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SHORELINE FACIES OF THE YESO FORMATION IN THE NORTHERN PEDERNAL HILLS

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INTRODUCTION

The Pedernal Hills are near the geographic center of New Mexico, on the western edge of the Great Plains about 80 km east–southeast of Albuquerque. The hills form a 150- to 450-m-high upland, east of the Estancia Valley, and slope gently eastward to merge with the High Plains. This 650-km^2 raised area is underlain chiefly by rocks of Precambrian age—mostly rounded granite-gneiss knobs on the south that give way northward to sharp, rugged ridges of metaquartzite—and culminates at Pedernal Mountain, altitude 2307 m. In depositional contact with the Precambrian units are shoreline facies of the middle Permian Yeso Formation, alluvial beds of the Ogallala Formation, pediment sediments and alluvium.

PREVIOUS WORK

The Precambrian rocks have been described by Fallis (1958), Woodward and Fitzsimmons (1965), Gonzales (1968), Gonzales and Woodward (1972) and Armstrong and Holcombe (1982). Depositional relationships of the Yeso on the Precambrian were noted by Johnson (1902), Meinzer (1911), Darton (1928), Thompson (1942), Read and Wood (1947), Smith (1957), Fallis (1958), Kottlowski and Foster (1960), Kottlowski (1960, 1971) and Kelley (1972). Fallis (1958) described the Yeso Formation, correlating the basal facies that is unconformable on the Precambrian rocks, as the Meseta Blanca Sandstone Member and noted that angular quartzite fragments as much as 30 cm in diameter occur locally, in a matrix of fine- to medium-grained Yeso sandstone, near hills of Precambrian rocks.

LATE PALEOZOIC PEDERNAL LANDMASS

A north–south chain of ranges extends southward from the Pedernal Hills: the Gallinas Mountains, Jicarilla Mountains, Sierra Blanca and the Sacramento Mountains. Roughly speaking, this chain of ranges parallels the partly buried remnants of the higher parts of the late Paleozoic Pedernal landmass. This Pennsylvanian–Permian mountain range supplied some detritus to the Permian Basin; at that time the paleogeography was similar to present-day topographic relationships if sea level were raised about 1800 m. The higher parts of the Pedernal landmass were in central New Mexico and supplied large amounts of eroded materials to depositional basins to the west, in areas more or less outlined by the Estancia and Tularosa basins. Eastward, toward the Permian Basin, was a relatively gentle slope, the battleground of land and sea, where shorelines fluctuated many kilometers and changes in sea level were slight.

The Pedernal Hills area was only a small part of the Pedernal landmass, but it was important for at least three reasons: first, it was the northern end of the Pedernal upland, with possible connections to the Sierra Grande arch to the northeast and the Uncompahgre axis to the northwest; secondly, it was one of the higher parts of the Pedernal landmass where, locally, middle Leonardian and even Triassic strata overlie the Precambrian rocks; and thirdly, it is one of the better preserved uplands of the Pedernal Mountains, being neither buried by post-Paleozoic sediments, nor removed by post-Paleozoic erosion.

Similar but smaller remnants of the Pedernal landmass occur to the north–northeast in the southeastern Sangre de Cristo Mountains; as southern outliers of the Pedernal Hills in Cerro del Pino, Chameleon Hill and Rattlesnake Hill; on the Cerrito del Lobo to the northwest; and farther south in the Gallinas Mountains, as well as in the Sacramento Mountains near Bent and at Pajarito Mountain.

Deposition during Pennsylvanian and Early Permian time tended to fill in the depressions and erode away the uplands. The major uplift and maximum erosion appear to have occurred during latest Pennsylvanian and earliest Permian time. This episode ended in central New Mexico with deposition of the continental Abo red beds.

During Pennsylvanian time, probably chiefly during the latter part of that period, as much as 1200 m of clastic strata with some interbedded limestones were dumped westward into the Estancia trough, derived mainly from the Pedernal landmass. The overlying basal Permian is of intercalated limestone and red beds that grade upward into arkoses and red shales of the Abo red beds and mark a change from marine sedimentation of Late Pennsylvanian and Early Permian time to the continental Abo deposition of middle and late Wolfcampian time. Nowhere within the basins or near the uplands does there appear to be an appreciable break between the Abo red beds and the overlying marine sandstones, dolomites and gypsum of the Leonardian Yeso Formation. The Yeso in turn appears to grade upward into the Glorieta Sandstone, and the Glorieta intertongues with the overlying San Andres Limestone of central New Mexico.

The Abo and older strata pinch out abruptly against the Pedernal massif, as shown in oil tests drilled in the Estancia basin. The contact between the various sedimentary units and the Precambrian rocks on the west side of the Pedernal Hills dips at angles of only 5 to 6°. The apparent steep west side of the Pedernals, therefore, does not need to be explained by faulting. Normal faults cutting the Yeso Formation along the west edge of the Pedernal Hills have relatively insignificant displacements, and the present-day exhumed Pedernal Hills are surrounded by onlapping beds of the Yeso Formation. Faults mapped by Fallis (1958) along the west side have a maximum displacement of 60 m; Kelley (1972) suggested displacements of 60 to 90 m. He pointed out that the structure indicates two periods of faulting, the younger system being probably of Laramide age. Armstrong and Holcombe (1982) suggest displacement of 400 m based on subsurface resistivity data.

Keller et al. (1984) complicate the consideration of the Pedernal Hills structure by their observation, based on newly compiled gravity and aeromagnetic maps (scale 1:500,000), that the Precambrian rocks are rootless, i.e., underlain by a thrust zone, with perhaps Paleozoic strata beneath the thrust. If this is the situation, the thrusting should be pre-Yeso because the delicate contact relationships of soft Yeso sandstones abutting Precambrian quartzite hills would have been disturbed by large-scale movements of thrust plates.

YESO SHORELINE SEDIMENTS

The basal Yeso sediments were deposited in quiet, shallow, warm seas and filled the channels and embayments around the shoreline of the main Pedernal massif and its surrounding islands. Most of the basal part of these ancient-shoreline sediments appears to be reworked local alluvium derived from the metaquartzites and schists that form the northern Pedernal Hills. This area is marked, at present, as during Permian time, by scattered hills of Precambrian quartzite surrounded by outcrops of Yeso strata. The basal beds of the Yeso rest upon, and abutt against, quartzites on the steep original sides of these Early Permian ridges of Precambrian metaquartzite, which stood 60 to 250 m above the early Yeso seas and were gradually buried amid their own debris.

Even in the ancient valleys the basal Yeso rests unconformably upon the Precambrian, where in places the basal rubble conglomerate of the Yeso is almost horizontal and overlies steeply dipping metaquartzite beds. This basal conglomerate of the Yeso consists of angular cobbles and boulders of quartzite in matrix of tan, fine-grained, porous, even-

bedded marine sandstone. Many of the coarse fragments were from rubble that lay on the pre-deposition surface. However, as shown by large, angular, isolated quartzite clasts in higher sandstones, many of the larger fragments fell and rolled from nearby quartzite ridges into the sea-bottom sands. Sand-cemented talus borders some of the quartzite ridges and grades laterally into "breccia"-conglomerate lenses.

Most of the sandstone beds are thinly and evenly bedded, but there are local lenses of crosslaminated sandstone which appear to be deltaic deposits, although some are channel-fill-sand bodies and few are wedge-shaped, high-angle, well-sorted, crosslaminated sands of probable dunal origin.

Regularly spaced oscillation marks are the most common type of ripple marks occurring on the horizontally bedded sandstones. In most cases the strike of the crests and troughs parallels the ancient shorelines.

Scattered throughout this porous, dominantly sandstone sequence are thin but widespread beds of silty shale. Most of these shale beds are red or green, but several dark-gray shales occur.

The typical Yeso shoreline sediments of the Pedernal Hills are tan, even-bedded, porous, fossiliferous, marine sandstones with some intercalated sandy-shale laminae. There are some extensive beds of crosslaminated sandstone interbedded with the horizontally bedded strata. Continuous incline-bedded banks occur bounded above and below by horizontal strata, with the upper surface being one of truncation and the lower contact being a gradational one of the foreset beds grading downward and laterally into the bottomset sands. Some of these tabular banks or sets of crosslaminae are continuous for several kilometers, with the crosslaminae dipping about 15° with amazing similarity in size, dip, shape, grain size and grain composition.

In the lower part of the Yeso are brown, calcareous beds beginning with a lower bed best classified as calcareous sandstone, a middle bed of very arenaceous limestone and an upper bed of oolitic arenaceous limestone.

The arenaceous limestones are calcarenites with grains ranging from silt size to very coarse. Angular fragments of fossils and limestone grains predominate, followed by fragments of quartz, quartzite and minor feldspar. The upper part of the limestones is oolitic, and the bedding planes expose irregular patterns of burrows and sparse, badly broken shells of brachiopods, gastropods and pelecypods. Some of the fossil debris appears to be remnants of tubelike algal filaments perhaps belonging to the family Porostromata.

In thin section, these arenaceous limestones are revealed to be dolomitized arenaceous intramicrite. The terrigenous constituents range from 10 to 75% and consist of angular grains and slivers of quartz, quartzite, feldspars, muscovite and other noncarbonate minerals. The allochems are of intraclasts, fossil fragments, pellets and oolites, in about that order. The original cement seems to have been microcrystalline ooze; it has been recrystallized and partly replaced by microsparry dolomite and calcite.

The oolitic beds are of arenaceous intraclastic oosparite; the terrigenous grains are rounded to angular quartz, quartzite and minor feldspar, often occurring as cores of the oolites. The allochems are chiefly oolites, with sparse to abundant intraclasts; the matrix is coarsely crystalline sparry calcite.

Angular granules and pebbles of quartzite are scattered throughout these limestones. These larger fragments bear no relationship to other grains, nor to the lamination or any other depositional features. They resemble ice-rafted detritus found within fine-grained marine glacial deposits. These large pieces may have been moved occasionally by storm currents, but probably were merely scattered talus fragments that rolled off the adjoining quartzite ridges into the shallow calcium-carbonate-saturated seas.

The tan, evenly bedded, limy sandstones are shoreline sediments; they form the lower part of the Yeso Formation only on the edges of, and in local depositional pockets within, the Pedernal Hills. They appear to be reworked local alluvium that partially covered the Pedernal landmass during Early Permian time. The upper part of the Yeso Formation within the Pedernal Hills and most of the formation to the east and west consist of reddish-orange silty sandstone with interbeds of gypsum and arenaceous limestone. The orange sandstones have a bimodal grain-size distribution, and the grains are subrounded to rounded and chiefly of nonstrained quartz. They contrast with the impure tan sandstones and apparently were derived mainly from uplifts far north of the Pedernal Hills, as they are typical of the Yeso over much of central and north-central New Mexico. The Pedernal landmass was almost entirely buried by the Yeso and overlying Glorieta Sandstone, and ceased being a major source of detritus in middle Permian time.

In many areas around the Pedernal landmass, from the Pedernal Hills area southward to its junction with the Diablo Plateau, all of the Pennsylvanian and Lower Permian units appear to pinch out landward. These distinctive shoreline deposits should form lenticular stratigraphic traps abutting against the Pedernal landmass; they could contain oil fields wherever petroleum has migrated into them from source beds in the nearby marine basins. The relatively gentle southeastward slope from the Pedernals toward the Permian Basin was the locus of widely shifting shorelines, and could be the site of many stratigraphic traps in ancient shoreline sands.

KEY YESO OUTCROPS

One of the best and most accessible exposures is the field-trip stop along the small canyon south of Hill 6995 (N1/2, SE1/4 sec. 1, T7N, R12E). The north end of the hill is cut by the quarry of J. W. Construction Company, utilizing the Precambrian quartzite that makes up most of the hill.

The Yeso Formation in the canyon consists of tan, even-bedded, porous marine sandstones bearing oscillation ripple marks. Interbeds are of shaley siltstones and oolitic sandy limestone containing scattered angular metaquartzite fragments. Traced eastward and across Highway 285 to the bluffs called Red Hill, the tan sandstones underlie reddish-orange silty sandstones, which have a bimodal grain-size distribution and subrounded to rounded grains, similar to the basal Yeso in much of central New Mexico.

Two of the more interesting features of this outcrop are scattered angular fragments in otherwise relatively uniform sandstones and limestone; these obviously were dropped in from the nearby quartzite hills. The second feature is the limestone beds (described previously) in a unit that begins at the base as a limy sandstone, then a bed of very arenaceous limestone and an upper bed of oolitic limestone. A measured section extended eastward to the Red Hill bluffs shows about 18 m of tan feldspathic sandstone and minor siltstone below the limestone unit, then more than 60 m of more typical Yeso reddish-orange sandstones and siltstones and Cenozoic alluvium.

The group of hills at the northwest corner of the Pedernal Hills is composed of quartzite, with flanks and valleys of Yeso outcrops. The gully in SW1/4 sec. 32, T8N, R12E exhibits Yeso sandstones angularly unconformable on quartzite and containing angular blocks of quartzite in a matrix of yellowish-brown fine-grained sandstone. Between the sandstone and shattered foliated quartzite are 30- to 60-cm-thick lenses of quartzite breccia cemented by fine-grained sandstone.

The east–west valley in S1/2 sec. 6, T7N, R12E has numerous outcrops of basal Yeso on Precambrian quartzite. In places the dip of sandstones off the flanks of the quartzite hills is as much as 15°, with cemented rubble at the contact. Clean exposures of the steep depositional contact show more than 20 m of relief, and as much as 90 m is exhibited by scattered outcrops. The initial surface invaded by Yeso seas and buried by Yeso sediments was rugged, with sharp quartzite ridges and hills cut by small canyons.

REFERENCES

Armstrong, D, G. and Holcombe, R. J., 1982, Precambrian rocks of a portion of the Pedernal highlands, Torrance County, New Mexico: New Mexico Geological Society, Guidebook 34, pp. 203–210.

Darton, N. H., 1982, "Red beds" and associated formations in New Mexico: U.S. Geological Survey, Bulletin 794, 356 pp.

Fallis, J. F., Jr., 1958, Geology of the Pedernal Hills area, Torrance County, New Mexico [M.S. thesis]: Albuquerque, University of New Mexico, 50 pp.

Gonzales, R. A., 1968, Petrography and structure of the Pedernal Hills, Torrance County, New Mexico [M.S. thesis]: Albuquerque, University of New Mexico, 78 pp.

Gonzales, R. A. and Woodward, L. A., 1972, Petrology and structure of the Pedernal Hills, Torrance County, New Mexico: New Mexico Geological Society, Guidebook 23, pp. 144–147.

Johnson, D. W., 1902, Notes of a geological reconnaissance in eastern Valencia County, New Mexico: American Geologist, v. 29, p. 87.

Keller, G. R., Cordell, L. and Suleiman, A. S., 1984, Geophysical evidence for allochthonus terraces in northern New Mexico and southern Colorado: Geological Society of America, Abstracts with Programs, v. 16, p. 557.

Kelley, V. C., 1972, Geology of the Fort Sumner sheet, New Mexico: New Mexico Bureau of Mines and Mineral Resources, Bulletin 98, 55 p.

Kottlowski, F. E., 1960, Summary of Pennsylvanian sections in southwestern New Mexico and southeastern Arizona: New Mexico Bureau of Mines and Mineral Resources, Bulletin 66, 187 pp.

Kottlowski, F. E., 1971, Influence of the Pedernal uplift on sedimentation; *in* Basins of the Southwest: West Texas Geological Society, v. 1, pp. 21–40.

Kottlowski, F. E. and Foster, R. W., 1960, Ancient shoreline sedimentary rocks of Permian age, northern Pedernal Hills, New Mexico: Geological Society of America, Bulletin, v. 71, pp. 1908–1909.

Meinzer, O. E., 1911, Geology and water resources of the Estancia Valley, New Mexico: U.S. Geological Survey, Water-supply Paper 275, 89 pp.

Read, C. B. and Wood, G. H., 1947, Distribution and correlation of Pennsylvanian rocks in late Paleozoic sedimentary basins of northern New Mexico: Journal of Geology, v. 55, pp. 220–236.

Smith, R. E., 1957, Geology and ground-water resources of Torrance County, New Mexico: New Mexico Bureau of Mines and Mineral Resources, Groundwater Report 5, 186 pp.

Thompson, M. L., 1942, Pennsylvanian System in New Mexico: New Mexico Bureau of Mines and Mineral Resources, Bulletin 17, 90 pp.

Woodward, L. A. and Fitzsimmons, F. P., 1967, Precambrian banded iron formation, Pedernal Peak, Torrance County, New Mexico: New Mexico Geological Society, Guidebook 18, p. 228.

Phytosaur teeth in conglomerate of Chinle Redonda Member at Apache Canyon (photo: S. G. Lucas)