts may hinder seedling establishment and root penetration (Verheye and Boyadgiev 1997). The relative importance of chemical and physical restrictions in hypergypsic soils is still open to debate.

Obligate gypsophiles are plant species that grow only on gypseous substrates(Parson 1976, Moore et al. 2008). On the Gypsum Plain, these include gyp grama, gyp dropseed, gypsum ringstem, and gray coldenia, among many others. Important shrubs that occur on hypergypsic soils include are littleleaf sumac, oneseed juniper, soaptree yucca, spiny althorn, ocotillo, with creosotebush on hypergypsic soils that also contain carbonates (Waterfall 1946, Warnock 1974).

A veneer of silicate soil material only 10 cm thick can radically alter the species composition, diversity, and productivity of plant communities. Silicate-rich soils support vegetation more representative of the northern Chihuahuan Desert. Important shrubs are western honey mesquite, creosotebush, and littleleaf sumac. Grasses include sideoats grama, black grama, tobosa, blue grama, and burrograss. Dolomite and limestone outcrops associated with the Rustler Formation support ocotillo, lechuguilla, and viscid acacia. Black grama and sideoats grama grow on carbonate substrates, whereas gyp grama and gyp dropseed do not.

Forms of Gypsum

Gypsum occurs as gyprock, gypsite, selenite, and satinspar (Stone 1920). Gyprock or massive gypsum (Plate 1) is the most common form of gypsum in the Salado and Castile Formations. Gyprock (and precursor anhydrite) of the Castile Formation is characteristically varved, whereas that within the Salado Formation is massive. Very fine grained gyprock that is white, slightly translucent, and suitable for carving and sculpturing is known as alabaster.

Gypsite or earthy gypsum (Plate 2) is soft, incoherent, impure gypsum formed at or near the surface by the evaporation of gypsiferous water. It is an efflorescent deposit and ranges from powdery, to sandy, to slightly consolidated forms.

Selenite is a form of gypsum that occurs in distinct crystals or in broad folia. Pure selenite is colorless and transparent. It easily splits into sheet. Selenite can be found within dissolution breccias of the Castile Formation, and has been observed as a planar sheet exposed at Site 7. The large, continuous gypsum crystals that compose selenite suggest precipitation under conditions of constant water and solute availability, atypical of desert surface environments.

Satinspar is crystalline gypsum made up of needle-like fibers. It occurs in narrow seams or veins, usually less than 10 cm (4 in) thick in gyprock deposits. Like gypsite, satinspar is formed by evaporation of gypsiferous water.

A common sequence of gypsum varieties on the Castile Formation starts with surficial gypsite from 0.2 to 3 m (1 to 10 ft) thick (Plate 1). This veneer may be absent on areas with slope gradients greater than eight percent. Below the gypsite is massive gypsum bedrock, derived from anhydrite. Associated with solution breccias and veins within gyprock are selenite crystals. Satinspar may be observed in solution voids near the surface. Anhydrite bedrock below a depth of 25 and 125 m (80 to 400 ft) is the ultimate source of sulfates.

Gypsum Transformations

Hall et al. (2004) recognized three environmental zones within which physical and chemical changes can take place: vadose pedogenic, vadose non-pedogenic, and phraetic. They observed different macroscopic and microscopic textures and structures of calcite within these environments. Similar relationships may hold true for gypsum as well.

The vadose pedogenic zone extends from the surface down to a depth of about 5 m (16 ft). It is subject to diurnal and seasonal variations of solar radiation, temperature, moisture, and pressure as well as to the influence of plant roots, animals, and gravity. Alterations to minerals in this zone are considered pedogenic.

At depths from about 5 meters down to a permanent water table is the vadose non-pedogenic zone. Isolated from dynamically fluctuating temperature, moisture, and pressure associated with the immediate surface, physical and chemical reactions respond to rather constant environmental conditions. The effect of gravity on water movement is evident in the spatial relationship of calcite concentrations to depositional foci.

The vadose zone occurs below a regional water table, where perpetually saturated conditions exist with near-constant temperature. Groundwater conditions regulate chemical reactions. Precipitation of minerals and growth of larger crystals occur more slowly than in near-surface environments. Below the water table, the effects of gravity on crystal growth are minimal.

The Castile Formation exists mainly as anhydrite below depths ranging from 25 to 125 m (80 to 400 ft). Within the vadose zone, sulfates have been hydrated to form gypsum. Anhydrite transforms to gypsum within a subsurface environment isolated from the influence of plant roots, and diurnal and seasonal variations of radiation, temperature, moisture, and pressure. For this reason, the hydration reaction is not considered pedogenic.

On the other hand, alteration of gypsum to bassanite within near-surface environments is considered a pedogenic change. Dehydration may occur in response to high surface temperatures resulting from intense solar insolation. This reaction and the subsequent hydration back to gypsum would be considered pedogenic. The specific reactants and products of a physical or chemical reaction do not determine whether the transformation is pedogenic or non-pedogenic. Rather, it is the environmental circumstances driving a particular reaction that determine whether the product, in this case gypsum, has a geologic versus pedogenic origin.

Geologic Transformations

Diagenesis includes the chemical, physical, and biological changes that sediments undergo after initial deposition. Compaction, cementation, reworking, replacement, recrystallization, leaching and hydration that take place at temperatures (<100 to 300 C) and pressures (<1000 bars) near the earth's surface are considered diagenetic, not metamorphic. Choquet and Pray (1970) defined three stages of diagenesis: 1) eogenetic transformations that transpire during early burial stages; 2) mesogenetic alterations that take place during intermediate-burial stages; and 3) telogenetic changes that occur during uplift, when long-buried rocks are exposed to surficial weathering, erosion, and dissolution. The following mesogenetic and telogenetic transformations have been described for the Castile Formation (Hill 1996).

The Castile Formation was deposited as gypsum in deep waters (~600 m, ~2000 ft) within the Delaware Basin under hypersaline conditions. Mesogenetic changes occurred as strata were buried by later deposition. Increasing temperatures and pressures present at depths greater than 300 to 600 m (1000 to 2000 ft) expelled water from gypsum, transforming it to anhydrite (Blatt et al. 1972). Until uplift and exposure to water moving through fractures and along bedding planes, anhydrite remained stable.

Telogenetic alteration of anhydrite occurred following Miocene uplift. Anhydrite was rehydrated back to gypsum as overburden pressure was released and as meteoric water began to enter through fractures. At depths between 25 and 125 m (80 to 400 ft) gypsum and anhydrite coexist. Conversion to gypsum is complete at variable depths: less than 20 m (65 ft) (Anderson and Kirkland 1966); 25 m (80 ft) (Quinlan 1978); 60 m (200 ft) (Crawford 1988); and 90 to 150 m (300 to 500 ft) (Hentz et al. 1989). Most of the rehydration took place during the mid- and late-Tertiary (Hill 1996).

Pedogenic Transformations

Genesis of residual gypsite deposits is thought to begin with the infiltration of precipitation into gyprock exposed at the surface. Rainwater moves downward through fractures, dissolves near-surface gypsum, and translocates the ions downward in solution. Subsequent loss of water through evaporation and transpiration results in gypsum precipitation. Gypsum crystals precipitate and grow within voids between existing gypsum crystals. The small pore dimensions

(Plate 15) and dynamic geochemical environment, i.e. constantly changing moisture, temperature, and CO_2 partial pressure, combine to limit the extent of crystal growth. Expanding crystals exert force on and fracture adjoining crystals.

The above-mentioned processes recursively fill voids and fracture neighbors, until a relatively uniform particle size exists and a dense root restrictive horizon forms. Artieda (1996) termed this process “self-milling”. Wetting fronts associated with individual rainstorms typically penetrate only a few centimeters into the material, insufficient to leach significant quantities of gypsum from the soil. Because the Castile is composed of mostly gypsum, detecting surface losses and subsurface gains resulting from translocation is difficult, if not impossible.

Its high solubility in water decreases the likelihood that gypsum within the surface wetting zone has escaped dissolution and re-precipitation, with or without translocation. However, recognizing visible evidence of illuvial processes in materials that have greater than 40% gypsum content is difficult, if not impossible. How can illuvial gypsum be distinguished from transformed or inherited gypsum if gypsum from all three origins occurs within a horizon? What morphological properties can provide field evidence of pedogenic alteration?

Land Use in the Tour Area

Rangeland in Culberson-Reeves-Eddy Counties is used for livestock production, wildlife habitat, and for energy production. Cow-calf systems are the most common form of ranching enterprise. Carrying capacity of rangeland in the Gyp Hills ecological site is low; stocking rates of about 50 ha (125 acres) per animal unit yearlong are recommended. Ranchers and landowners obtain a substantial portion of their income from selling trespass rights to hunters. Important game species include mule deer, blue quail, and dove, with a few antelope in very favorable habitats. Despite low vegetation productivity, mule deer on the Gypsum Plain grow to exceptional size, in both body and antler.

Production of oil and natural gas is growing in economic and environmental importance. Exploration, production, and pipeline construction activities directly impact the environment. The construction of dense road networks usually accompanies the development of oil and gas fields. A windfarm has been recently established on the crest of the Delaware Mountains north of Van Horn.

Surface water diverted from the Pecos River and from San Solomon spring, and groundwater pumped from the Cenozoic Pecos Alluvium Aquifer are used to irrigate about 8100 ha in Reeves and Ward Counties. The major irrigated crops are cotton, small grain, forage and grain sorghum, alfalfa, and vegetables, especially cantaloupes. Management concerns on cropland are salinity, wind erosion, soil tilth, and management of irrigation water (Jaco 1980).

Saltcedar (*Tamarix spp.*) is a non-native phreatophyte that grows along riparian corridors throughout West Texas. Estimates of saltcedar water use range from 0.8 L d^{-1} – 57 L d^{-1} per tree depending on age, size, morphology, atmospheric conditions and depth to water table. Salts can accumulate in the leaves; leaf litter may increase salinity at soil surface beneath the saltcedar canopy. During the late 1990’s the Pecos River Ecosystem Project (PREP) was organized to improve irrigation delivery efficiency from Red Bluff Reservoir to the irrigation districts. Since 1999, more than 4,000 ha (18,000 ac) along 481 river km (300 mi) have been treated with Arsenal (imazypr) herbicide. Control remains at greater than 85%. Initial funding for PREP was provided by Red Bluff Water Power Control Board and the 7 irrigation districts that purchase water from the Board. Texas Department of Agriculture, Texas State Soil and Water Conservation Board, and USDA-NRCS EQIP funds were used in subsequent treatment years. Researchers at Texas AgriLife Extension in Fort Stockton and Texas AgriLife Research in El Paso are evaluating the hydrologic response of Pecos River alluvial aquifer to saltcedar control.

Challenges in Describing and Classifying Hypergypsic Soils

Soil scientists seek to recognize and describe soil features that 1) affect water intake, movement, retention, and release, 2) relate to nutrient retention and release, 3) impact the ability of soil to support plant growth and engineered structures, and for those reasons 4) are significant to land use and management. The rationale and methods for describing and classifying soils were tailored for soils in humid climates dominated by silicate minerals. The basic properties of particle size distribution, soil structure, and color were chosen because they have many accessory properties. That is, they are related to other properties that are more expensive or more difficult to quantify. Clay content relates to a soil's ability to take in, store, and release water, as well as cation exchange capacity. Soil structure is a proxy for resistance to erosion. Soil color serves as an indicator of organic matter content, soil wetness, etc.

Describing the morphology of gypseous materials and classifying hypergypsic soils pose unique challenges for field soil scientists. Concepts and field protocols for describing basic soil properties such as texture, structure, and color seem to fail for soils that contain more than 40% gypsum. These same protocols also show weakness for soils that are high in carbonates, organic matter, and amorphous material.

A comprehensive system of terms to describe significant features of hypergypsic soils does not yet exist. In the absence of a systematic approach, we have coined a set of very informal terms that may bear little relationship to one another or to terms and concepts in the literature. Among these *ad hoc* terms are flour gyp, sugar gyp, bundle-of-needles gyp, porphyritic gyp, gyp blisters, and gyp pies.

Texture and Particle-Size Distribution

The concept and particle size distribution and standard soil texture class are nearly meaningless in materials that contain more than about 40% gypsum. The fundamental relationships of water intake, retention, and release, and cation exchange capacity, with particle-size distribution in silicate-dominated soils differ markedly from those in hypergypsic soils.

For the following reasons, data on particle size distribution of gypseous materials are more a reflection of the processing method rather than of the material sampled in the field. 1) Gypsum crystals and crystal fragments are inherently fragile; they are much easier to fracture than quartz or feldspar minerals. Their particle size distribution is easily modified by standard sample preparation methods. Sample grinding techniques can fracture gypsum crystal fragments further.

2) Hypergypsic soil material cannot be readily dispersed. Aggregates of silt-size gypsum particles behave in suspension as sand. Furthermore, gypsum causes silicate clays to flocculate and descend from suspension. 3) A proportion of solid gypsum dissolves within sedimentation jars. Soluble salts increase the solubility of gypsum. The gypsum contained in pipette aliquots is interpreted as clay or silt, depending on the sedimentation time. 5) The particle density of gypsum (2.35) differs significantly from that of quartz and other silicate minerals (2.65). Simply stated, results of particle-size analysis for hypergypsic materials are artifacts and cannot be interpreted as are other particle-size data.

Alternate systems for describing particle size distribution exist for soils in the Andosols and Histosols soil orders, as well as specific protocols for identifying the alternate class. Three basic substitute-for-particle-size classes have been established for Andisols: ashy, medial,and hydrous (Soil Taxonomy, p. 820). For Histosols, the three classes of materials were devised: fibric, histic, and sapric. A similar, three-fold alternative particle size class system has been proposed for soils very rich in gypsum. Names of the classes are sucrosic (for hypergypsic materials dominated by sand); placoid for the in-between class; and pulverulent (flour-like gypsum).

Soil Color

The standard Munsell soil color charts do not have chips to describe very white gypseous materials. The color value of hypergypsic soils almost always exceeds 8. The whitest color combination, 10YR 8/1, does not communicate the whiteness observed in hypergypsic soils, as well as soils and bedrock layers high in carbonate and volcanic ash. A Munsell high value page (white page) that includes chips with hues of N, 7.5YR, 10YR and 2.5Y, values of 8, 8.5, 9, and 9.5, and chromas 1 and 2, has been created to supplement the standard Munsell soil color charts. Relationships to be established between soil color and gypsum content should allow the estimation of gypsum content in the field.

Soil Structure

Soil horizons with greater than 40% gypsum content normally develop weak soil structure. Very coarse prismatic structure is commonly observed in petrogypsic horizons. Vertical fractures between prisms provide pathways for water movement. The prism surfaces along fractures are usually coated with gypsum and/or carbonates. Prism boundaries have greater pedo-resistance than prism interiors; they are less susceptible to weathering and erosion, and stand out in relief when exposed at the surface.

Rupture Resistance

Among the soil survey standards that function well for hypergypsic and petrogypsic soil horizons are the protocols, criteria, and classes of consistence (rupture resistance, cementation, pedo-resistance) (Schoeneberger et al. 2002). Under the protocol, specimens of standard size are subjected to a compressive force at three different water states: air dry, moist, and air dry, then submerged for a period of one hour. The quantity of force at which the specimen fails is noted, and rupture resistance class is assigned.

Roots

The abundance, distribution, and orientation of roots are key attributes to describe. Roots normally occur throughout hypergypsic horizons with no pedo-resistance. Weakly pedo-resistant and stronger hypergypsic horizons allow roots only within fractures. If fractures are spaced at intervals greater than 10 cm, the horizon is considered a physical barrier to roots and classed as a petrogypsic diagnostic horizon. Roots commonly occur as mats on the upper surface of root restrictive layers: petrogypsic horizon, densic contact, paralithic contact, and lithic contact.

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Appendices

Data Sheet Symbols (2F)

The analytical result of “zero” is not reported by the National Soil Survey Laboratory. The following symbols are used or have been used for trace or zero quantities and for samples not tested by the National Soil Survey Laboratory.

tr, Tr, TR	**Trace - either is not measurable by quantitative procedure used or is less than reported amount.**
tr(s)	**Trace detected only by qualitative procedure more sensitive than quantitative procedure used.**
-	**Analysis run but none detected.**
--	**Analysis run but none detected.**
-(s)	**None detected by sensitive qualitative test.**
blank	**Analysis not run.**
nd	**Not determined, analysis not run.**
<	**Either none is present or amount is less than reported amount, e.g., <0.1 is in fact <0.05 since 0.05 to 0.1 is reported as 0.1**

Code Laboratory Preparation
Char >2mm

S Blank	**Weigh sample at field moisture content and record weight. Air-dry, weigh, and record weight. Sieve >2-mm fractions, weigh, record weights, and discard. Report all analytical results on <2-mm basis. Refer to procedure 1B1, Standard Air-dry.**
G P	**Weigh sample at field moisture content and record weight. Air-dry, weigh, and record weight. Grind entire sample to <2 mm. Report all analytical results for ground sample on a whole soil basis. Refer to procedure 1B6, Whole Soil.**

PEDON DESCRIPTION

Print Date: 07/15/2008

Description Date: 09/01/1983

Describer: J. Rives B. L. Allen and P. Finnell

Site ID: S83-TX389-001

Site Note:

Pedon ID: S83-TX389-001

Pedon Note: Vegetation; Creosotebush, mesquite burrograss. Range site - loamy

Lab Source ID: SSL

Lab Pedon #: 83P0888

Soil Name as Described/Sampled: Hoban

Soil Name as Correlated:

Classification: fine-loamy, mixed, superactive, thermic Ustic Haplocalcids

Pedon Type:

Pedon Purpose: full pedon description

Taxon Kind:

Associated Soils:

Physiographic Division:

Physiographic Province:

Physiographic Section:

State Physiographic Area:

Local Physiographic Area:

Geomorphic Setting: playa or alluvial flat intermontane basin

Upslope Shape:

Cross Slope Shape:

Particle Size Control Section:

Description origin: Converted from SSL-CMS data

Diagnostic Features: ochric epipedon 0 to 9 cm.
cambic horizon 9 to 63 cm.
calcic horizon 63 to 134 cm.
gypsic horizon 134 to 175 cm

Country:

State: Texas

County: Reeves

MLRA: 42 -- Southern Desertic Basins, Plains, and Mountains

Soil Survey Area:

Map Unit:

Quad Name:

Location Description: Reeves County, TX. About 8 mi NW of Pecos; about 5.3 mi N on ranch road 2119. Duval Road

Legal Description:

Lat: 31 degrees 23 minutes 14.00 seconds N

Lon: 103 degrees 26 minutes 11.00 seconds W

Datum:

UTM Zone:

UTM Easting:

UTM Northing:

Primary Earth Cover:

Secondary Earth Cover:

Existing Vegetation:

Parent Material:

Bedrock Kind:

Bedrock Depth:

Bedrock Hardness:

Bedrock Fracture Interval:

Surface Fragments:

Description database: NSSL

A--0 to 9 centimeters; light brown (7.5YR 6/4), loam, brown (7.5YR 4/4), moist; moderate medium subangular blocky, and moderate medium single grain; firm, slightly hard; strong effervescence, by HCl, unspecified; abrupt smooth boundary. Lab sample # 83P4539.

Bw1--9 to 34 centimeters; light brown (7.5YR 6/4) loam, brown (7.5YR 4/4), moist; moderate medium subangular blocky structure; very firm, very hard; few medium roots throughout; strong effervescence, by HCl, unspecified; gradual wavy boundary. Lab sample # 83P4540.

Bw2--34 to 63 centimeters; light brown (7.5YR 6/4) silty clay loam, brown (7.5YR 5/4), moist; moderate medium subangular blocky structure; firm, hard; few medium roots throughout; violent effervescence, by HCl, unspecified; clear wavy boundary. Lab sample # 83P4541.

Bk1--63 to 100 centimeters; light brown (7.5YR 6/4) silty clay loam, brown (7.5YR 5/4), moist; moderate fine subangular blocky structure; firm, hard; violent effervescence, by HCl, unspecified; gradual smooth boundary. Lab sample # 83P4542.

Bk2--100 to 134 centimeters; light brown (7.5YR 6/4) silty clay loam, strong brown (7.5YR 5/6), moist; moderate fine subangular blocky structure; firm, hard; violent effervescence, by HCl, unspecified; abrupt wavy boundary. Lab sample # 83P4543.

Bky1--134 to 158 centimeters; reddish yellow (7.5YR 6/6)silty clay loam, strong brown (7.5YR 5/6), moist; weak fine subangular blocky structure; very firm, very hard; violent effervescence, by HCl, unspecified; gradual wavy boundary. Lab sample # 83P4544.

Bky2--158 to 175 centimeters; reddish yellow (7.5YR 6/6) silty clay, strong brown (7.5YR 5/6), moist; weak fine subangular blocky structure; firm, hard; violent effervescence, by HCl, unspecified. Lab sample # 83P4545.

Hoban S83-TX389-001

PSDA & Rock Fragments

Horz	Depth (cm)	Total Clay < 0.002	Total Silt 0.002 -0.05	Total Sand 0.05 -2	Clay CO3 < 0.002	Silt Fine 0.002 -0.02	Silt Coarse 0.02 -0.05	Sand VF 0.05 -0.1	Sand F 0.1 -0.25	Sand M 0.25 -0.5	Sand C 0.5 -1	Sand VC 1 -2	Rock Fragments (mm) Weight 2 -5	Weight 5 -20	Weight 20 -75	Weight .1- 75	>2 mm wt % whole soil
		(- - - % of <2mm Mineral Soil										- - -)	(- - - % of <75mm			- - -)	
A	0-9	12.6	29.8	57.6	2.3	18.1	11.7	20.3	20.6	13.8	2.6	0.3	tr	tr	--	37	tr
Bw1	9-34	15.1	32.6	52.3	2.8	21.5	11.1	18.4	18.4	12.3	2.7	0.5	tr	tr	--	34	tr
Bw2	34-63	19.5	34.6	45.9		22.9	11.7	18.0	15.6	9.4	2.0	0.9	1	1	--	29	2
Bk1	63-100	20.3	33.4	46.3	5.6	23.2	10.2	17.3	15.3	9.1	2.7	1.9	1	1	2	32	4
Bk2	100-134	23.8	30.7	45.5	8.5	22.9	7.8	17.6	19.4	6.7	1.2	0.6	tr	tr	--	28	tr
Bky1	134-158	5.2	36.0	58.8	0.9	33.2	2.8	14.2	26.8	13.6	3.5	0.7	1	tr	--	45	1
Bky2	158-175	5.3	47.3	47.4	0.9	40.1	7.2	19.8	15.0	7.3	4.4	0.9	tr	--	--	28	--

Bulk Density & Moisture

Horz	Depth (cm)	(Bulk Density) 33 kPa ($g\ cm^{-3}$)	Oven Dry ($g\ cm^{-3}$)	Cole Whole Soil	Water Content 33 kPa (% of < 2mm)	1500 kPa (% of < 2mm)	Ratio AD/OD	WRD Whole Soil ($cm^3\ cm^{-3}$)	(Ratio/Clay) CEC7	1500 kPa
A	0-9	1.56	1.60	0.008	14.7	8.0	1.020	0.10	1.12	0.63
Bw1	9-34	1.69	1.76	0.014	15.9	9.0	1.023	0.12	0.91	0.60
Bw2	34-63	1.48	1.56	0.018	18.5	9.5	1.024	0.13	0.69	0.49
Bk1	63-100	1.33	1.40	0.017	19.7	9.5	1.023	0.13	0.63	0.47
Bk2	100-134	1.39	1.47	0.019	18.8	8.0	1.019	0.15	0.45	0.34
Bky1	134-158	1.40	1.44	0.009	18.0	11.7		0.09	2.46	2.25
Bky2	158-175	1.38	1.42	0.010	20.9	11.2		0.13	3.02	2.11

Hoban S83-TX389-001

pH & Carbonates

Horz	Depth (cm)	pH: KCl	pH: $CaCl_2$ 0.01M 1:2	pH: H_2O 1:1	pH: Sat Paste	pH: Sulf	pH: NaF	Carbonate As $CaCO_3$ <2mm (%)	Carbonate As $CaCO_3$ <20mm (%)	Gypsum As $CaSO_4 \cdot 2H_2O$ <2mm (%)	Gypsum As $CaSO_4 \cdot 2H_2O$ <20mm (%)	Resist ohms cm^{-1}
A	0-9	7.5	7.8	8.3	8.0			11		--		
Bw1	9-34	7.3	7.6	8.2	7.8			17		--		
Bw2	34-63	7.2	7.5	8.1	7.7			24		--		
Bk1	63-100	7.2	7.4	7.9	7.6			32		--		1400
Bk2	100-134	7.2	7.5	7.8	7.6			36		--		
Bky1	134-158	7.2	7.4	7.6	7.6			13		32		
Bky2	158-175	7.0	7.4	7.6	7.5			18		26		

Carbon & Extractions

Horz	Depth (cm)	Total C (% of <2 mm)	Total N (% of <2 mm)	Total S (% of <2 mm)	Org C (% of <2 mm)	C/N Ratio
A	0-9		0.061		0.56	9
Bw1	9-34		0.059		0.54	9
Bw2	34-63		0.048		0.41	9
Bk1	63-100				0.46	
Bk2	100-134				0.31	
Bky1	134-158				0.10	
Bky2	158-175				0.13	

Hoban S83-TX389-001

CEC & Bases

Horz	Depth (cm)	Ca	Mg	Na	K	CEC7 NH_4 OAC	Base Saturation Sum	Base Saturation NH_4OAC	Exch Na
		(- - - NH4OAC Extr Bases - - -)							
		(- - - - - - cmol(+) kg-1 - - - - - - - -)					(- - - - - - - % - - - - - -)		
A	0-9	47.3*	1.4	0.1	1.2	14.1	100	100	1
Bw1	9-34	50.8*	1.1	0.1	0.8	13.7	100	100	1
Bw2	34-63	59.2*	1.1	0.1	0.5	13.4	100	100	1
Bk1	63-100	53.6*	1.1	0.2	0.4	12.7	100	100	1
Bk2	100-134	50.5*	0.9	tr	0.3	10.7	100	100	--
Bky1	134-158	340.9*	1.0	0.1	0.5	12.8	100	100	1
Bky2	158-175	274.6*	1.4	0.7	0.6	16.0	100	100	2

Salt

(- - - - - - - - - - -- - - - - - - Water Extracted From Saturated Paste -)

Horz	Depth (cm)	Ca	Mg	Na	K	CO_3	HCO_3	F	Cl	SO_4	NO_2	NO_3	H_2O	Total Salts	Elec Cond	Pred Elec Cond	SAR
		(- - - - - mmol(+) L-1 - -- - -)				(- - - - - - - - - - - - - - - mmol(-) L-1 - - - - - - - - - - - - - - -)							(- - - - % - - - -)		(- dS m-1 -)		
A	0-9	6.10	0.60	0.30	0.50	--	3.60	0.10	0.40	3.50	--	0.20	29.00	tr	0.73	0.31	tr
Bw1	9-34	3.90	0.30	0.30	0.20	--	3.00	0.10	0.30	1.80	--	tr	34.70	tr	0.48	0.26	tr
Bw2	34-63	8.60	0.60	0.70	0.10	--	2.20	0.10	0.50	6.80	0.20	0.70	39.60	tr	0.94	0.38	tr
Bk1	63-100	15.60	1.10	0.90	0.10	--	1.70	0.90	2.00	11.00	0.50	5.80	39.10	tr	1.61	0.56	tr
Bk2	100-134	17.00	1.20	1.20	0.10	--	1.30	0.60	2.20	6.10	--	12.80	36.00	tr	1.92	0.57	tr
Bky1	134-158	32.10	2.00	3.20	0.30	--	1.10	1.30	4.00	30.20	--	6.30	50.80	0.1	2.98	2.43	1
Bky2	158-175	33.60	2.60	6.80	0.30	--	1.00	1.30	7.20	30.80	--	7.70	46.30	0.1	3.60	2.58	2

PEDON DESCRIPTION

Print Date: 09/14/2008
Description Date: 10/26/1961
Describer: R.E. Daniell, J.R. Coover, R. Fox
Site ID: 61TX389003

Site Note:

Pedon ID: 61TX389003
Pedon Note:
Lab Source ID: SSL

Lab Pedon #: 40A0171
Soil Name as Described/Sampled: Reeves
Soil Name as Correlated: Reeves
Classification: Fine-loamy, gypsic, thermic Ustic Calcigypsids
Pedon Type:
Pedon Purpose:
Taxon Kind: series
Associated Soils:
Physiographic Division:
Physiographic Province:
Physiographic Section:

State Physiographic Area:
Local Physiographic Area:
Geomorphic Setting: terrace
leveled land
Upslope Shape:
Cross Slope Shape:
Particle Size Control Section: 25 to 100 cm.
Description origin: Converted from PDP 3.x
Diagnostic Features: ochric epipedon 0 to 13 cm.
calcic horizon 33 to 56
gypsic horizon 56 to 180 cm

Country:
State: Texas
County: Reeves
MLRA: 42 -- Southern Desertic Basins, Plains, and Mountains
Soil Survey Area: TX389 -- Reeves County, Texas
Map Unit:
Quad Name:
Location Description: S 1.6 miles of US Highway 80 on TX Highway 17; thence 0.25 miles E.
Legal Description:
Lat: 31 degrees 23 minutes 37.00 seconds N
Lon: 103 degrees 31 minutes 6.00 seconds W
Datum:
UTM Zone:
UTM Easting:
UTM Northing:

Primary Earth Cover:
Secondary Earth Cover:
Existing Vegetation: alkali sacaton, mesquite, plains bristlegrass, tarbush
Parent Material:
Bedrock Kind:
Bedrock Depth:
Bedrock Hardness:
Bedrock Fracture Interval:
Surface Fragments:
Description database: NSSL

A1--0 to 3 centimeters; light gray (10YR 7/2) loam, brown (10YR 5/3), moist; platy structure; very friable, slightly hard; strong effervescence; abrupt boundary. Lab sample # 40A01263

A2--3 to 5 centimeters; light gray (10YR 7/2) clay loam, brown (10YR 5/3), moist; weak medium platy structure; very friable, slightly hard; strong effervescence; clear boundary. Lab sample # 40A01264

A3--5 to 13 centimeters; light gray (10YR 7/2) clay loam, brown (10YR 5/3), moist; weak fine subangular blocky structure; friable, hard; strong effervescence; gradual boundary. Lab sample # 40A01265

Bk1--13 to 33 centimeters; pink (7.5YR 7/3) clay loam, brown (7.5YR 5/4), moist; weak fine and medium subangular blocky structure; friable, hard; 1 percent carbonate threads; strong effervescence; diffuse boundary. Lab sample # 40A01266

Bk2--33 to 56 centimeters; pink (7.5YR 7/4) clay loam, light brown (7.5YR 6/4), moist; weak fine subangular blocky structure; friable, hard; 1 percent carbonate threads; strong effervescence; abrupt wavy boundary. Lab sample # 40A01267. Boundary varies from 46 to 66 centimeters below the surface. Carbonate and gypsum were removed to obtain the results reported for sample 40A1268.

Byy1--56 to 84 centimeters; very pale brown (10YR 8/3) clay, very pale brown (10YR 7/3), moist; friable, very hard, weakly cemented*; brittle; diffuse boundary. Lab sample # 40A01269

Byy2--84 to 117 centimeters; very pale brown (10YR 8/3) silty clay loam, very pale brown (10YR 7/3), moist; friable, very hard, weakly cemented*; brittle; gradual boundary. Lab sample # 40A01270

Byy3--117 to 140 centimeters; light gray (10YR 7/2) silty clay, grayish brown (10YR 5/2), moist; friable, very hard, weakly cemented*; brittle; gradual boundary. Lab sample # 40A01271. Similar to above horizon, but contains less $CaCO_3$ and probably more fine earth.

Byy4--140 to 178 centimeters; very pale brown (10YR 7/3) silty clay, brown (10YR 5/3), moist; friable, very hard, weakly cemented*; brittle. Lab sample # 40A01272

Reeves S61-TX389-003

PSDA & Rock Fragments

		(- - - - - - - Total - - - - - -)			Clay	(- - - - Silt - - - -)		(- - - - - - - - - - - - - - Sand - - - - - - - - - - - - -)					(Rock Fragments (mm))				
		Clay	Silt	Sand	CO3	Fine	Coarse	VF	F	M	C	VC	(- - - - - - - - - Weight - - - - - - - - -)				>2 mm
		<	0.002	0.05	<	0.002	0.02	0.05	0.1	0.25	0.5	1	2	5	20	.1-	wt %
	Depth	0.002	-0.05	-2	0.002	-0.02	-0.05	-0.1	-0.25	-0.5	-1	-2	-5	-20	-75	75	whole
Horz	(cm)	(- % of <2mm Mineral Soil -)											(- - - - - - - % of <75mm - - - - - - -)				soil
A1	0-1	25.6	43.4	31.0	2.0	23.0	20.4	20.5	7.8	2.3	0.4	tr	--	--	--	11	--
A2	1-5	29.9	41.8	28.3	3.0	25.1	16.7	17.5	7.5	2.5	0.8	--	--	--	--	11	--
A3	5-13	29.2	42.2	28.6	3.0	25.6	16.6	17.8	7.5	2.6	0.7	--	--	--	--	11	--
Bk1	13-33	34.7	39.8	25.5	4.0	25.6	14.2	16.4	6.7	2.0	0.4	--	--	--	--	9	--
Bk2	33-56	38.3	40.1	21.6	8.0	25.9	14.2	14.5	5.2	1.5	0.4	--	--	--	--	7	--
Byy1	56-84	49.8	30.2	20.0		14.7	15.5	17.1	2.7	0.2	tr	--	--	--	--	3	--
Byy2	84-115	39.3	50.4	10.3		21.4	29.0	10.0	0.3	tr	tr	--	--	--	--	tr	--
Byy3	115-140	44.2	40.5	15.3		22.9	17.6	11.9	2.6	0.6	0.2	--	--	--	--	3	--
Byy4	140-180	42.8	42.8	14.4		23.9	18.9	11.7	2.2	0.4	0.1	--	--	--	--	3	--
Bk2*	33-56	41.1	34.3	24.6		20.1	14.2	16.8	5.5	1.8	0.5	tr	--	--	--	8	--

* Carbonates and gypsum removed prior to analysis

Reeves S61-TX389-003

Bulk Density & Moisture

Horz	Depth (cm)	(Bulk Density) 33 kPa (- g cm^{-3} -)	Oven Dry	Cole Whole Soil	Water Content 33 kPa % of < 2mm	1500 kPa	Ratio AD/OD	WRD Whole Soil cm^{3} cm^{-3}	(Ratio/Clay) CEC7	1500 kPa
A1	0-1					11.3	1.029		0.73	0.44
A2	1-5					12.2	1.032		0.68	0.41
A3	5-13		1.45		19.8	12.8	1.031	0.10	0.68	0.44
Bk1	13-33					13.4	1.033		0.55	0.39
Bk2	33-56		1.33		23.1	13.6		0.14	0.48	0.36
Byy1	56-84		1.36		18.0	5.0	1.178	0.19	0.11	0.10
Byy2	84-115					6.0	1.180		0.12	0.15
Byy3	115-140					10.0	1.124		0.19	0.23
Byy4	140-180					10.0	1.143		0.19	0.23
Bk2*	33-56						1.036			

* Carbonates and gypsum removed prior to analysis

Reeves S61-TX389-003

pH & Carbonates

		(- - - - - -	- - - pH - - -	- - - - - -	- - - - - -	- - - - - -	- - - - -)	(Carbonate)		(Gypsum)		
			$CaCl_2$					As $CaCO_3$		As $CaSO_4*2H_2O$		Resist
	Depth		0.01M	H_2O	Sat			<2mm	<20mm	<2mm	<20mm	ohms
Horz	(cm)	KCl	1:2	1:1	Paste	Sulf	NaF	(- - - - - -	- - % - -	- - - - - -	- - - -)	cm^{-1}
A1	0-1			7.9	7.3			12		--		
A2	1-5			7.9	7.6			12		--		
A3	5-13			7.9	7.5			12		--		
Bk1	13-33			7.8	7.4			19		--		
Bk2	33-56			7.4	7.3			26		--		
Byy1	56-84			7.6	7.2			10		68		
Byy2	84-115			7.7	7.5			8		68		
Byy3	115-140			7.8	7.6			14		47		
Byy4	140-180			7.9	7.7			11		52		

Reeves S61-TX389-003

Carbon & Extractions

		(- - - - - Total - - - - -)			Org	C/N
	Depth	C	N	S	C	Ratio
Horz	(cm)	(- - - - - - % of <2 mm - - - - - -)				
A1	0-1	2.50	0.112	0.02	1.27	11
A2	1-5	2.33	0.094	0.05	0.96	10
A3	5-13	2.26	0.088	0.05	0.93	11
Bk1	13-33	2.83	0.066	0.08	0.63	10
Bk2	33-56		0.068		0.63	9
Byy1	56-84	1.42	0.025	12.11	0.26	10
Byy2	84-115	1.14		12.68	0.14	
Byy3	115-140	1.83		8.93	0.16	
Byy4	140-180	1.46		9.75	0.18	
Bk2*	33-56	3.47		0.17		

* Carbonates and gypsum removed prior to analysis

Reeves S61-TX389-003

CEC & Bases

						CEC7	- - - - Base - - - -		
		(- NH4OAC Extr Bases -)				NH_4	(Saturation)		Exch
	Depth	Ca	Mg	Na	K	OAC	Sum	NH_4OAC	Na
Horz	(cm)	(- - - - - - cmol(+) kg-1 - - - - - - - -)					(- - - - - - - % - - - - - -)		
A1	0-1	17.7*	2.1	0.1	2.2	18.8	100	100	1
A2	1-5	20.0*	2.8	0.9	3.5	20.4	100	100	3
A3	5-13	18.2*	3.2	1.1	3.2	20.0	100	100	4
Bk1	13-33	18.1*	3.0	3.6	3.2	19.2	100	100	10
Bk2	33-56		3.5	5.1	3.1	18.3	100		8
Byy1	56-84			1.7	0.7	5.7	100		30
Byy2	84-115			2.7	0.5	4.8	100		2
Byy3	115-140			3.8	0.8	8.4	100		6
Byy4	140-180			5.3	0.6	8.1	100		8

*Extractable Ca may contain Ca from calcium carbonate or gypsum. CEC7 base saturation set to 100.

Reeves S61-TX389-003

Salt

Horz	Depth (cm)	Ca	Mg	Na	K	CO_3	HCO_3	F	Cl	SO_4	NO_2	NO_3	H_2O	Total Salts	Elec Cond	Pred Elec Cond	SAR
		(- - - - - - - - - - -- - - - - - - Water Extracted From Saturated Paste										- - - - - - - - - - - - - - - - - - - -)					
		(- - - - - mmol(+) L-1 - -- - -)				(- - - - - - - - - - - - - - - mmol(-) L-1 - - - - - - - - - - - - - - -)							(- - - - % - - - -)		(- dS m-1 -)		
A1	0-1			1.0	1.7								33.0	0.1	2.5		
A2	1-5			9.0	3.3								32.9	0.1	3.8		
A3	5-13			10.6	3.2	--	3.3		5.4	36.0			34.2	0.1	4.0		
Bk1	13-33			41.8	4.4	--	2.5		62.5	37.4			42.0	0.3	9.2		
Bk2	33-56			77.0	13.0	--	1.5		256.0	22.5			47.1	0.1	29.1		
Byy1	56-84			49.2	5.0	--	2.0		198.0	22.3			38.0	0.7	21.3		
Byy2	84-115			68.2	3.6	--	1.5		153.0	33.7			38.0	0.5	17.4		
Byy3	115-140			76.4	2.8	--	2.0		135.0	46.1			43.0	0.6	16.6		
Byy4	140-180			104.0	2.0	--	1.5		186.0	52.6			45.0	0.8	21.3		

PEDON DESCRIPTION

Print Date: 07/15/2008
Description Date: 01/01/1978
Describer:
Site ID: S78-TX389-003
Site Note:
Pedon ID: S78-TX389-003
Pedon Note:
Lab Source ID: SSL
Lab Pedon #: 79P0142
Soil Name as Described/Sampled: Saragosa
Soil Name as Correlated: Saragosa
Classification: Fine-silty, gypsic, thermic Typic Aquisalids
Pedon Type:
Pedon Purpose: full pedon description
Taxon Kind: series
Associated Soils:
Physiographic Division:
Physiographic Province:
Physiographic Section:
State Physiographic Area:
Local Physiographic Area:
Geomorphic Setting: None Assigned
Upslope Shape:
Cross Slope Shape:
Particle Size Control Section: 25 to 100 cm.
Description origin: Converted from SSL-CMS data
Diagnostic Features: ochric epipedon 0 to 28 cm.
salic horizon 0 to 71 cm.
gypsic horizon 0 to 127 cm.
calcic horizon 28 to 71 cm.

Country:
State: Texas
County: Reeves
MLRA:
Soil Survey Area:
Map Unit:
Quad Name:
Location Description: From E bound junction of I-20 and US285 south of Pecos, 2.1 km S on 285, 1 km W on dirt rd 15 meters N in range.
Legal Description:
Lat: 31 degrees 23 minutes 7.00 seconds N
Lon: 103 degrees 28 minutes 39.00 seconds W
Datum:
UTM Zone:
UTM Easting:
UTM Northing:
Primary Earth Cover:
Secondary Earth Cover:
Existing Vegetation:
Parent Material:
Bedrock Kind:
Bedrock Depth:
Bedrock Hardness:
Bedrock Fracture Interval:
Surface Fragments:
Description database: NSSL

Ayyz1--0 to 5 centimeters; pale brown (10YR 6/3) silt loam, brown (10YR 5/3), moist; common medium distinct dark gray (10YR 4/1) and common medium distinct brownish yellow (10YR 6/6) and common medium distinct very pale brown (10YR 8/4) mottles; weak fine platy structure; friable, soft; few fine and medium roots; moderately alkaline, pH 8.2, Hellige-Truog; abrupt smooth boundary. Lab sample # 79P00695.

Ayyz2--5 to 28 centimeters; light yellowish brown (10YR 6/4) loam, yellowish brown (10YR 5/4), moist; common medium distinct brown (10YR 4/3) and common medium distinct very pale brown (10YR 8/3) mottles; weak medium subangular blocky structure; friable, soft; few fine and medium roots; many fine and medium tubular pores; few salt masses; moderately alkaline, pH 8.2, Hellige-Truog; abrupt wavy boundary. Lab sample # 79P00696.

Byyz--28 to 71 centimeters; very pale brown (10YR 8/2) silt loam; common fine distinct light yellowish brown (10YR 6/4) and common fine distinct brownish yellow (10YR 6/6) mottles; massive; friable, slightly hard; few fine and medium roots; common fine tubular pores; few salt masses; few old root channels filled with Az2 soil material; moderately alkaline, pH 8.2, Hellige-Truog; clear wavy boundary. Lab sample # 79P00697.

Byy1--71 to 89 centimeters; very pale brown (10YR 8/3) silt loam, very pale brown (10YR 7/4) interior, moist; massive; firm, hard; few salt masses; Few old root channels 1.3 cm wide filled with Az2 material; moderately alkaline, pH 8.2, Hellige-Truog; clear smooth boundary. Lab sample # 79P00698.

Byy2--89 to 127 centimeters; very pale brown (10YR 7/4) silt loam, light yellowish brown (10YR 6/4) interior, moist; few coarse distinct light olive gray (5Y 6/2) mottles; massive; firm, very hard; few salt masses. Lab sample # 79P00699.

Saragosa S83-TX109-003

PSDA & Rock Fragments

		(- - - - - - - Total - - - - - -)			Clay	(- - - - Silt - - - -)		(- - - - - - - - - - - - - - Sand - - - - - - - - - - - -)					(Rock Fragments (mm))				
		Clay	Silt	Sand	CO3	Fine	Coarse	VF	F	M	C	VC	(- - - - - - - - - Weight - - - - - - - - -)				>2 mm
		<	0.002	0.05	<	0.002	0.02	0.05	0.1	0.25	0.5	1	2	5	20	.1-	wt %
	Depth	0.002	-0.05	-2	0.002	-0.02	-0.05	-0.1	-0.25	-0.5	-1	-2	-5	-20	-75	75	whole
Horz	(cm)	(- % of <2mm Mineral Soil -)											(- - - - - - - % of <75mm - - - - - - -)				soil
Ayyz1	0-5												tr	--	--		
Ayyz2	5-28	32.3	49.4	18.3		34.8	14.6	16.0	2.0	0.3	--	--	tr	--	--	2	--
Byyz	28-71	70.4	26.3	3.3		26.3	--	2.6	0.4	0.2	0.1	--	--	--	--	1	--
Byy1	71-89	80.3	17.0	2.7		17.0	--	2.1	0.3	0.3	--	--	--	--	--	1	--
Byy2	89-127	71.9	26.4	1.7		26.3	0.1	1.4	0.2	0.1	--	--	--	--	--	tr	--

Bulk Density & Moisture

		(Bulk Density)		Cole	Water Content			WRD		
		33	Oven	Whole	33	1500	Ratio	Whole	(Ratio/Clay)	
		kPa	Dry	Soil	kPa	kPa	AD/OD	Soil	CEC7	1500 kPa
		(- g cm^{-3} -)			% of < 2mm			cm^3 cm^{-3}		
Ayyz1	0-5					8.0	1.185			
Ayyz2	5-28					9.2	1.186		0.18	0.28
Byyz	28-71					12.1	1.201		0.06	0.17
Byy1	71-89					9.9	1.225		0.07	0.12
Byy2	89-127					13.1	1.196		0.14	0.18

Saragosa S83-TX109-003

pH & Carbonates

Horz	Depth (cm)	KCl	pH: $CaCl_2$ 0.01M 1:2	pH: H_2O 1:1	pH: Sat Paste	Sulf	NaF	Carbonate As $CaCO_3$ <2mm (%)	Carbonate As $CaCO_3$ <20mm (%)	Gypsum As $CaSO_4*2H_2O$ <2mm (%)	Gypsum As $CaSO_4*2H_2O$ <20mm (%)	Resist ohms cm^{-1}
Ayyz1	0-5		8.7	8.6	7.8			2		62		
Ayyz2	5-28		7.9	7.9	7.2			tr		61		
Byyz	28-71		8.1	8.1	7.6			10		62		
Byy1	71-89		8.0	8.0	7.6			1		71		
Byy2	89-127		8.0	8.0	7.5			4		60		380

Carbon & Extractions

Horz	Depth (cm)	Total C (% of <2 mm)	Total N (% of <2 mm)	Total S (% of <2 mm)	Org C (% of <2 mm)	C/N Ratio
Ayyz1	0-5	0.57	0.01	13.91	0.70	
Ayyz2	5-28	0.37	--	13.63	0.49	
Byyz	28-71	1.40	--	15.39	0.15	
Byy1	71-89	0.21	--	16.83	0.09	
Byy2	89-127	0.53	--	14.77	0.08	

Saragosa S83-TX109-003

CEC & Bases

Horz	Depth (cm)	Ca	Mg	Na	K	CEC7 NH4 OAC	Base Saturation Sum	Base Saturation NH4OAC	Exch Na
		(- - - NH4OAC Extr Bases - - -)					(- - - - Base - - - -)		
		(- - - - - - cmol(+) kg-1 - - - - - - - -)					(- - - - - - - % - - - - - -)		
Ayyz1	0-5		54.7	102.6	2.7	4.3			
Ayyz2	5-28		15.7	25.3	0.9	5.7	100		444
Byyz	28-71		14.2	7.1	0.4	4.3	100		165
Byy1	71-89		4.1	3.8	0.3	5.8	100		66
Byy2	89-127		5.3	4.5	0.8	10.0	100		7

Salt

(- - - - - - - - - - - - - - - - - - Water Extracted From Saturated Paste -)

Horz	Depth (cm)	Ca	Mg	Na	K	CO_3	HCO_3	F	Cl	SO_4	NO_2	NO_3	H_2O	Total Salts	Elec Cond	Pred Elec Cond	SAR
		(- - - - - mmol(+) L-1 - -- - -)				(- - - - - - - - - - - - - - - mmol(-) L-1 - - - - - - - - - - - - - - -)							(- - - - % - - - -)		(- dS m-1 -)		
Ayyz1	0-5	54.6	713.3	1812.8	36.8	--	1.5	--	2468.3	213.1	--	--	51.8		91.40		
Ayyz2	5-28	67.4	161.5	544.3	11.7	--	1.9	--	698.1	90.7	--	--	57.1	2.4	45.90		51
Byyz	28-71	42.3	27.2	99.5	2.3	--	1.0	--	105.6	65.1	--	--	72.1	0.7	12.00		17
Byy1	71-89	37.2	17.3	57.7	1.6	--	1.2	--	55.4	55.9	--	1.0	66.0	0.4	8.02		11
Byy2	89-127	32.4	17.5	56.0	1.8	--	1.4	--	47.0	60.6	--	--	67.7	0.4	8.15		11

PEDON DESCRIPTION

Print Date: 09/08/2008
Description Date: 01/09/2008
Describer: Philip Schoeneberger, Doug Wysocki, and Lynn Loomis
Site ID: 31104-F4-005
Site Note:
Pedon ID: S08-TX109-005
Pedon Note:
Lab Source ID: SSL
Lab Pedon #: 08N0264
Soil Name as Described/Sampled: Elcor
Soil Name as Correlated:
Classification: Loamy, gypsic, thermic Lithic Torriorthents
Pedon Type:
Pedon Purpose:
Taxon Kind:
Associated Soils:
Physiographic Division:
Physiographic Province:
Physiographic Section:
State Physiographic Area:
Local Physiographic Area:
Geomorphic Setting: on shoulder of None Assigned
Upslope Shape: linear
Cross Slope Shape: concave
Particle Size Control Section: 0 to 18 cm.
Description origin: PedonPC

Country:
State: Texas
County: Culberson
MLRA: 42 -- Southern Desertic Basins, Plains, and Mountains
Soil Survey Area:
Map Unit:
Quad Name:
Location Description:
Legal Description:
Lat: 31 degrees 40 minutes 16.28 seconds N
Lon: 104 degrees 26 minutes 0.53 seconds W
Datum: NAD83
UTM Zone: 13
UTM Easting: 553749 meters
UTM Northing: 3503930 meters
Primary Earth Cover:
Secondary Earth Cover:
Existing Vegetation:
Parent Material: slightly weathered residuum weathered from gyprock
Bedrock Kind: gyprock
Bedrock Depth: 18 centimeters
Bedrock Hardness: indurated
Bedrock Fracture Interval: 10 to less than 45 centimeters
Surface Fragments:
Description database: NSSL

Diagnostic Features: ochric epipedon 1 to 7 cm.
lithic contact 18 cm.

Top Depth (cm)	Bottom Depth (cm)	Restriction Kind	Restriction Hardness
18		bedrock, lithic	indurated

Oyy--0 to 1 centimeters; grayish brown (10YR 5/2), 60 percent black (10YR 2/1) and 40 percent very dark gray (10YR 3/1), moist; structureless massive; moderate; slight effervescence, by HCl, 1 normal; abrupt wavy boundary. Lab sample # 08N01673

Ayy--1 to 7 centimeters; light gray (10YR 7/2) gypsiferous material, yellowish brown (10YR 5/6), moist; 70 percent sand; 22 percent silt; 8 percent clay; weak very fine subangular blocky structure; very friable, slightly hard, nonsticky, nonplastic; common fine roots throughout and common very fine roots throughout; slight effervescence, by HCl, 1 normal; clear broken boundary. Lab sample # 08N01674

Cyy--7 to 18 centimeters; very pale brown (10YR 8/3) cemented material, very pale brown (10YR 7/3), moist; structureless massive; weakly cemented; very few roots; very slight effervescence, by HCl, 1 normal; clear irregular boundary. Lab sample # 08N01675

Byy--7 to 18 centimeters; white (10YR 8/1) gypseous material, very pale brown (10YR 7/3), moist; structureless massive; strongly cemented; high excavation difficulty; very few roots; noneffervescent, by HCl, 1 normal; clear irregular boundary. Lab sample # 08N01675

R--18 centimeters; white (10YR 8/1) bedrock, white (10YR 8/1), moist; structureless massive; indurated; extremely high excavation difficulty; very few roots top of horizon; very slight effervescence, by HCl, 1 normal. Lab sample # 08N01676

Elcor S08-TX109-005

PSDA & Rock Fragments

		(- - - - - - - Total	- - - - - -	-)	Clay	(- - - - Silt	- - - -)	(- - - - - - - - - - - - - -	- - - Sand - - -	- - - - - - - -	- - - - -	-)	(Rock Fragments	(mm))			
		Clay	Silt	Sand	CO3	Fine	Coarse	VF	F	M	C	VC	(- - - - - - - - -	- - - Weight	- - - - - -	- - -)	>2 mm
		<	0.002	0.05	<	0.002	0.02	0.05	0.1	0.25	0.5	1	2	5	20	.1-	wt %
	Depth	0.002	-0.05	-2	0.002	-0.02	-0.05	-0.1	-0.25	-0.5	-1	-2	-5	-20	-75	75	whole
Horz	(cm)	(- - - - - - - - - - - -	- - - - - - - - - - - -	- - - - - - % of	<2mm Mineral Soil	- - - - - -	- - - - - -	- - - - - -	- - - - - -	- - - - - -	- - - - - -	-)	(- - - - - - -	% of <75mm	- - - - - -	-)	soil
Oyy	0-1												2	--	--	--	2
Ayy	1-7	13.7	48.0	38.3	--	12.7	35.3	33.9	3.5	0.4	0.4	0.1	1	--	--	5	1
Cyy/Byy	7-18	20.5	40.5	39.0	6.8	6.2	34.3	33.0	4.0	1.6	0.4	--	5	1	35	45	41
R	18	17.0	41.9	41.1	--	17.2	24.7	34.6	6.0	0.3	0.2	tr					

Bulk Density & Moisture

		(Bulk Density)		Cole	Water Content			WRD		
		33	Oven	Whole	33	1500	Ratio	Whole	(Ratio/Clay)	
		kPa	Dry	Soil	kPa	kPa	AD/OD	Soil	CEC7	1500 kPa
		(- g cm^{-3} -)			% of < 2mm			cm^3 cm^{-3}		
Oyy	0-1					14.1	1.071			
Ayy	1-7					4.3	1.173		0.28	0.31
Cyy/Byy	7-18					3.7	1.208		0.07	0.18
R	18					25.1				

Elcor S08-TX109-005

pH & Carbonates

Horz	Depth (cm)	pH KCl	pH $CaCl_2$ 0.01M 1:2	pH H_2O 1:1	pH Sat Paste	pH Sulf	pH NaF	Carbonate As $CaCO_3$ <2mm (%)	Carbonate As $CaCO_3$ <20mm (%)	Gypsum As $CaSO_4$*$2H_2O$ <2mm (%)	Gypsum As $CaSO_4$*$2H_2O$ <20mm (%)	Resist ohms cm^{-1}
Oyy	0-1	7.6	7.6					16				
Ayy	1-7	7.9	8.0	7.8				7		67		
Cyy/Byy	7-18	7.8	8.0					5		81		
R	18	8.0	8.0	8.0				4		64		

Carbon & Extractions

Horz	Depth (cm)	Total C (% of <2 mm)	Total N (% of <2 mm)	Total S (% of <2 mm)	Org C (% of <2 mm)	C/N Ratio
Oyy	0-1	4.09	0.254	4.81		9
Ayy	1-7	1.05	0.236	14.80		1
Cyy/Byy	7-18	0.66	0.036	16.95		2
R	18	0.37	--	17.39		

Elcor S08-TX109-005

CEC & Bases

Horz	Depth (cm)	(- NH4OAC Extr Bases -) Ca	Mg	Na	K	CEC7 NH_4 OAC	- - - - Base - - - - (Saturation) Sum	NH_4OAC	Exch Na
		(- - - - - - cmol(+) kg-1			- - - - - - - -)		(- - - - - - - %	- - - - - -)	
Ayy	1-7	318.4*	0.1	--	0.2	3.9		100	
Cyy/Byy	7-18	291.2*	0.1	--	0.1	1.5		100	
R	18	51.7*	12.4	--	--	0.3	99	100	

Salt

(- - - - - - - - - - -- - - - - - - Water Extracted From Saturated Paste - - - - - - - - - - - - - - - - - - -)

Horz	Depth (cm)	Ca	Mg	Na	K	CO_3	HCO_3	F	Cl	SO_4	NO_2	NO_3	H_2O	Total Salts	Elec Cond	Pred Elec Cond	SAR
		(- - - - - mmol(+) L-1			- -- - -)	(- - - - - - - - - - - - - - - mmol(-) L-1						- - - - - - - - - - - - - - -)	(- - - - %	- - - -)	(- dS m-1 -)		
Ayy	1-7	27.2	0.1	0.2	--	--	0.9	0.1	0.2	28.2	--	0.1	58.7	0.1	2.16	2.09	--
Cyy/Byy	7-18															2.13	
R	18	26.9	1.4	0.7	0.1	--	0.4	--	0.4	28.3	--	0.1	46.1		2.19	2.21	

PEDON DESCRIPTION

Print Date: 07/15/2008	**Country:**
Description Date: 09/01/1983	**State:** Texas
Describer: J. Rives and J. Williams	**County:** Culberson
Site ID: S83-TX109-001	**MLRA:** 42 -- Southern Desertic Basins, Plains, and Mountains
Site Note:	**Soil Survey Area:**
Pedon ID: S83-TX109-001	**Map Unit:**
Pedon Note: Soil formed in gypsum beds of Castille Fm Permian. Range site - Gyp.	**Quad Name:**
Lab Source ID: SSL	**Location Description:** Culberson County, TX. Ranch road 652 about 30 mi W of Orla TX.
Lab Pedon #: 83P0884	**Legal Description:**
Soil Name as Described/Sampled: Holloman	**Lat:** 31 degrees 53 minutes 0.00 seconds N
Soil Name as Correlated: Holloman	**Lon:** 104 degrees 19 minutes 34.00 seconds W
Classification: Loamy, gypsic, thermic, shallow Typic Torriorthents	**Datum:**
Pedon Type:	**UTM Zone:**
Pedon Purpose: full pedon description	**UTM Easting:**
Taxon Kind: series	**UTM Northing:**
Associated Soils:	
Physiographic Division:	**Primary Earth Cover:**
Physiographic Province:	**Secondary Earth Cover:**
Physiographic Section:	**Existing Vegetation:**
State Physiographic Area:	**Parent Material:**
Local Physiographic Area:	**Bedrock Kind:**
Geomorphic Setting: upland slope intermontane basin	**Bedrock Depth:**
Upslope Shape:	**Bedrock Hardness:**
Cross Slope Shape:	**Bedrock Fracture Interval:**
Particle Size Control Section: 25 to 47 cm.	**Surface Fragments:**
Description origin: Converted from SSL-CMS data	**Description database:** NSSL
Diagnostic Features: ochric epipedon 0 to 2 cm.	

A --- 0 to 2 centimeters; light brownish gray (10YR 6/2) dry, silt loam, dark grayish brown (10YR 4/2) moist, interior; very friable, slightly hard; many fine tubular and many very fine tubular pores; strongly effervescent; abrupt smooth boundary; Lab sample # 83P4505.

Byy --- 2 to 15 centimeters; very pale brown (10YR 8/3), silt loam, very pale brown (10YR 7/3) moist, interior; weak fine subangular blocky structure; friable, slightly hard; common fine roots; many very fine tubular pores; slightly effervescent; Water perched on underlying horizon thought to remove gypsum laterally.; common fine roots; clear smooth boundary; Lab sample # 83P4506.

Byym --- 15 to 29 centimeters; very pale brown (10YR 8/1), loam, very pale brown (10YR 8/2) moist, interior; friable, hard; common very fine tubular pores; slightly effervescent; clear wavy boundary; Lab sample # 83P4507.

Cr --- 29 to 47 centimeters; very pale brown (10YR 8/1) and very pale brown (10YR 8/3), weathered bedrock, very pale brown (10YR 7/4), moist; extremely hard; slightly effervescent; Hard; Lab sample # 83P4508.

Byy --- 29 to 47 centimeters; very pale brown (10YR 8/1) dry, very fine sandy loam, very pale brown (10YR 7/3) moist; very friable, soft; slightly effervescent; abrupt wavy boundary; Lab sample # 83P4508.

R --- 47 to 91 centimeters; very pale brown (10YR 8/1) dry, bedrock. Lab sample #83P04509

Hollebeke S83-TX109-001

PSDA & Rock Fragments

		(- - - - - - - Total	- - - - - - -)		Clay	(- - - - Silt	- - - -)	(- - - - - - - - - - - - - - Sand				- - - - - - - - - - - -)	(Rock Fragments (mm))				
		Clay	Silt	Sand	CO3	Fine	Coarse	VF	F	M	C	VC	(- - - - - - - - - Weight			- - - - - - - - -)	>2 mm
		<	0.002	0.05	<	0.002	0.02	0.05	0.1	0.25	0.5	1	2	5	20	.1-	wt %
	Depth	0.002	-0.05	-2	0.002	-0.02	-0.05	-0.1	-0.25	-0.5	-1	-2	-5	-20	-75	75	whole
Horz	(cm)	(- % of <2mm Mineral Soil										- -)	(- - - - - - - % of <75mm			- - - - - - -)	soil
A	0-2	6.3	46.1	47.6	1.4	18.8	27.3	14.3	21.9	6.8	3.1	1.5	--	--	--	33	--
Byy	2-15	6.8	54.0	39.2		21.5	32.5	17.3	14.9	5.3	1.5	0.2	tr	1	--	23	1
Byym	15-29	6.0	52.4	41.6		30.0	22.4	14.4	14.5	8.4	3.7	0.6	--	--	--	27	--
Byy/Cr	29-47	5.8	47.2	47.0		17.9	29.3	16.0	15.5	9.6	4.4	1.5	--	--	--	31	--
R	47-90	3.8	43.3	52.9		21.1	22.2	9.5	11.1	9.2	10.9	12.2	--	--	--	43	--
A	0-10	4.6	53.1	42.3	1.8	36.8	16.3	23.2	12.1	5.0	1.6	0.4	1	tr	--	20	1

Bulk Density & Moisture

		(Bulk Density)		Cole	Water Content			WRD		
		33	Oven	Whole	33	1500	Ratio	Whole	(Ratio/Clay)	
		kPa	Dry	Soil	kPa	kPa	AD/OD	Soil	CEC7	1500 kPa
		(- g cm^{-3} -)			% of < 2mm			cm^3 cm^{-3}		
A	0-2	1.09	1.09	--	28.3	9.9	1.174	0.20	0.54	1.57
Byy	2-15	1.08	1.08	--	14.6	10.7	1.230	0.04	0.19	1.57
Byym	15-29	1.37	1.37	--	18.3	11.5	1.228	0.09	0.17	1.92
Byy/Cr	29-47	1.49	1.49	--	13.3	10.4	1.235	0.04	0.07	1.79
R	47-90	1.79	1.79	--	21.6	10.6	1.234	0.20	0.11	2.79
A	0-10					10.4	1.161		0.85	2.26

Hollebeke S83-TX109-001

pH & Carbonates

		(- - - - - -	pH - - - - - -	- - - - - -)				(Carbonate)		(Gypsum)		
			$CaCl_2$					As $CaCO_3$		As $CaSO_4$*$2H_2O$		Resist
	Depth		0.01M	H_2O	Sat			<2mm	<20mm	<2mm	<20mm	ohms
Horz	(cm)	KCl	1:2	1:1	Paste	Sulf	NaF	(- - - - - - - - - -	%	- - - - - - - - - -)		cm^{-1}
A	0-2	7.3	7.0	7.5	7.5			3		55		
Byy	2-15	7.1	6.7	7.5	7.4			1		60		
Byym	15-29	7.5	6.7	7.6	7.5			1		61		
Byy/Cr	29-47	7.5	6.9	7.2	7.5			2		63		
R	47-90	7.4	6.8	7.5	7.6			2		62		3000
A	0-10	7.7	7.2	7.8	7.7			4		52		

Carbon & Extractions

		(- - - - -	Total	- - - - -)	Org	C/N
	Depth	C	N	S	C	Ratio
Horz	(cm)	(- - - - - -	% of <2 mm	- - - - - -)		
A	0-2	0.82	0.067	14.29	0.67	10
Byy	2-15	0.47	0.044	18.09	0.42	10
Byym	15-29	0.35	0.050	16.88	0.35	7
r	29-47	0.71		15.38	0.15	
R	47-90	0.33		18.06	0.09	
A	0-10	1.77	0.114	13.77	1.37	12

Hollebeke S83-TX109-001

CEC & Bases

Horz	Depth (cm)	(- NH4OAC Extr Bases -) Ca	Mg	Na	K	CEC7 NH_4 OAC	---- Base ---- (Saturation) Sum	NH_4OAC	Exch Na
		(------ cmol(+) kg-1 --------)					(------- % ------)		
A	0-2	247.0*	0.1	tr	0.1	3.4	100	100	--
Byy	2-15	267.0*	0.1	tr	tr	1.3	100	100	--
Byym	15-29	269.7*	0.1	tr	tr	1.0	100	100	--
Byy/Cr	29-47	283.9*	0.1	0.1	--	0.4	100	100	18
R	47-90	289.0*	0.1	tr	--	0.4	100	100	--
A	0-10	306.5*	2.5	tr	0.2	3.9	100	100	--

Salt

(------------------ Water Extracted From Saturated Paste -------------------)

Horz	Depth (cm)	Ca	Mg	Na	K	CO_3	HCO_3	F	Cl	SO_4	NO_2	NO_3	H_2O	Total Salts	Elec Cond	Pred Elec Cond	SAR
		(----- mmol(+) L-1 -----)				(--------------- mmol(-) L-1 ---------------)							(---- % ----)		(- dS m-1 -)		
A	0-2	34.1	0.3	0.1	0.2	--	3.0	0.4	1.3	30.0	0.5	--	63.5	0.1	2.40	2.30	--
Byy	2-15	31.3	0.2	0.1	0.1	--	1.6	0.5	1.2	30.8	0.5	tr	67.5	0.1	2.34	2.27	--
Byym	15-29	31.0	0.2	0.2	0.2	--	1.3	0.4	1.2	30.3	0.4	0.2	59.5	0.1	2.32	2.28	tr
Byy/Cr	29-47	31.2	0.9	0.5	0.1	--	1.5	0.4	1.3	31.1	--	--	52.4	0.1	2.42	2.33	tr
R	47-90	29.9	1.1	0.7	0.2	--	0.8	0.5	1.5	31.2	--	0.3	45.6	0.1	2.42	2.26	tr
A	0-10	33.3	5.9	0.6	0.7	--	5.2	0.9	2.6	35.5	1.1	--	71.0	0.1	2.91	2.53	tr

PEDON DESCRIPTION

Print Date: 07/15/2008

Description Date: 10/23/2006

Describer: Lynn Loomis, Wayne Hudnall, Philip Schoeneberger, Arlene Tugel, Greg Cates

Site ID: 31104-H4-902

Site Note:

Pedon ID: S06-TX109-902

Pedon Note:

Lab Source ID: SSL

Lab Pedon #: 07N0078

Soil Name as Described/Sampled: Pokorny

Soil Name as Correlated:

Classification: Gypsic, thermic Ustic Petrogypsids

Pedon Type:

Pedon Purpose:

Taxon Kind:

Associated Soils:

Physiographic Division:

Physiographic Province:

Physiographic Section:

State Physiographic Area:

Local Physiographic Area:

Geomorphic Setting: on tread

Upslope Shape: linear

Cross Slope Shape: linear

Particle Size Control Section: 25 to 42 cm.

Description origin: PedonPC

Country: United States

State: Texas

County: Culberson

MLRA: 42 -- Southern Desertic Basins, Plains, and Mountains

Soil Survey Area:

Map Unit:

Quad Name:

Location Description:

Legal Description:

Lat: 31 degrees 52 minutes 7.20 seconds N

Lon: 104 degrees 19 minutes 50.30 seconds W

Datum: NAD83

UTM Zone: 13

UTM Easting: 563315 meters

UTM Northing: 3526073 meters

Primary Earth Cover:

Secondary Earth Cover:

Existing Vegetation: littleleaf sumac

Parent Material:

Bedrock Kind:

Bedrock Depth:

Bedrock Hardness:

Bedrock Fracture Interval:

Surface Fragments:

Description database: NSSL

Diagnostic Features: ochric epipedon 0 to 3 cm.
gypsic horizon 3 to 42 cm.
petrogypsic horizon 4 to 200 cm.

Top Depth (cm)	Bottom Depth (cm)	Restriction Kind	Restriction Hardness
42	95	petrogypsic	moderately cemented
95	200	petrogypsic	weakly cemented

A --- 0 to 3 centimeters; yellowish brown (10YR 5/4) dry, gypsiferous fine sandy loam, brown (10YR 4/3) moist; weak thin platy structure; extremely weakly cemented, slightly sticky, slightly plastic; low excavation difficulty; common very fine roots throughout; common fine roots throughout; 2 percent (common) very coarse prominent irregular noncemented insects casts with clear boundaries in matrix and 1 percent (few) medium distinct platy moderately cemented masses of carbonate with sharp boundaries along lamina or strata surfaces; strongly effervescent by HCl, 1 normal; clear smooth boundary; Lab sample # 07N00493.

Byy1 --- 3 to 15 centimeters; very pale brown (10YR 8/1) dry, gypsiferous sandy loam, very pale brown (10YR 8/1) moist; moderate medium subangular blocky parting to moderate fine subangular blocky structure; very weakly cemented, slightly sticky, moderately plastic; high excavation difficulty; common very fine roots throughout; common fine roots throughout; common medium roots throughout; slightly effervescent by HCl, 1 normal; gradual smooth boundary; Lab sample # 07N00494.

Byy2 --- 15 to 42 centimeters; very pale brown (10YR 8/1) dry, gypsiferous sandy loam, pale yellow (2.5Y 8/2) moist; moderate coarse prismatic structure; very weakly cemented, very sticky, moderately plastic; brittle; moderate excavation difficulty; common very fine roots in cracks; common fine roots in cracks; common medium roots in cracks; 2 percent (very few) continuous prominent carbonate coats on vertical faces of peds; slightly effervescent by HCl, 1 normal; abrupt smooth boundary; Lab sample # 07N00495.

Byym1 --- 42 to 71 centimeters; very pale brown (10YR 8/3) dry, cemented material, light yellowish brown (10YR 6/4) moist; strong coarse prismatic structure; moderately cemented, moderately sticky, slightly plastic; brittle; very high excavation difficulty; common very fine roots in cracks; common fine roots in cracks; common medium roots in mat at top of horizon; 2 percent (very few) continuous prominent carbonate coats on vertical faces of peds; strongly effervescent by HCl, 1 normal; clear smooth boundary; Lab sample # 07N00496.

Byym2 --- 71 to 95 centimeters; very pale brown (10YR 8/1) dry, cemented material, pale yellow (2.5Y 8/3) moist; strong coarse prismatic structure; moderately cemented, moderately sticky, moderately plastic; brittle; very high excavation difficulty; very few very fine roots in cracks; very few fine roots in cracks; 2 percent (very few) continuous prominent carbonate coats on vertical faces of peds; strongly effervescent by HCl, 1 normal; clear smooth boundary; Lab sample # 07N00497.

Byym3 --- 95 to 132 centimeters; (10YR) dry, cemented material, (2.5Y) moist; strong coarse prismatic structure; weakly cemented, slightly sticky, slightly plastic; brittle; very high excavation difficulty; very few very fine roots in cracks; very few fine roots in cracks; 2 percent (very few) continuous prominent carbonate coats on vertical faces of peds; strongly effervescent by HCl, 1 normal; clear smooth boundary; Lab sample # 07N00498.

Byym4 --- 132 to 200 centimeters; (10YR) dry, cemented material, (2.5Y) moist; strong coarse prismatic structure; weakly cemented, slightly sticky, nonplastic; brittle; very high excavation difficulty; very few very fine roots in cracks; very few fine roots in cracks; 2 percent (very few) continuous prominent carbonate coats on vertical faces of peds; strongly effervescent by HCl, 1 normal; Lab sample # 07N00499.

Pokorny S06-TX109-902

PSDA & Rock Fragments

Horz	Depth (cm)	(- - - - - - - Total - - - - - -) Clay < 0.002	Silt 0.002 -0.05	Sand 0.05 -2	Clay CO3 < 0.002	(- - - - Silt - - - -) Fine 0.002 -0.02	Coarse 0.02 -0.05	(- - - - - - - - - - - - - - Sand - - - - - - - - - - - - -) VF 0.05 -0.1	F 0.1 -0.25	M 0.25 -0.5	C 0.5 -1	VC 1 -2	(Rock Fragments (mm)) (- - - - - - - - - Weight - - - - - - - - -) 2 -5	5 -20	20 -75	.1- 75	>2 mm wt % whole soil
		(- % of <2mm Mineral Soil										- -)	(- - - - - - - % of <75mm - - - - - - -)				
Prep = GP																	
A	0-3	12.3	38.1	49.6	0.7	16.4	21.7	37.3	9.2	2.4	0.6	0.1					
Byy1	3-15	2.3	66.5	31.2	--	24.3	42.2	26.0	2.0	1.7	1.2	0.3					
Byy2	15-42	24.0	62.2	13.8	--	53.6	8.6	7.0	3.9	1.1	0.7	1.1					
Byym1	42-71	16.6	40.2	43.2	--	17.4	22.8	40.4	2.6	0.2	tr	--					
Byym2	71-95	22.8	43.9	33.3	8.4	22.2	21.7	31.2	2.0	0.1	--	--					
Byym3	95-130	12.1	64.3	23.6	--	35.3	29.0	20.6	2.4	0.4	0.2	--					
Byym4	130-185	23.6	59.0	17.4	--	29.1	29.9	16.1	1.1	0.2	--	--					
Prep= S																	
A	0-3	11.9	39.6	48.5	--	16.9	22.7	31.0	14.3	2.5	0.6	0.1	tr	--	--	18	tr
Byy1	3-15	9.7	56.2	34.1	--	28.0	28.2	27.7	4.0	1.6	0.3	0.5	1	tr	--	7	1
Byy2	15-42	37.1	52.2	10.7	--	45.7	6.5	6.8	2.1	1.1	0.7	--	1	2	1	8	4
Byym1	42-71	21.2	46.8	32.0	--	20.7	26.1	29.9	1.8	0.2	0.1	--	4	6	6	18	16
Byym2	71-95	24.1	47.7	28.2	7.3	20.8	26.9	26.2	1.7	0.1	0.2	--	2	3	1	8	6
Byym3	95-130	15.2	59.1	25.7	--	30.5	28.6	21.5	3.2	0.6	0.4	--	2	tr	--	6	2
Byym4	130-185	1.0	85.1	13.9	--	53.5	31.6	13.3	0.3	0.3	--	--	--	--	--	1	--
Krot	95-130	18.6	38.8	42.6	--	13.5	25.3	38.1	4.4	0.1	tr	--	--	--	--	5	--

Pokorny S06-TX109-902

Bulk Density & Moisture

		(Bulk Density)		Cole	Water Content			WRD	(Ratio/Clay)	
		33 kPa	Oven Dry	Whole Soil	33 kPa	1500 kPa	Ratio AD/OD	Whole Soil	CEC7	1500 kPa
		(- g cm^{-3} -)			% of < 2mm			cm^3 cm^{-3}		
Prep = GP										
A	0-3					7.3	1.015			
Byy1	3-15					4.6	1.237			
Byy2	15-42					6.4	1.240			
Byym1	42-71					6.9	1.178			
Byym2	71-95					3.9	1.207			
Byym3	95-130					6.2	1.234			
Byym4	130-185					4.0	1.229			
Prep = S										
A	0-3					7.9	1.015		1.10	0.66
Byy1	3-15	1.15	1.17	0.006	36.8	5.3	1.238	0.36	0.09	0.55
Byy2	15-42	1.17	1.18	0.003	32.8	5.7	1.243	0.31	0.03	0.15
Byym1	42-71	1.30	1.31	0.002	22.8	8.1	1.182	0.18	0.14	0.38
Byym2	71-95	1.44	1.45	0.002	21.9	3.9	1.208	0.25	0.05	0.16
Byym3	95-130	1.24	1.25	0.003	29.4	6.2	1.231	0.28	0.03	0.41
Byym4	130-185	1.28	1.29	0.003	29.5	3.9	1.227	0.33	0.90	3.90
Krot	95-130					7.1	1.168		0.31	0.38

Pokorny S06-TX109-902

pH & Carbonates

		(- - - - -	- - pH - -	- - - - -	- - - - -	- - - - - -)		(Carbonate)		(Gypsum)		
			$CaCl_2$					As $CaCO_3$		As $CaSO_4$*$2H_2O$		Resist
	Depth		0.01M	H_2O	Sat			<2mm	<20mm	<2mm	<20mm	ohms
Horz	(cm)	KCl	1:2	1:1	Paste	Sulf	NaF	(- - - - -	- - - - %	- - - - -	- - - - -)	cm^{-1}
Prep = GP												
A	0-3		7.6	7.8	7.0		10.5	18		--		
Byy1	3-15		7.8	7.8	7.4		10.1	4		84		
Byy2	15-42		7.8	7.9	7.6		9.9	2		86		
Byym1	42-71		8.1	8.2	8.0		10.1	11		61		
Byym2	71-95		8.0	8.1	8.0		10.2	9		77		
Byym3	95-130		8.1	8.2	8.2		10.1	6		81		
Byym4	130-185		8.1	8.2	8.3		10.1	6		84		
Prep = S												
A	0-3		7.6	7.7	7.0		10.5	18	18	--	--	
Byy1	3-15		7.7	7.8	7.4		10.1	4	4	86	86	
Byy2	15-42		7.8	8.0	7.6		9.8	2	2	88	87	
Byym1	42-71		8.0	8.1	7.9		10.1	10	10	60	60	
Byym2	71-95		8.0	8.1	8.1		10.1	8	8	80	79	
Byym3	95-130		8.0	8.0	8.2		10.0	5	5	78	78	
Byym4	130-185		8.1	8.2	8.3		10.0	6		86	86	
Krot	95-130		8.0	8.1	8.1		10.1	9		56	56	

Pokorny S06-TX109-902

Carbon & Extractions

Horz	Depth (cm)	Total C	Total N	Total S	Org C	C/N Ratio
		(- - - - - - % of <2 mm - - - - - -)				
Prep = GP						
A	0-3	3.61	0.167	0.10		
Byy1	3-15	0.84	0.012	16.94		
Byy2	15-42	0.50	0.221	16.85		
Byym1	42-71	1.47	0.002	11.95		
Byym2	71-95	1.15	--	17.77		
Byym3	95-130	0.77	0.072	17.85		
Byym4	130-185	0.80	--			
Prep = S						
A	0-3	3.22	0.091	0.09		11
Byy1	3-15	0.82	0.028	16.38		14
Byy2	15-42	0.66	0.045	18.02		10
Byym1	42-71	1.42	--	14.49		
Byym2	71-95	1.03	--	16.85		
Byym3	95-130	0.79	0.019	17.78		9
Byym4	130-185	0.79	--	17.36		
Krot	95-130	1.10	0.029	13.55		3

Pokorny S06-TX109-902

CEC & Bases

Horz	Depth (cm)	Ca	Mg	Na	K	CEC7 NH_4 OAC	Base Saturation Sum	Base Saturation NH_4OAC	Exch Na
		(- - - NH4OAC Extr Bases - - -)							
		(- - - - - - cmol(+) kg-1 - - - - - - - -)					(- - - - - - - % - - - - - -)		
Prep = GP									
A	0-3	58.1	0.8	--	0.8	12.4			
Byy1	3-15	309.1	0.1	--	0.1	0.8			
Byy2	15-42	341.6	1.2	0.1	0.2	0.7			
Byym1	42-71	371.5	2.0	0.9	0.3	2.7			
Byym2	71-95	346.7	0.9	1.0	0.2	1.2			
Byym3	95-130	303.8	0.6	1.2	0.1	0.7			
Byym4	130-185	270.2	0.9	1.4	0.1	0.8			
Prep = S									
A	0-3	60.5	0.8	--	0.9	13.1		100	--
Byy1	3-15	282.8	0.1	--	0.1	0.9		100	--
Byy2	15-42	329.9	1.2	0.1	0.1	1.0		100	1
Byym1	42-71	378.0	2.2	1.0	0.3	3.0		100	6
Byym2	71-95	325.8	0.8	1.0	0.2	1.1		100	--
Byym3	95-130	333.3	0.5	1.2	0.1	0.4		100	--
Byym4	130-185	278.6	0.9	1.3	0.1	0.9		100	--
Krot	95-130	362.8	2.4	1.6	0.4	5.7		100	5

Pokorny S06-TX109-902

Salt

		(- - - - - - - - - - - -- - - - - - - Water Extracted From Saturated Paste -)													Pred	
														Total	Elec	Elec	
	Depth	Ca	Mg	Na	K	CO_3	HCO_3	F	Cl	SO_4	NO_2	NO_3	H_2O	Salts	Cond	Cond	SAR
Horz	(cm)	(- - - - - mmol(+) L-1 - -- - -)				(- - - - - - - - - - - - - - - mmol(-) L-1 - - - - - - - - - - - - - - -)							(- - - - % - - - -)		(- dS m-1 -)		
Prep = GP																	
A	0-3	43.8	1.6	0.2	0.6	--	11.1	--	0.4	28.1	--	--	42.9		3.06	1.29	
Byy1	3-15	31.5	0.3	0.2	0.2	--	2.1	tr	0.2	30.5	0.1	--	67.7		2.41	2.16	
Byy2	15-42	30.6	1.7	0.8	0.2	--	1.5	tr	0.3	31.5	0.2	--	74.3		2.42	2.23	
Byym1	42-71	25.9	10.1	17.0	0.5	--	1.0	tr	3.6	52.6	--	0.4	51.3		3.95	2.64	
Byym2	71-95	25.4	7.5	14.2	0.4	--	0.9	0.1	5.2	39.2	--	0.3	51.2		4.12	2.66	
Byym3	95-130	27.7	6.3	27.3	0.4	--	0.5	0.1	13.2	44.8	--	0.9	53.0		4.90	2.74	
Byym4	130-185	28.5	8.2	31.7	0.4	--	0.6	0.1	6.4	64.1	--	0.4	52.3		5.31	2.70	
Prep = S																	
A	0-3	36.0	1.6	0.2	0.6	--	10.0	--	0.4	28.3	--	--	42.6	0.1	3.01	1.34	--
Byy1	3-15	31.9	0.3	0.2	0.2	--	2.1	--	0.2	30.9	0.1	--	90.4	0.1	2.37	2.13	--
Byy2	15-42	30.2	1.7	0.8	0.2	--	1.4	tr	0.4	31.5	0.2	--	75.2	0.1	2.41	2.18	tr
Byym1	42-71	25.5	9.5	14.2	0.2	--	1.0	tr	1.8	47.1	--	0.2	57.7	0.2	3.64	2.59	3
Byym2	71-95	25.1	7.3	20.5	0.4	--	0.6	tr	3.8	48.7	--	0.3	52.2	0.2	4.14	2.55	5
Byym3	95-130	27.4	6.2	26.5	0.4	--	0.4	tr	13.3	46.1	--	0.9	54.9	0.2	4.93	2.67	6
Byym4	130-185	27.1	8.4	29.2	0.4	--	0.6	0.1	19.6	49.0	--	0.3	54.6	0.2	5.28	2.59	7
Krot	95-130	23.9	10.9	26.1	0.6	--	0.6	tr	2.7	52.8	1.3	1.9	51.1	0.2	4.66	2.76	6

PEDON DESCRIPTION

Print Date: 09/08/2008
Description Date: 01/08/2008
Describer: Wayne Hudnall, Susan Horton, Doug Wysocki
Site ID: 31104-E4-003
Site Note:
Pedon ID: S08-TX109-003
Pedon Note:
Lab Source ID: SSL
Lab Pedon #: 08N0262
Soil Name as Described/Sampled: Joberanch
Soil Name as Correlated:
Classification: Loamy, mixed, thermic, shallow Ustic Petrogypsids
Pedon Type:
Pedon Purpose:
Taxon Kind:
Associated Soils:
Physiographic Division:
Physiographic Province:
Physiographic Section:
State Physiographic Area:
Local Physiographic Area:
Geomorphic Setting: valley floor remnant on karst
Upslope Shape: linear
Cross Slope Shape: linear
Particle Size Control Section: 0 to 30 cm.
Description origin: PedonPC

Country:
State: Texas
County: Culberson
MLRA: 42 -- Southern Desertic Basins, Plains, and Mountains
Soil Survey Area:
Map Unit:
Quad Name:
Location Description:
Legal Description:
Lat: 31 degrees 36 minutes 58.10 seconds N
Lon: 104 degrees 24 minutes 45.87 seconds W
Datum: NAD83
UTM Zone: 13
UTM Easting: 555747 meters
UTM Northing: 3497839 meters
Primary Earth Cover:
Secondary Earth Cover:
Existing Vegetation:
Parent Material: slightly weathered, loamy alluvium derived from sandstone over slightly weathered, alluvium derived from gyprock
Bedrock Kind:
Bedrock Depth:
Bedrock Hardness:
Bedrock Fracture Interval:
Surface Fragments:
Description database: NSSL

Diagnostic Features: ochric epipedon 0 to 21 cm.
cambic horizon 21 to 30 cm.
petrogypsic horizon 30 to 216 cm.

Top Depth (cm)	Bottom Depth (cm)	Restriction Kind	Restriction Hardness
30	80	petrogypsic	moderately cemented
80	150	petrogypsic	very strongly cemented

A1--0 to 7 centimeters; very pale brown (10YR 7/3) loam, yellowish brown (10YR 5/4), moist; strong medium platy structure; very friable, slightly hard, nonsticky, slightly plastic; moderate excavation difficulty; common fine roots throughout and common very fine roots throughout; prominent manganese masses and prominent cylindrical manganese coatings infused into matrix adjacent to pores; violent effervescence, by HCl, 1 normal; clear smooth boundary. Lab sample # 08N01656

A2--7 to 21 centimeters; pale yellow (2.5Y 7/3) silt loam, light yellowish brown (2.5Y 6/4), face; moderate coarse prismatic parting to moderate medium subangular blocky structure; friable, slightly hard, slightly sticky, slightly plastic; moderate excavation difficulty; common fine roots throughout and common very fine roots throughout; violent effervescence, by HCl, 1 normal; clear smooth boundary. Lab sample # 08N01657

Bky--21 to 30 centimeters; light yellowish brown (2.5Y 6/3) clay loam, light yellowish brown (2.5Y 6/4), moist; weak coarse prismatic parting to moderate medium subangular blocky structure; friable, moderately hard, slightly sticky, slightly plastic; moderate excavation difficulty; common fine roots throughout and common very fine roots throughout; violent effervescence, by HCl, 1 normal; very abrupt wavy boundary. Lab sample # 08N01658

2Bkyym--30 to 48 centimeters; pale yellow (2.5Y 8/2) cemented material, light gray (10YR 7/2), moist; structureless massive; moderately cemented; high excavation difficulty; very few very fine roots in cracks; violent effervescence, by HCl, 1 normal; gradual smooth boundary. Lab sample # 08N01659

2Byym1--48 to 80 centimeters; pale yellow (2.5Y 8/2) cemented material, very pale brown (10YR 7/3), moist; massive; moderately cemented; high excavation difficulty; very few medium roots top of horizon and very few very fine roots in cracks; violent effervescence, by HCl, 1 normal; abrupt wavy boundary. Lab sample # 08N01660

2Byym2--80 to 125 centimeters; very pale brown (10YR 7/3), cemented material, light yellowish brown (10YR 6/4), moist; massive; very strongly cemented; extremely high excavation difficulty; very few very fine roots; strong effervescence, by HCl, 1 normal; gradual smooth boundary. Lab sample # 08N01661

2Byym3--125 to 150 centimeters; white (10YR 8/1), cemented material, light gray (10YR 7/2), moist; massive; very strongly cemented; extremely high excavation difficulty; very few very fine roots; 2 percent discontinuous strong brown (7.5YR 5/6) and yellowish brown (10YR 5/6) clay films on surfaces along pores; 2 percent medium prominent cylindrical black (10YR 2/1) manganese coatings lining pores and on vertical faces of peds; strong effervescence, by HCl, 1 normal; gradual smooth boundary. Lab sample # 08N01662

2Byym4--150 to 184 centimeters; very pale brown (10YR 8/2), cemented material, pale yellow (2.5Y 7/4), moist; strongly cemented; extremely high excavation difficulty; very few very fine roots; strong effervescence, by HCl, 1 normal; gradual smooth boundary. Lab sample # 08N01663

2Byym5--184 to 216 centimeters; very pale brown (10YR 7/3), cemented material, light yellowish brown (2.5Y 6/3), moist; moderately cemented; very high excavation difficulty; very few very fine roots; slight effervescence, by HCl, 1 normal; rupture resistance varies from weakly (10%) to strongly (25 %) cemented. Lab sample # 08N01664

Joberanch S08-TX109-003

PSDA & Rock Fragments

		(- - - - - - - Total - - - - - -)			Clay	(- - - - Silt - - - -)		(- - - - - - - - - - - - - - Sand - - - - - - - - - - - - -)					(Rock Fragments (mm))				
		Clay	Silt	Sand	CO3	Fine	Coarse	VF	F	M	C	VC	(- - - - - - - - - Weight - - - - - - - - -)				>2 mm
		<	0.002	0.05	<	0.002	0.02	0.05	0.1	0.25	0.5	1	2	5	20	.1-	wt %
	Depth	0.002	-0.05	-2	0.002	-0.02	-0.05	-0.1	-0.25	-0.5	-1	-2	-5	-20	-75	75	whole
Horz	(cm)	(- % of <2mm Mineral Soil -)											(- - - - - - - % of <75mm - - - - - - -)				soil
A1	0-7	16.9	42.9	40.2	5.9	21.0	21.9	29.2	7.5	1.9	1.0	0.6	1	--	--	12	1
A2	7-21	28.2	47.1	24.7	12.5	25.7	21.4	19.4	3.2	1.0	0.8	0.3	1	tr	--	6	1
Bky	21-30	24.1	47.1	28.8	8.7	21.9	25.2	23.5	2.9	1.5	0.7	0.2	1	1	--	7	2
2Bkyym	30-48	33.2	55.1	11.7	5.8	32.1	23.0	10.4	0.8	0.2	0.2	0.1	2	--	--	3	2
2Byym1	48-80	33.6	59.5	6.9	4.4	36.9	22.6	6.5	0.4	tr	--	--	1	--	--	1	1
2Byym2	80-125	13.9	60.6	25.5	--	20.6	40.0	25.2	0.2	0.1	tr	--	3	1	80	84	84
2Byym3	125-150	26.1	54.7	19.2	--	26.0	28.7	18.4	0.6	0.1	0.1	--	2	2	83	87	87
2Byym4	150-184	12.2	34.4	53.4	1.8	10.5	23.9	49.2	4.0	0.1	0.1	tr	2	1	42	47	45
2Byym5	184-216	10.3	36.0	53.7	1.3	9.4	26.6	48.2	5.4	0.1	tr	--	7	10	42	61	59

Joberanch S08-TX109-003

Bulk Density & Moisture

		(Bulk Density) 33 kPa	Oven Dry	Cole Whole Soil	Water Content 33 kPa	1500 kPa	Ratio AD/OD	WRD Whole Soil	(Ratio/Clay) CEC7	1500 kPa
		(- g cm^{-3} -)			% of < 2mm			cm^3 cm^{-3}		
A1	0-7					7.3	1.020		0.72	0.43
A2	7-21	1.23	1.28	0.013	16.0	9.0	1.024	0.09	0.45	0.32
Bky	21-30	1.26	1.33	0.018	19.8	8.0	1.025	0.15	0.51	0.33
2Bkyym	30-48	1.33	1.35	0.005	16.6	4.6	1.180	0.16	0.13	0.14
2Byym1	48-80	1.25	1.26	0.003	15.8	5.3	1.175	0.13	0.16	0.16
2Byym2	80-125	1.57	1.59	0.001	15.7	5.4	1.112	0.04	0.38	0.39
2Byym3	125-150	1.51	1.52	tr	16.5	5.9	1.148	0.03	0.20	0.23
2Byym4	150-184	1.47	1.47	--	12.7	4.8	1.134	0.08	0.28	0.39
2Byym5	184-216	1.55	1.56	0.001	14.0	4.8	1.094	0.08	0.44	0.47

Joberanch S08-TX109-003

pH & Carbonates

		(- - - - - - - - - - - - - - pH					- - - - - - - - - - - - -)	(Carbonate)		(Gypsum)		
			$CaCl_2$					As $CaCO_3$		As $CaSO_4$*$2H_2O$		Resist
	Depth		0.01M	H_2O	Sat			<2mm	<20mm	<2mm	<20mm	ohms
Horz	(cm)	KCl	1:2	1:1	Paste	Sulf	NaF	(- - - - - - - - - - %			- - - - - - - - - -)	cm^{-1}
A1	0-7	7.8	8.0	7.6				22		--		
A2	7-21	7.8	8.3	7.7				40		--		
Bky	21-30	7.8	7.9	7.5				40		tr		
2Bkyym	30-48	7.9	7.9	7.8				9		70		
2Byym1	48-80	7.9	7.9	7.8				10		68		
2Byym2	80-125	7.8	7.9					8		41		
2Byym3	125-150	7.8	7.9	7.7				8		58		
2Byym4	150-184	7.8	7.9	7.8				4		52		
2Byym5	184-216	7.8	7.9	7.8				6		34		

Joberanch S08-TX109-003

Carbon & Extractions

		(- - - - - Total - - - - -)			Org	C/N
	Depth	C	N	S	C	Ratio
Horz	(cm)	(- - - - - - % of <2 mm - - - - - -)				
A1	0-7	3.45	0.170	0.03		5
A2	7-21	4.94	0.106	0.02		1
Bky	21-30	4.71	0.077	0.12		--
2Bkyym	30-48	1.09	0.196	12.29		--
2Byym1	48-80	1.08	0.159	13.08		--
2Byym2	80-125	0.83	--	9.00		
2Byym3	125-150	0.87	--	11.88		
2Byym4	150-184	0.36	--	11.28		
2Byym5	184-216	0.61	--	7.75		

Joberanch S08-TX109-003

CEC & Bases

Horz	Depth (cm)	Ca	Mg	Na	K	CEC7 NH_4 OAC	Base (Saturation) Sum	Base (Saturation) NH_4OAC	Exch Na
		(- NH4OAC Extr Bases -)							
		(- - - - - - cmol(+) kg-1			- - - - - - - -)		(- - - - - - - %		- - - - - -)
A1	0-7	64.7*	0.8	--	0.7	12.2		100	--
A2	7-21	76.7*	0.7	--	0.4	12.8		100	--
Bky	21-30	87.7*	0.5	--	0.3	12.2		100	--
2Bkyym	30-48	331.4*	0.3	--	0.2	4.4		100	--
2Byym1	48-80	325.8*	0.3	--	0.3	5.5		100	--
2Byym2	80-125	323.1*	0.7	--	0.2	5.3		100	--
2Byym3	125-150	323.4*	0.6	--	0.2	5.2		100	--
2Byym4	150-184	274.5*	0.3	--	0.2	3.4		100	--
2Byym5	184-216	324.4*	0.4	--	0.2	4.5		100	--

Joberanch S08-TX109-003

Salt

Horz	Depth (cm)	Ca	Mg	Na	K	CO_3	HCO_3	F	Cl	SO_4	NO_2	NO_3	H_2O	Total Salts	Elec Cond	Pred Elec Cond	SAR
		(- - - - - - - - - - -- - - - - - - Water Extracted From Saturated Paste -)															
		(- - - - - mmol(+) L-1 - -- - -)				(- - - - - - - - - - - - - - - mmol(-) L-1 - - - - - - - - - - - - - - -)							(- - - - % - - - -)		(- dS m-1 -)		
A1	0-7	22.1	1.2	0.2	0.6	--	5.4	--	0.2	22.1	tr	--	44.0	tr	1.73	0.62	tr
A2	7-21	5.1	0.2	0.4	--	--	2.1	--	0.2	2.8	0.4	tr	51.2	tr	0.64	0.25	tr
Bky	21-30	26.8	0.5	0.5	--	--	1.5	--	0.2	29.8	0.1	--	52.8	0.1	2.17	1.69	tr
2Bkyym	30-48	30.5	0.4	0.3	0.1	--	0.8	0.1	0.2	29.3	--	0.1	58.2	0.1	2.27	2.18	tr
2Byym1	48-80	29.7	0.6	0.6	0.2	--	1.0	0.1	0.3	29.4	--	0.5	55.7	0.1	2.33	2.21	tr
2Byym2	80-125															2.30	
2Byym3	125-150	28.6	1.5	2.9	0.2	--	0.8	0.8	1.0	29.2	--	1.5	45.7	0.1	2.51	2.27	1
2Byym4	150-184	27.9	1.2	2.4	0.2	--	0.5	0.4	0.7	29.3	--	0.9	41.5	0.1	2.41	2.18	1
2Byym5	184-216	28.6	1.2	2.8	0.2	--	0.5	0.4	1.0	29.7	--	1.2	41.5	0.1	2.49	2.25	1

PEDON DESCRIPTION

Print Date: 07/15/2008

Description Date: 10/24/2006

Describer: Lynn Loomis, Wayne Hudnall, Philip Schoeneberger, Arlene Tugel, Greg Cates

Site ID: 31104-H4-903

Site Note:

Pedon ID: S06-TX109-903

Pedon Note:

Lab Source ID: SSL

Lab Pedon #: 07N0079

Soil Name as Described/Sampled: Shippingpens

Soil Name as Correlated:

Classification: Gypsic, thermic, shallow Ustic Petrogypsids

Pedon Type:

Pedon Purpose:

Taxon Kind:

Physiographic Division:

Physiographic Province:

Physiographic Section:

State Physiographic Area:

Local Physiographic Area:

Geomorphic Setting: on tread of None Assigned

Upslope Shape: linear

Cross Slope Shape: linear

Particle Size Control Section: 0 to 27 cm.

Description origin: PedonPC

Country: United States

State: Texas

County: Culberson

MLRA: 42 -- Southern Desertic Basins, Plains, and Mountains

Soil Survey Area:

Map Unit:

Quad Name:

Location Description:

Legal Description:

Lat: 31 degrees 54 minutes 16.60 seconds N

Lon: 104 degrees 21 minutes 44.00 seconds W

Datum: NAD83

UTM Zone: 13

UTM Easting: 560294 meters

UTM Northing: 3529845 meters

Primary Earth Cover:

Secondary Earth Cover:

Existing Vegetation: fourwing saltbush, alkali sacaton

Parent Material: slightly weathered, alluvium derived from gyprock over slightly weathered, residuum weathered from gyprock

Bedrock Kind: gyprock

Bedrock Depth: 165 centimeters

Bedrock Hardness: indurated

Bedrock Fracture Interval: 100 to less than 200 centimeters

Surface Fragments:

Description database: NSSL

Diagnostic Features: ochric epipedon 0 to 5 cm.
gypsic horizon 5 to 27 cm.
petrogypsic horizon 27 to 57 cm.
paralithic contact 110 cm.
paralithic materials 110 to 165 cm.
lithic contact 165 to 200 cm.

Top Depth (cm)	Bottom Depth (cm)	Restriction Kind	Restriction Hardness
27	57	petrogypsic	moderately cemented
110	165	bedrock, paralithic	moderately cemented
165	200	bedrock, lithic	indurated

A--0 to 5 centimeters; (10YR/), gypsiferous very fine sandy loam, brown (10YR 4/3), moist; weak thin platy structure; noncemented, nonsticky, nonplastic; moderate excavation difficulty; common fine roots throughout and many medium roots throughout and many very fine roots throughout; strong effervescence, by HCl, 1 normal; clear smooth boundary. Lab sample # 07N00501

Byy1--5 to 14 centimeters; (10YR/), gypseous material, very pale brown (10YR 8/3), moist; moderate medium subangular blocky parting to weak fine subangular blocky structure; noncemented, moderately sticky, slightly plastic; moderate excavation difficulty; common fine roots throughout and many medium roots and many very fine roots throughout; slight effervescence, by HCl, 1 normal; gradual smooth boundary. Lab sample # 07N00502

Byy2--14 to 27 centimeters; (10YR/), gypseous material, very pale brown (10YR 8/2), moist; moderate coarse subangular blocky parting to moderate medium subangular blocky structure; extremely weakly cemented, moderately sticky, moderately plastic; brittle; high excavation difficulty; common fine roots throughout and common medium roots throughout and common very fine roots throughout; slight effervescence, by HCl, 1 normal; gradual smooth boundary. Lab sample # 07N00503

Byym1--27 to 43 centimeters; (10YR/), cemented material, pale yellow (2.5Y 8/3), moist; strong coarse prismatic structure; extremely weakly cemented, moderately sticky, slightly plastic; high excavation difficulty; very few fine roots throughout and very few very fine roots throughout; very slight effervescence, by HCl, 1 normal; abrupt smooth boundary. Lab sample # 07N00504

Byym2--43 to 57 centimeters; (10YR/), cemented material, pale yellow (2.5Y 8/3), moist; strong coarse prismatic structure; weakly cemented, very sticky, slightly plastic; brittle; very high excavation difficulty; very few fine roots throughout and very few very fine roots throughout; noneffervescent, by HCl, 1 normal; abrupt wavy boundary. Lab sample # 07N00505

Byym3--57 to 110 centimeters; (10YR/), cemented material, pale yellow (2.5Y 7/3), moist; strong coarse prismatic structure; extremely weakly cemented, moderately sticky, slightly plastic; high excavation difficulty; very few very fine roots throughout; very slight effervescence, by HCl, 1 normal; clear wavy boundary. Lab sample # 07N00506

Cry--110 to 165 centimeters; bedrock; structureless massive; weakly cemented; very high excavation difficulty; very few roots; noneffervescent, by HCl, 1 normal; Varved Castile gyprock, moderately weathered, dark bands are very slightly effervescent; very abrupt smooth boundary. Lab sample # 07N00507

R--165 to 200 centimeters; indurated gyprock, fractured at intervals of 100 to less than 200 centimeters; structureless massive; indurated; extremely high excavation difficulty; very few roots; noneffervescent, by HCl, 1 normal.

Shippingpens S06-TX109-903

PSDA & Rock Fragments

		(- - - - - - - Total	- - - - - -	-)	Clay	(- - - - Silt	- - - -)	(- - - - - - - - - - - - - - Sand				- - - - - - - - - - - - -)	(Rock Fragments	(mm))			
		Clay	Silt	Sand	CO3	Fine	Coarse	VF	F	M	C	VC	(- - - - - - - - - Weight			- - - - - - - - -)	>2 mm
		<	0.002	0.05	<	0.002	0.02	0.05	0.1	0.25	0.5	1	2	5	20	.1-	wt %
	Depth	0.002	-0.05	-2	0.002	-0.02	-0.05	-0.1	-0.25	-0.5	-1	-2	-5	-20	-75	75	whole
Horz	(cm)	(- % of <2mm Mineral Soil										- -)	(- - - - - - - % of <75mm			- - - - - - -)	soil
Prep = GP																	
A	0-5	23.0	43.8	33.2		19.1	24.7	28.1	3.7	0.6	0.4	0.4					
Byy1	5-14	55.6	18.3	26.1		12.4	5.9	16.6	3.7	4.0	1.2	0.6					
Byy2	14-27	21.6	59.6	18.8		27.0	32.6	6.7	6.7	2.7	2.7	--					
Byym1	27-43	74.1	13.2	12.7		12.8	0.4	10.2	1.9	0.6	--	--					
Byym2	43-57	28.5	50.2	21.3		20.9	29.3	17.5	2.4	1.4	--	--					
Byym3	57-110	45.3	32.3	22.4		20.1	12.2	20.6	1.5	0.3	--	--					
Cr	110-165	33.2	14.2	52.6		--	14.2	46.5	5.2	0.6	0.3	--					
Prep = S																	
A	0-5	22.7	44.2	33.1		19.4	24.8	27.6	4.7	0.6	0.2	tr	tr	tr	--	6	tr
Byy1	5-14	33.7	36.0	30.3		35.4	0.6	21.9	4.2	1.7	0.8	1.7	--	--	--	8	--
Byy1	5-14	41.5	31.7	26.8		29.8	1.9	14.9	4.8	4.2	2.6	0.3	--	--	--	12	--
Byy2	14-27	18.3	36.2	45.5		30.5	5.7	30.4	10.6	3.0	--	1.5	--	--	--	15	--
Byym1	27-43	5.2	82.3	12.5		72.3	10.0	10.7	0.9	0.9	--	--	2	--	--	4	2
Byym1	27-43	48.1	32.8	19.1		25.2	7.6	16.2	1.4	0.9	0.6	--	--	--	--	3	--
Byym2	43-57	80.2	14.7	5.1		4.5	10.2	1.7	2.8	0.6	--	--	tr	--	--	3	tr
Byym3	57-110	37.2	42.1	20.7		25.0	17.1	18.8	1.4	0.3	0.2	--	tr	--	--	2	tr
Cr	110-165	19.5	27.0	53.5		4.9	22.1	39.3	12.6	1.2	0.2	0.2	6	10	42	64	58

Shippingpens S06-TX109-903

Bulk Density & Moisture

		(Bulk Density)		Cole	Water Content			WRD	(Ratio/Clay)	
		33 kPa	Oven Dry	Whole Soil	33 kPa	1500 kPa	Ratio AD/OD	Whole Soil	CEC7	1500 kPa
		(- g cm^{-3} -)			% of < 2mm			cm^3 cm^{-3}		
Prep = GP										
A	0-5					14.3	1.035			
Byy1	5-14					4.0	1.229			
Byy2	14-27					4.3	1.240			
Byym1	27-43					5.4	1.240			
Byym2	43-57					4.2	1.244			
Byym3	57-110					4.0	1.228			
Cr	110-165					1.7	1.236			
Prep = S										
A	0-5					14.9	1.036		0.99	0.66
Byy1	5-14	0.95	1.06	0.037	59.4	4.0	1.228	0.53	0.04	0.10
Byy2	14-27	1.17	1.19	0.006	41.9	4.3	1.240	0.44	0.03	0.23
Byym1	27-43	1.23	1.24	0.003	39.3	6.0	1.244	0.40	0.06	1.15
Byym2	43-57	1.28	1.29	0.003	37.2	5.0	1.246	0.41	tr	0.06
Byym3	57-110	1.33	1.33	--	31.1	4.1	1.228	0.36	0.04	0.11
Cr	110-165					2.4	1.231		0.02	0.12

Shippingpens S06-TX109-903

pH & Carbonates

			(- - - pH - - -)					(Carbonate) As $CaCO_3$		(Gypsum) As $CaSO_4$*$2H_2O$		Resist
	Depth		$CaCl_2$ 0.01M	H_2O	Sat			<2mm	<20mm	<2mm	<20mm	ohms
Horz	(cm)	KCl	1:2	1:1	Paste	Sulf	NaF	(- - - %	- - -	- - -	- - -)	cm^{-1}
Prep = GP												
A	0-5		8.0	8.0	7.8		10.2	10		tr		
Byy1	5-14		8.2	8.3	7.7		10.0	5		82		
Byy2	14-27		8.4	8.6	7.8		9.8	3		90		
Byym1	27-43		8.7	8.8	8.4		9.4	1		96		
Byym2	43-57		8.5	8.6	8.5		9.6	2		95		
Byym3	57-110		7.9	8.0	7.9		9.4	2		93		
Cr	110-165		7.8	7.9	7.9		9.3	7		83		
Prep = S												
A	0-5		8.0	8.1	7.9		10.1	10	10	2	2	
Byy1	5-14		8.2	8.3	7.7		10.1	5		86	86	
Byy2	14-27		8.4	8.5	7.9		9.8	3		92	92	
Byym1	27-43		8.7	8.8	8.6		9.2	1	1	89	89	
Byym2	43-57		8.4	8.6	8.4		9.2	2	2	87	87	
Byym3	57-110		7.8	7.9	7.9		9.3	2	2	85	85	
Cr	110-165		7.7	7.9	7.9		9.2	7	7	84	80	

Shippingpens S06-TX109-903

Carbon & Extractions

		(- - - - - Total - - - - -)			Org	C/N
	Depth	C	N	S	C	Ratio
Horz	(cm)	(- - - - - - % of <2 mm - - - - - -)				
Prep = GP						
A	0-5	5.45	0.378	1.36		
Byy1	5-14	1.37	0.088	17.36		
Byy2	14-27	0.73	0.017	17.99		
Byym1	27-43	0.27	0.035	18.17		
Byym2	43-57	0.29	0.043	18.32		
Byym3	57-110	0.76	0.034	16.79		
Cr	110-165	0.91	0.251	17.28		
Prep = S						
A	0-5	4.98	0.304	1.32		13
Byy1	5-14	1.36	0.007	17.13		108
Byy2	14-27	0.74	0.072	17.96		5
Byym1	27-43	0.28	0.035	18.41		4
Byym2	43-57	0.28	0.060	18.71		1
Byym3	57-110	0.38	0.004	15.85		28
Cr	110-165	0.80	0.006	18.03		1

Shippingpens S06-TX109-903

CEC & Bases

Horz	Depth (cm)	Ca	Mg	Na	K	CEC7 NH_4 OAC	Base Saturation Sum	Base Saturation NH_4OAC	Exch Na
		(- - - NH4OAC Extr Bases - - -)							
		(- - - - - - cmol(+) kg-1 - - - - - - - -)					(- - - - - - - % - - - - - -)		
Prep = GP									
A	0-5	115.2	15.7	0.5	2.1	21.9			
Byy1	5-14	310.7	5.0	1.6	0.7	1.7			
Byy2	14-27	268.7	4.5	3.0	0.9	0.6			
Byym1	27-43	251.4	5.3	7.5	1.2	0.3			
Byym2	43-57	284.4	3.9	5.2	0.9	0.3			
Byym3	57-110	237.2	0.8	0.5	0.3	1.5			
Cr	110-165	318.2	0.2	tr	0.1	--			

Horz	Depth (cm)	Ca	Mg	Na	K	CEC7 NH_4 OAC	Base Saturation Sum	Base Saturation NH_4OAC	Exch Na
Prep = S									
A	0-5	147.5*	21.6	0.7	2.3	22.4		100	
Byy1	5-15	304.3*	3.7	0.8	0.6	1.10		100	
Byy2	14-27	309.7*	4.6	2.9	0.8	0.6		100	
Byym1	27-43	265.0*	5.3	7.1	1.2	0.3		100	
Byym2	43-57	307.5*	4.0	5.3	0.9	0.3		100	
Byym3	57-110	308.4*	0.8	0.4	0.3	1.4		100	
Cr	110-165	375.7*	0.3	0.2	0.1	0.3		100	

Shippingpens S06-TX109-903

Salt

		(- - - - - - - - - - -- - - - - - - Water Extracted From Saturated Paste -)															
																Pred	
														Total	Elec	Elec	
	Depth	Ca	Mg	Na	K	CO3	HCO3	F	Cl	SO4	NO2	NO3	H2O	Salts	Cond	Cond	SAR
Horz	(cm)	(- - - - - mmol(+) L-1 - -- - -)				(- - - - - - - - - - - - - - - - mmol(-) L-1 - - - - - - - - - - - - - - -)							(- - - - % - - - -)		(- dS m-1 -)		
Prep = GP																	
A	0-5	34.1	24.8	2.7	2.4	--	11.2	tr	5.4	43.6	--	--	71.6		4.24	3.15	
Byy1	5-14	28.4	22.4	19.1	5.9	--	5.1	0.1	11.3	67.5	--	--	73.2		5.64	3.04	
Byy2	14-27	25.9	49.2	62.5	13.5	--	4.0	0.1	46.1	108.4	--	1.0	57.7		10.44	3.96	
Byym1	27-43	24.5	97.7	219.7	27.0	--	2.2	0.7	108.8	262.0	--	2.3	49.3		23.10	6.34	
Byym2	43-57	25.5	77.5	151.5	18.9	--	1.4	0.3	82.6	174.2	--	2.1	48.1		19.10	5.30	
Byym3	57-110	30.5	4.7	12.6	0.7	--	0.8	tr	8.9	39.7	--	--	44.3		4.00	2.52	
Cr	110-165	28.8	1.6	3.6	tr	--	0.6	tr	2.4	33.2	--	--	48.3		2.72	2.18	
Prep = S																	
A	0-5	31.6	24.6	3.7	3.0	--	6.8	0.1	4.9	48.1	1.5	2.2	73.2	0.2	4.59	3.18	1
Byy1	5-14	27.4	23.6	20.1	5.9	--	4.9	0.1	8.9	62.6	--	--	71.3	0.3	5.72	3.22	4
Byy2	14-27	25.2	43.7	66.2	12.9	--	3.7	0.1	32.8	112.9	--	--	57.7	0.5	10.60	3.67	11
Byym1	27-43	24.3	104	179.7	26.4	--	1.6	0.2	125.8	183.8	--	2.1	54.3	1	22	6.18	22
Byym2	43-57	25.7	77.5	160.1	18.8	--	1.5	0.5	100.5	206.6	--	2.8	47.4	0.8	19.30	5.22	22
Byym3	57-110	29.6	5.1	12.9	0.7	--	0.9	0.1	9.8	40.4	--	--	44.8	0.1	4.01	2.38	3
Cr	110-165	30.8	2.7	7.7	0.2	--	0.8	0.1	5.3	36.6	--	--	52.3	0.1	3.28	2.25	2

B horizons: *Horizons that have formed below an A, E, or O horizon. They are dominated by the obliteration of all or much of the original rock structure and show one or more of the following:*

1. Illuvial concentration of silicate clay, iron, aluminum, humus, carbonates, gypsum, or silica, alone or in combination;
2. Evidence of the removal, addition, or transformation of carbonates and/or gypsum;
3. Residual concentration of oxides;
4. Coatings of sesquioxides that make the horizon conspicuously lower in color value, higher in chroma, or redder in hue, without apparent illuviation of iron;
5. Alteration that forms silicate clay or liberates oxides, or both, and that forms a granular, blocky, or prismatic structure if volume changes accompany changes in moisture content;
6. Brittleness; *or*
7. Strong gleying.

All of the different kinds of B horizons are, or were originally, subsurface horizons. Included as B horizons, where contiguous to other genetic horizons, are layers of illuvial concentration of carbonates, gypsum, or silica that are the result of pedogenic processes (and may or may not be cemented) and brittle layers that show other evidence of alteration, such as prismatic structure or illuvial accumulation of clay.

Examples of layers that are not B horizons are layers in which clay films either coat rock fragments or cover finely stratified unconsolidated sediments, regardless of whether the films were formed in place or by illuviation; layers into which carbonates have been illuviated but that are not contiguous to an overlying genetic horizon; and layers with gleying but no other pedogenic changes.

k *Accumulation of secondary carbonates*

This symbol indicates an accumulation of visible pedogenic calcium carbonate (less than 50 percent, by volume). Carbonate accumulations occur as carbonate filaments, coatings, masses, nodules, disseminated carbonate, or other forms.

kk *Engulfment of horizon by secondary carbonates*

This symbol indicates major accumulations of pedogenic calcium carbonate. The suffix kk is used when the soil fabric is plugged with fine grained pedogenic carbonate (50 percent or more, by volume) that occurs as an essentially continuous medium. The suffix corresponds to the stage III plugged horizon or higher of the carbonate morphogenetic stages (Gile et al., 1966).

y *Accumulation of gypsum*
This symbol indicates presence of 1 to 40 percent gypsum by volume.

yy *Dominance of horizon by gypsum*
continuous gypsum so that all or most other pedological and/or lithological features and structures disappear (greater than about 40 percent gypsum by volume)

classes in leiu of texture

flour gyp-pulverulent
in-between gyp-placoid
sugar gyp-sucrosic

Root Restricting Depth

The root restricting depth is where root penetration would be strongly inhibited because of physical (including soil temperature) and/or chemical characteristics. Restriction means the incapability to support more than a few *fine* or *very fine* roots if depth from the soil surface and water state, other than the occurrence of frozen water, are not limiting. For cotton or soybeans and possibly other crops with less abundant roots than the grasses, the *very few* class is used instead of the *few* class. The restriction may be below where plant roots normally occur because of limitations in water state, temperatures, or depth from the surface. The evaluation should be for the specific plants that are important to the use of the soil. These plants should be indicated. The root-restriction depth may differ depending on the plant considered.

Rupture resistance classes

Dry Class 1	Moist Class 2	Cementation class 3	Pedo-resistance 4	Specimen Fails Under	Force Quantity
Loose	Loose	Not Applicable	Not Applicable	Intact specimen not obtainable	
Soft	Very Friable	Non-cemented	Non-pedo-resistant	Very slight force between fingers	<8 N
Slightly Hard	Friable	Extremely Weakly Cemented	Extremely-weakly pedo-resistant	Slight force between fingers	8 to < 20 N
Mod Hard	Firm	Very Weakly Cemented	Very Weakly Pedo-resistant	Moderate force between fingers	20 to < 40 N
Hard	Very Firm	Weakly Cemented	Weakly Pedo-resistant	Strong force between fingers	40 to < 80 N
Very Hard	Extr Firm	Moderately Cemented	Moderately Pedo-resistant	Moderate force between hands	80 to < 160 N
Extremely Hard	Slightly Rigid	Strongly Cemented	Strongly Pedo-resistant	Foot pressure by full body weight	160 to < 800 N
Rigid	Rigid	Very Strongly Cemented	Very Strongly Pedo-resistant	Blow of < 3 J but not body weight	800 N to < 3 J
Very Rigid	Very Rigid	Indurated	Pedo-indurated	Blow of ≥3 J (3 J = 2 kg weight dropped 15 cm)	

1 Dry Rupture Resistance column applies to soils that are moderately dry or drier (Moderately Dry and Very Dry Soil Water State sub-classes).
2 Moist column applies to soils that are slightly dry or wetter (Slightly Dry through Satiated Soil Water State sub-classes; Soil Survey Staff, 1993; p. 91).
3 Specimen must first be air dried and then submerged in water for a minimum of 1 hour prior to test (Soil Survey Staff, 1993; p. 173).
4 Materials that behave as if "cementated" (e.g. physically interlocked) but lack true cementation in the petrological sense, (i.e. material; the matrix is not bonded together by another kind of material; e.g. a "glue").

<u>Diagnostic features and horizons</u>

Definition of Hypergypsic horizon taken from 1989 Aridisol proposal

Required Characteristics

A gypsic horizon has *all* of the following properties:

1. Is 15 cm or more thick; *and*

2. Is not cemented or indurated by gypsum, with or without other cementing agents; is cemented and the cemented parts are less than 10 cm thick; or, because of lateral discontinuity, roots can penetrate along vertical fractures with a horizontal spacing of less than 10 cm; *and*

3. Is 60 percent or more (by weight) gypsum and 50 percent or more (by volume) secondary visible gypsum; *and*

4. Has a product of thickness, in cm, multiplied by the gypsum content (percent by weight) of 900 or more.

Proposed definition of Hypergypsic horizon

A hypergypsic horizon is a surface or subsurface horizon that meets the following requirements

Required Characteristics

A hypergypsic horizon has *all* of the following properties:

1. Is 15 cm or more thick; *and*

2. Has no pedo-resistance; or if pedo-resistance is present, it is less than 5 mm cm thick; or, because of lateral discontinuity, roots can penetrate along vertical fractures with a horizontal spacing of less than 10 cm; *and*

3. Is 40% or more (by weight) gypsum

4. Has a product of thickness, in cm, multiplied by the gypsum content (percent by weight) of 600 or more. Thus, a horizon 20 cm thick that is 50 percent gypsum qualifies as a hypergypsic horizon if any cementation is as described in requirement 2 above. The gypsum content (percent by weight) is calculated as the product of gypsum content, expressed as cmolc kg-1 soil (of the fine earth fraction), and the equivalent weight of gypsum (86) expressed as a percentage.

Gypsic Horizon (taken from 2006 Keys to Soil Taxonomy

The gypsic horizon is an illuvial horizon in which secondary gypsum has accumulated to a significant extent.

This description begs the questions: “How does one identify secondary (pedogenic) gypsum in the field? or stated another way “How does one distinguish transformed, translocated, and inherited gypsum when all three origins may occur within a single horizon?” These questions have no answer yet.

Required Characteristics
A gypsic horizon has *all* of the following properties:

1. Is 15 cm or more thick; *and*

2. Is not cemented or indurated by gypsum, with or without other cementing agents; is cemented and the cemented parts are less than 10 cm thick; or, because of lateral discontinuity, roots can penetrate along vertical fractures with a horizontal spacing of less than 10 cm; *and*

3. Is 5 percent or more (by weight) gypsum and 1 percent or more (by volume) secondary visible gypsum; *and*

4. Has a product of thickness, in cm, multiplied by the gypsum content (percent by weight) of 150 or more. Thus, a horizon 30 cm thick that is 5 percent gypsum qualifies as a gypsic horizon if it is 1 percent or more (by volume) visible gypsum and any cementation is as described in 2 above. The gypsum content (percent by weight) is calculated as the product of gypsum content, expressed as cmolc kg-1 soil (of the fine earth fraction), and the equivalent weight of gypsum (86) expressed as a percentage.

Proposed definition of Gypsic Horizon

The gypsic horizon is a horizon that contains more pedogenic gypsum than the presumed parent material contained. Morphologic evidence exhibits visual, meso-scale evidence of addition, loss, translocation, or transformation of gypsum within the soil horizon in question.

If gypsum in the soil zone gets wet, it likely dissolves and reprecipitates, and therefore can be considered pedogenic in origin. By defining B horizons with removal, addition, or transformation of gypsum, questions regarding pedogenic origin can be avoided.

Most gypsic horizons occur in arid environments where the parent materials are rich in gypsum. In soils that have ground water near the surface, capillary rise and evaporation plus transpiration can result in significant accumulations of gypsum.

Gypsum may accumulate uniformly throughout a matrix of sand and finer textured material or as masses or clusters of crystals. In gravelly or stony material, it may accumulate as pendants on the bottom of rock fragments. Gypsum can readily dissolve in soils due to its solubility and thereby cause substantial damage to buildings, roads, irrigation delivery systems, earthen dams, and other structures.

Required Characteristics

A gypsic horizon has *all* of the following properties:

1. Is 15 cm or more thick; *and*

2. Is not cemented or indurated by gypsum, with or without other cementing agents; is cemented and the cemented parts are less than 10 cm thick; or, because of lateral discontinuity, roots can penetrate along vertical fractures with a horizontal spacing of less than 10 cm; *and*

3. Is 5 to 40 percent (by weight) gypsum and 1 percent or more (by volume) visible gypsum; *and*

4. Has a product of thickness, in cm, multiplied by the gypsum content (percent by weight) of 150 or more. Thus, a horizon 30 cm thick that is 5 percent gypsum qualifies as a gypsic horizon if it is 1 percent or more (by volume) visible gypsum and any cementation is as described in 2 above. The gypsum content (percent by weight) is calculated as the product of gypsum content, expressed as cmolc kg-1 soil (of the fine-earth fraction), and the equivalent weight of gypsum (86) expressed as a percentage.

Petrogypsic Horizon from 2006 Keys to Soil Taxonomy

The petrogypsic horizon is an illuvial horizon, 10 cm or more thick, in which secondary gypsum has accumulated to the extent that the horizon is cemented or indurated.

Required Characteristics

A petrogypsic horizon must meet the following requirements:

1. The horizon is cemented or indurated by gypsum, with or without other cementing agents; *and*

2. Because of lateral continuity, roots can penetrate only along vertical fractures with a horizontal spacing of 10 cm or more; *and*

3. The horizon is 10 cm or more thick; *and*

4. The horizon is 5 percent or more gypsum, and the product of its thickness, in cm, multiplied by the gypsum content percentage is 150 or more.

Proposed definition of Petrogypsic Horizon

The petrogypsic horizon is a horizon, 5 mm or thicker, that has a pedo-resistance class of very weak or stronger.

Air-dry fragments do not slake in water after a period of on hour submerged under water, and commonly have a weak pedo-resistance class. Roots commonly occur as mats on the upper surface, but cannot enter vertically except in vertical fractures that have a horizontal spacing of 10 cm or more. The minimum gypsum content observed is about 60 percent, and the product of the thickness, in cm, multiplied by the gypsum content percentage is 600 or more.

Petrogypsic horizons are known to occur only in arid regions and develop in parent materials that are very rich in gypsum. They are rare (though locally dominant) in the United States, but are common in parts of Africa and Asia.

Required Characteristics

A petrogypsic horizon must meet the following requirements:

1. The horizon is 5 mm or more thick; *and*

2. The horizon has a pedo-resistance class of very weak or stronger, and a brittle manner of failure at or near field capacity; *and*

3. Because of lateral continuity, roots can penetrate only along vertical fractures with a horizontal spacing of 10 cm or more.

4. The horizon is 5 percent or more gypsum, and the product of its thickness, in cm, multiplied by the gypsum content percentage is 150 or more.

Family classes

Substitutes for particle-size class

Sucrosic-sugar gyp
Pulverulent -flour gyp
Placoid-in between gyp

Dual particle-size classes / dual mineralogy classes observed in field at Dell City, Texas

coarse-loamy over pulvurulent / mixed over hypergypsic: Goodleg series
fine-loamy over xx / mixed over hypergypsic: Twinleg series
fine over xx / smectitic over hypergypsic: Badleg series

Key to Orders

G. Other soils that:

1. Have:

a. An aridic soil moisture regime; *and*

b. An ochric or anthropic epipedon; *and*

c. *One or more* of the following with the upper boundary within 100 cm of the soil surface: a cambic horizon with a lower depth of 25 cm or more; a cryic temperature regime and a cambic horizon; a calcic, petrocalcic, gypsic, hypergypsic, petrogypsic, or salic horizon; or a duripan; *or*
d. An argillic or natric horizon; *or*

2. Have a salic horizon; *and*

a. Saturation with water in one or more layers within 100 cm of the soil surface for 1 month or more during a normal year; *and*

b. A moisture control section that is dry in some or all parts at some time during normal years; *and*

c. No sulfuric horizon that has its upper boundary within 150 cm of the mineral soil surface.

Aridisols

Key to Suborders

GD. Other Aridisols that have a gypsic, hypergypsic, or petrogypsic horizon that has its upper boundary within 100 cm of the soil surface and do not have a petrocalcic horizon overlying these horizons.

Gypsids

Key to Great Groups

GDA. Gypsids that have a petrogypsic or petrocalcic horizon that has its upper boundary within 100 cm of the soil surface.

Petrogypsids

GDB. Other Gypsids that have a natric horizon that has its upper boundary within 100 cm of the soil surface.

Natrigypsids

GDC. Other Gypsids that have a hypergypsic horizon that has its upper boundary within 100 cm of the soil surface.

Hypergypsids

GDD. Other Gypsids that have an argillic horizon that has its upper boundary within 100 cm of the soil surface.

Argigypsids

GDE. Other Gypsids that have a calcic horizon that has its upper boundary within 100 cm of the soil surface.

Calcigypsids

GDF. Other Gypsids

Haplogypsids

Argigypsids

Key to Subgroups

GDDA. Argigypsids that have a lithic contact within 50 cm ofthe soil surface.

Lithic Argigypsids

GDDB. Other Argigypsids that have:

1. Cracks within 125 cm of the soil surface that are 5 mmor more wide through a thickness of 30 cm or more for some time in normal years and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the soil surface; *or*

2. A linear extensibility of 6.0 cm or more between the soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower.

Vertic Argigypsids

GDDC. Other Argigypsids that have a calcic horizon overlying the gypsic horizon.

Calcic Argigypsids

Basso series

Talos series

GDDD. Other Argigypsids that have one or more horizons, within 100 cm of the soil surface and with a combined thickness of 15 cm or more, that contain 20 percent or more (by volume) durinodes, nodules, or concretions.

Petronodic Argigypsids

GDDE. Other Argigypsids that have *both*:

1. A moisture control section that is dry in all parts for less than three-fourths of the time (cumulative) when the soil temperature is 5 oC or higher at a depth of 50 cm and a soil moisture regime that borders on xeric; *and*

2. Throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the soil surface, *one or both* of the following:

a. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent is cinders, pumice, and pumicelike fragments; *or*

b. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter, of which 5 percent or more is volcanic glass, and [(Al plus 1/2 Fe, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is 30 or more.

Vitrixerandic Argigypsids

GDDF. Other Argigypsids that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the soil surface, *one or both* of the following:

1. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent is cinders, pumice, and pumicelike fragments; *or*

2. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter, of which 5 percent or more is volcanic glass, and [(Al plus 1/2 Fe, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is 30 percent or more.

Vitrandic Argigypsids

GDDG. Other Argigypsids that have a moisture control section that is dry in all parts for less than three-fourths of the time (cumulative) when the soil temperature at a depth of 50 cm is 5 oC or higher and have a soil moisture regime that borders on xeric.

Xeric Argigypsids

GDDH. Other Argigypsids that have a moisture control section that is dry in all parts for less than three-fourths of the time (cumulative) when the soil temperature at a depth of 50 cm is 5 oC or higher and have a soil moisture regime that borders on ustic.

Ustic Argigypsids

GDDI. Other Argigypsids.

Typic Argigypsids

Calcigypsids

Key to Subgroups

GEEA. Calcigypsids that have a lithic contact within 50 cm of the soil surface.

Lithic Calcigypsids

GEEB. Other Calcigypsids that have one or more horizons, within 100 cm of the soil surface and with a combined thickness of 15 cm or more, that contain 20 percent or more (by volume) durinodes, nodules, or concretions.

Petronodic Calcigypsids

GEEC. Other Calcigypsids that have *both*:
1. A moisture control section that is dry in all parts for less than three-fourths of the time (cumulative) when the soil temperature is 5 oC or higher at a depth of 50 cm and a soil moisture regime that borders on xeric; *and*
2. Throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the soil surface, *one or both* of the following:
a. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent is cinders, pumice, and pumicelike fragments; *or*
b. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter, of which 5 percent or more is volcanic glass, and [(Al plus 1/2 Fe, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is 30 or more.

Vitrixerandic Calcigypsids

GEED. Other Calcigypsids that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the soil surface, *one or both* of the following:
1. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent is cinders, pumice, and pumicelike fragments; *or*
2. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter, of which 5 percent or more is volcanic glass, and [(Al plus 1/2 Fe, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is 30 or more.

Vitrandic Calcigypsids

GEEE. Other Calcigypsids that have a moisture control section that is dry in all parts for less than three-fourths of the time (cumulative) when the soil temperature at a depth of 50 cm is 5 oC or higher and have a soil moisture regime that borders on xeric.

Xeric Calcigypsids

GEEF. Other Calcigypsids that have a moisture control section that is dry in all parts for less than three-fourths of the time (cumulative) when the soil temperature at a depth of 50 cm is 5 oC or higher and have a soil moisture regime that borders on ustic.

Ustic Calcigypsids
Monahans series
Reeves series

GDEG. Other Calcigypsids.

Typic Calcigypsids

Jato series

Haplogypsids

Key to Subgroups

GEFA. Haplogypsids that have a lithic contact within 50 cm of the soil surface.

Lithic Haplogypsids

GEFB. Other Haplogypsids that have a gypsic horizon that has its upper boundary within 18 cm of the soil surface.

Leptic Haplogypsids

GEFC. Other Haplogypsids that have, in a horizon at least 25 cm thick within 100 cm of the mineral soil surface, an exchangeable sodium percentage of 15 or more (or an SAR of 13 or more) during at least 1 month in normal years.

Sodic Haplogypsids

GEFD. Other Haplogypsids that have one or more horizons, within 100 cm of the soil surface and with a combined thickness of 15 cm or more, that contain 20 percent or more (by volume) durinodes, nodules, or concretions.

Petronodic Haplogypsids

GEFE. Other Haplogypsids that have *both*:
1. A moisture control section that is dry in all parts for less than three-fourths of the time (cumulative) when the soil temperature is 5 oC or higher at a depth of 50 cm and a soil moisture regime that borders on xeric; *and*
2. Throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the soil surface, *one or both* of the following:
a. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent is cinders, pumice, and pumicelike fragments; *or*
b. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter, of which 5 percent or more is volcanic glass, and [(Al plus 1/2 Fe, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is 30 or more.

Vitrixerandic Haplogypsids

GEFF. Other Haplogypsids that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the soil surface, *one or both* of the following:
1. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent is cinders, pumice, and pumicelike fragments; *or*
2. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter, of which 5 percent or more is volcanic glass, and [(Al plus 1/2 Fe, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is 30 or more.

Vitrandic Haplogypsids

GEFG. Other Haplogypsids that have a moisture control section that is dry in all parts for less than three-fourths of the time (cumulative) when the soil temperature at a depth of 50 cm is 5 oC or higher and have a soil moisture regime that borders on xeric.

Xeric Haplogypsids

GEFH. Other Haplogypsids that have a moisture control section that is dry in all parts for less than three-fourths of the time (cumulative) when the soil temperature at a depth of 50 cm is 5 oC or higher and have a soil moisture regime that borders on ustic.

Ustic Haplogypsids

Dillyhunt series

GEFI. Other Haplogypsids.

Typic Haplogypsids

Hypergypsids

Key to subgroups

GDCA. Hypergypsids that have a lithic contact that has its upper boundary within 50 cm of the soil surface.

Lithic Hypergypsids
Elcor series

GDCB. Other Hypergypsids that have
1. a hypergypsic horizon that has its upper boundary within 15 cm of the soil surface, *and*
2. a moisture control section that is dry in all parts for less than three-fourths of the time (cumulative) when the soil temperature at a depth of 50 cm is 5 oC or higher and have a soil moisture regime that borders on ustic.

Leptic Ustic Hypergypsids
Hollomex series

GDCC. Other Hypergypsids that have a hypergypsic horizon that has its upper boundary within 15 cm of the soil surface.

Leptic Hypergypsids
Peligro series

GDCD. Other Hypergypsids that have
1. in a horizon at least 5 cm thick within 100 cm of the mineral soil surface, an exchangeable sodium percentage of 15 or more (or an SAR of 13 or more) during at least 1 month in normal years, *and*
2. a sucrosic substitute for particle size class through a thickness of 100 cm

Sodic Torripsammentic Hypergypsids
Psamlegro series

GDCE. Other Hypergypsids that have a sucrosic substitute for particle size class through a thickness of 100 cm.

Torripsammentic Hypergypsids
Gumo series

GDCF. Other Hypergypsids that have, in a horizon at least 5 cm thick within 100 cm of the mineral soil surface, an exchangeable sodium percentage of 15 or more (or an SAR of 13 or more) during at least 1 month in normal years

Sodic Hypergypsids
Badleg series

GDCG. Other Hypergypsids that have a calcic horizon that has its upper boundary within 100 cm of the soil surface.

Calcic Hypergypsids
Loki series

GDCH. Other Hypergypsids that have a moisture control section that is dry in all parts for less than three-fourths of the time (cumulative) when the soil temperature at a depth of 50 cm is 5 oC or higher and have a soil moisture regime that borders on xeric.

Xeric Hypergypsids

GDCI. Other Hypergypsids that have a moisture control section that is dry in all parts for less than three-fourths of the time (cumulative) when the soil temperature at a depth of 50 cm is 5 oC or higher and have a soil moisture regime that borders on ustic.

Ustic Hypergypsids

GDCJ. Other Hypergypsids

Typic Hypergypsids
Twinleg series
Goodleg series

Petrogypsids

Key to Subgroups

GDAA. Petrogypsids that have a lithic contact that has its upper boundary within 50 cm of the soil surface

Lithic Petrogypsids

GDAB. Other Petrogypsids that have
1. a lithic contact that has its upper boundary within 50 cm of the soil surface, *and*
2. a hypergypsic horizon that has its upper boundary within 15 cm of the soil surface, *and*
3. a moisture control section that is dry in all parts for less than three-fourths of the time (cumulative) when the soil temperature at a depth of 50 cm is 5 oC or higher and have a soil moisture regime that borders on ustic.

Leptic Lithic Ustic Petrogypsids
Hollebeke series

GDAC. Other Petrogypsids that have a hypergypsic horizon that has its upper boundary within 15 cm of the soil surface.

Leptic Petrogypsids
Corvus series

GDAD. Other Petrogypsids that have
1. a hypergypsic horizon that has its upper boundary within 15 cm of the soil surface, *and*
2. a moisture control section that is dry in all parts for less than three-fourths of the time (cumulative) when the soil temperature at a depth of 50 cm is 5 oC or higher and have a soil moisture regime that borders on ustic.

Leptic Ustic Petrogypsids
Cavewell series
Pokorny series

GDAE. Other Petrogypsids that have a moisture control section that is dry in all parts for less than three-fourths of the time (cumulative) when the soil temperature at a depth of 50 cm is 5 oC or higher and have a soil moisture regime that borders on ustic.

Ustic Petrogypsids
Joberanch series

GDAF. Other Petrogypsids that have a moisture control section that is dry in all parts for less than three-fourths of the time (cumulative) when the soil temperature at a depth of 50 cm is 5 oC or higher and have a soil moisture regime that borders on xeric.

Xeric Petrogypsids

GDAG. Other Petrogypsids

Typic Petrogypsids


Plate 1. Just west of Stop 6, FM Road 652 passes through a series of castiles where gypsum has been biogenically altered to calcite.


Plate 2. Road-cut exposure of gyprock at Stop 6. A veneer of gypsite about 20 cm thick occurs at the surface.


Plate 3. Very sparse cover of gyp grama at Stop 7.


Plate 4. Profile of the Elcor soil at Stop 7.

Plate 5. Close-up view of horizons from the Elcor soil.

Plate 7. Vegetation at Stop 8 is more diverse and productive than the plant community at Stop 7.

Plate 6. Close-up vertical view of biological / chemical crust on an Elcor soil.

Plate 8. Profile of the Hollebeke soil at Stop 8.

Plate 9. Boxworks weathering on Castile gyprock at Stop 8.

Plate 11. Close spatial pattern of Pokorny (light) and Joberanch (dark) soils.

Plate 10. Gyp grama growing on a thin silicate-rich A horizon, Cavewell-Hollebeke complex, 1 to 8 percent slopes.

Plate 12. Creosotebush vegetation on Pokorny-Joberanch complex, 0 to 2 percent slopes at Stop 9.

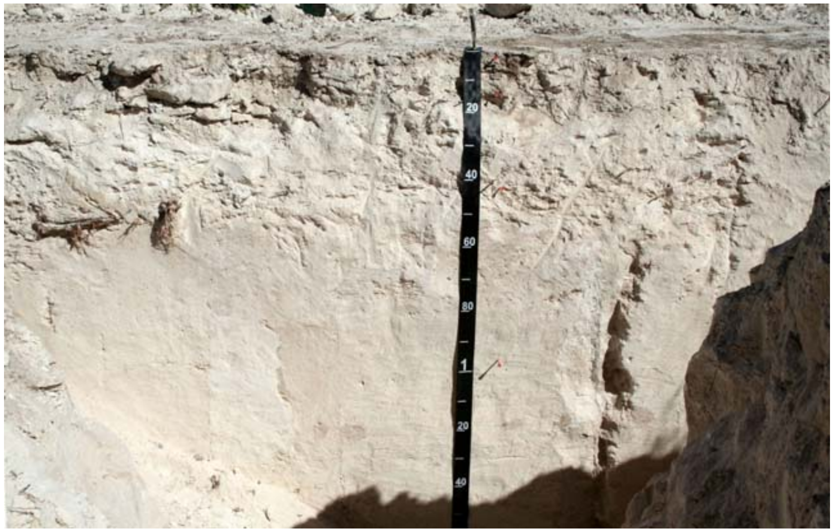

Plate 13. Soil profile of Pokorny soil at Stop 9.

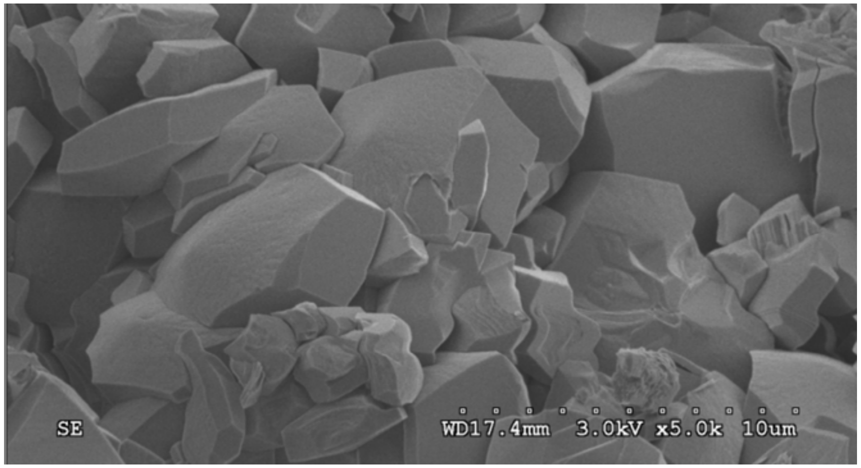

Plate 15. Scanning electron micrograph of Pokorny Byym2 horizon.

Plate 14. Slickensides on prism surface of Byym3 horizon, Pokorny soil at Stop 9.

Plate 16. Alkali sacaton dominates the plant community at Stop 10.

Plate 17. Discontinuous pedo-resistant laminae within Byym horizons of Shippingpens soil at Stop 10.


Plate 19. Landscape and vegetation of a small karst depression, northern Culberson County.

Plate 18. Flattened roots in crack between prism surfaces within Byym horizons, Shippingpens soil, Stop 10.


Plate 20. Runoff water draining into karst outlet, central Culberson County, Texas.