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Frank E. Kottlowski
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PENNSYLVANIAN ROCKS ON THE NORTHEAST EDGE OF THE DATIL PLATEAU

by Frank E. Kottlowski [1]

Pennsylvanian strata crop out in a few of the mountain ranges of the northeastern Datil volcanic plateau, are exposed in windows in the lavas, crown the uplifts on the west border of the Rio Grande trough, and are scattered among the pines in the Zuni Mountains. On the plain-and-mesa structural slope from the Zuni Mountains south to the Datil area a few oil tests have penetrated the Pennsylvanian rocks at depths down to more than a mile (fig. 1).

The available measured sections suggest the occurrence of a reasonably thick marine sequence southeast of the Zuni Mountains, and probably under much of the volcanic rock of the Datil-Mogollon Plateau. Structures on the slope, from the Zuni Mountains southward to beneath the Datil volcanic rocks, are gentle folds and normal faults with relatively small displacement. As noted by Wengerd (1958b), petroleum accumulation should be expected in reef masses or bioclastic lenses bordering the low Pennsylvanian Zuni-Defiance landmass (fig. 1). On the edge of such a positive area, there is always the possibility of a thick section a few miles away from a local upland source, where thick wedges of "granite wash" (porous arkose) may lie on the margin of a basin as yet imperfectly known or unknown.

PRE-PENNSYLVANIAN ROCKS

Scattered erosional remnants of Mississippian strata underlie the Pennsylvanian in the Magdalena Mountains (section 52, fig. 1 and table 1), Lemitar Mountains (section 50, fig. 1), Ladron Mountains (sections 36 and 37, fig. 1), and Manzano Mountains (section 38, fig. 1), as well as in the Sandia Mountains east of Albuquerque and the Penasco Canyon area northwest of Zia (Armstrong, 1955, 1958). Beneath these Mississippian beds, and beneath the Pennsylvanian throughout most of west-central New Mexico, are igneous and metamorphic rocks generally referred to the Precambrian. Similar rocks underlie the Cambrian Bliss sandstone to the south and the Cambrian Ignacio quartzite to the north (Baars and Knight, 1957); thus the assignment to the Precambrian. Devonian strata occur in the Four Corners area to the north, and as far north as the southern Oscura Mountains (south of section 59, fig. 1) in southern New Mexico, but are not present in the field conference area. Silurian and Ordovician rocks were not preserved in the Four Corners-San Juan Basin area but crop out as southward-thickening wedges 20 to 45 miles south of the area shown on figure 1.

In the Zuni Mountains, the Precambrian is chiefly granite gneiss and gneissoid granite, with some metarhyolite and various micaceous schists (Smith, 1958, 1959). Metasediments (quartzite, schist, argillite-greenstone) and felsite-metarhyolite, diabase, and pegmatites from significant parts of the Precambrian outcrops in the Manzano, Ladron, and Magdalena Mountains, Socorro Peak, and the Coyote Hills (section 57, fig. 1), and are present in the Marshall-Miller and Acme Development Co.-Santa Fe oil tests (nos. 1 and 26, fig. 1). The Huckleberry-Federal and Skelly-Goesling (nos. 30 and 29, fig. 1) tests encountered typical red granite below Paleozoic sediments, as did most of the oil tests in the northeastern part of the area. Lowest rocks penetrated in the Acme-Development Co.-Santa Fe oil test appear to consist of arkose or granite wash, micaceous sandstone or micaceous schist, white quartzitic sandstone or quartzite, and granite or granite wash. These rocks below a depth of 4,610 feet have been accepted as being Precambrian, but the arkose and quartzite between depths of 4,145 and 4,610 feet include some sandy limestone, and have been called basal Pennsylvanian by some geologists and Precambrian by others.

PENNSYLVANIAN ROCKS OF THE NORTHERN DATIL PLATEAU

The northern edge of the Datil volcanic plateau is drawn essentially on the northern outcrop of the Datil volcanic group or the Baca formation from the vicinity of Quemado eastward to just south of Puertecito(pertinent point 41, fig. 1) and Riley. The Snake Ranch Flats, east of the Bear Mountains (pertinent point 43, fig. 1) and Magdalena Mountains, are arbitrarily considered the east boundary. Pennsylvanian outcrops occur in the Magdalena Mountains

Table 1—Oil Tests, Pennsylvanian Sections, and Pertinent Localities in West-Central New Mexico. (see figure 1).

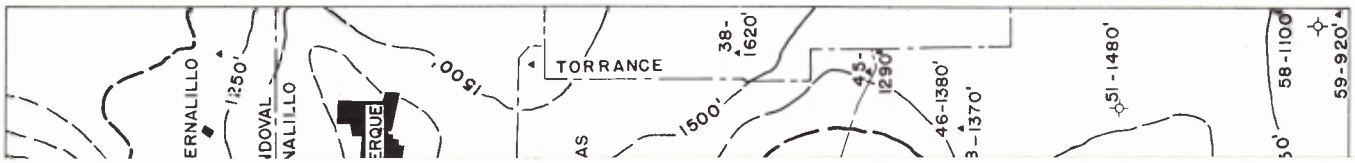
Pennsylvanian Sections

1. Marshall-Miller oil test, 3-15N-19W
2. Tidewater-Mariano oil test, 8-15N-13W
3. Plymouth-Santa Fe oil test, 13-15N-10W
4. Richfield-Drought oil test, 4-15N-6W
5. Avila-Odlum oil test, 15-15N-1W
7. Superior-San Mateo oil test, 14-14N-8W
8. Continental-Evans oil test, 2-13N-4W
9. Humble-Santa Fe oil test, 20-14N-1W
12. Section NW of Page
14. Section SW of Page
15. Section along Cottonwood Creek
19. Section along Bluewater Creek
20. Outcrops in Sawyer area
22. Section near La Jara Spring
23. Larrazolo-Gottlieb oil test, 21-10N-9W
26. Acme Development Co.-Santa Fe oil test, 27-7N-4W
29. Skelly-Goesling strat test, 27-3N-21W
30. Huckleberry-Federal oil test, 11-2N-16W
33. Mitchel-Red Lake oil test, 2-3N-8W
34. Mesa Aparejo section
35. Mesa Sarca section
36. Northern Ladron Mountains section
37. Southern Ladron Mountains section
38. Manzano Mountains composite section
45. Abo Pass section
46. Section on Sierra Montosa
47. Joyita Hills section
48. Section on Turret Mesa
50. Polvadera Mountain section
51. Skelly-Goddard oil test, 22-2S-4E
52. Magdalena Mountains section
53. Cerros de Amado section
54. Socorro Peak section
55. Section along Trout Creek
58. Section in northern Oscura Mountains
59. Sun-Bingham State oil test, 23-5S-5E

Other Localities

6. Fort Wingate
10. Pinehaven
11. McGaffey

[1] New Mexico Bureau of Mines and Mineral Resources, New Mexico Institute of Mining and Technology.



exposed section includes interbeds (?) of pink calcareous shale and brown lenticular arkosic sandstone. Fossil-fragment calcarenite and algal micro-oolitic limestone appear to be the most common carbonate rocks. Some of the clastic limestones contain scattered grains of red siltstone and local lenses of limestone conglomerate. Postulating 200 to 400 feet of early Pennsylvanian below the measured section, and at least 300 feet of late Desmoinesian, Missourian, and Virgilian strata above, the Pennsylvanian section may have a thickness of 1,100 feet or more.

Just across the state line in Arizona, on the northwest edge of Escudilla Mountain 13 miles northwest of section 55, on figure 1, Professor Donald Bryant of the University of Arizona reported Virigilian fusulinids collected from a few feet of limestone underlying basal Tertiary volcanic rocks.

Huckleberry-Federal oil test. This test, drilled 5 miles north of Quemado, went through thick Cretaceous, Triassic, and Permian sequences into red granite. The basal 70 to 200 to 230 feet of redbeds above the granite have been correlated by various means (electric log characteristics, gray shale chips, etc.) with fossiliferous upper Pennsylvanian rocks in other wells drilled near the Zuni Mountains. Although some of this basal clastic section may be of Pennsylvanian age (as are some of the lower Supai redbeds to the west in Arizona) it is not a marine limestone Pennslyvanian section and appears to have been deposited on the margin of, or at no great distance from, the low-lying Pennsylvanian Zuni uplift. Similar redbeds are reported (Foster, 1957) above granite in the Skelly-Goesling strat test (no. 29, fig. 1) 32 miles to the west, almost on the New Mexico-Arizona boundary.

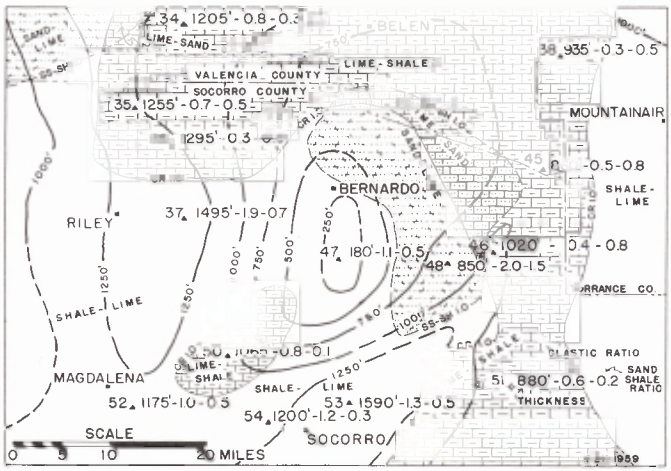
PENNSYLVANIAN ROCKS SOUTH OF THE ZUNI MOUNTAINS

From Atarque eastward to Acoma, the occurrence of Pennsylvanian strata is conjectural. Only Mitchel-Red Lake oil test (no. 33, fig. 1), drilled in 1924 has penetrated the Pennsylvanian which appears to be about 570 feet thick (Darton, 1928). Abo beds above the Magdalena limestone are mainly red shale and siltstone, with "lime" and "lime shells" scattered throughout. Clastic beds make up almost 80 percent of the Magdalena, but about 75 percent of these rocks are shales. The lower Abo consists of fine-grained sediments, appears to be gradational with the Magdalena, and may be of late Pennsylvanian age. The sediments appear to be typical of expected shallow marine deposits laid down southeast of, and at a considerable distance from, the Pennsylvanian Zuni uplift.

The thin clastic-rock sections of the Pennsylvanian in the Zuni Mountains, and the lack of marine Pennsylvanian in the Skelly-Goesling and Huckleberry-Federal tests (perhaps also the lack at present of other test wells) suggest that westernmost Valencia County was the high core of the low-lying Pennsylvanian uplift and the source of arkosic and quartzose sediments to the south and east.

PENNSYLVANIAN ROCKS OF THE ACOMA SAG AND UPLIFTS BORDERING THE RIO GRANDE GRABEN

Pennsylvanian strata are exposed prominently along



DERRYAN-DESMOINESIAN ISOPACH AND LITHOFACIES MAP OF JOYITA HILLS AREA

CONTOUR INTERVAL 250 FEET. SECTION NUMBERS FROM TABLE 1. THICKNESSES ARE MOSTLY ESTIMATES.

FIGURE 3

Co. (not on fig. 1) as well as in the wells drilled in southeastern McKinley County and southwestern Sandoval County.

The types of Pennsyqlvanian rocks and their thicknesses suggest, as noted by Wengerd (1958a, 1958b, 1959), an area of thick marine sedimentation - the Lucero basin (fig. 1) - probably connecting northward via the Cabezon sag with the San Juan Basin, and southward, southwest of Socorro, with the San Mateo basin. The waters of these basins and sags probably were only a few score or a few hundred feet deeper than those on the edges of the Pennsylvanian Zuni uplift, but the basinal sea bottoms sank more rapidly, allowing deposition of a thicker marine section. Dark shales and silty sandstones typical of sedimentation in deep marine basins such as the Permian Basin of southeastern New Mexico and west Texas form minor to considerable parts of the Cabezon-Lucero-San Mateo Pennsylvanian sequence.

Socorro area. Only the lower part of the Pennsylvanian remains beneath the early Tertiary erosion surface in the Socorro-Lemitar Mountains, but 8 miles across the Rio Grande the full Pennsylvanian sequence is 2,130 feet thick in Cerros de Amado (section 53, fig. 1; Wilpolt and Wanek, 1951). The lower Pennsylvanian (chiefly Derryan) includes much black shale, thick quartzose sandstones, silty coquinoid limestones, and coaly laminae. Upper beds above the cherty Desmoinesian limestones are interbedded fossiliferous limestones and marine shales with some thick biostromal masses and small algal bioherms. Eastward and southeastward, in the Skelly-Goddard and Sun-Bingham State oil tests and northern Oscura Mountains (nos. 51, 59, 58, fig. 1), the Pennsylvanian thins apparently uniformly throughout the faunal subdivisions.

Ladron Mountains. One of the thickest sections in this area is at the southern edge of the Ladron Mountains, where the Pennsylvanian is probably about 2,700 feet thick.

shale beds in the Desmoinesian, and a large percentage of shale and much arenaceous calcarenite in the upper Pennsylvanian.

Northward, in the Ladron Mountains, Mesa Sarca, Mesa Aparejo, and Acme Development Co.-Santa Fe oil test, the Pennsylvanian thins to about 2,000 feet and contains a larger amount of arigillaceous material. Some of the variation in thickness is in the lower sandy beds (probably chiefly of Derryan age) which are 695 to 450 feet thick in the southern Ladron Mountains and in the Acme Development Co.-Santa Fe oil test, but only about 400 feet thick in the intervening sections.

Joyita Hills. The Pennsylvanian sequence in the Joyita Hills (section 47, fig. 1) is an enigma. Cut by numerous faults, the section appears to be 180 to 400 feet thick and consists of a lower black shale unit and an upper cherty **Fusulina**-bearing limestone sequence. The upper bed of the limestones crops out on a dip slope and is in most places a silicified brecciated mass. It is overlain by the Bursum formation of early Wolfcampian age. The upper contact may be an erosion surface or a dip-slip fault zone. On the basis of this thin section which lacks beds of upper Pennsylvanian age, and on outcrops a few miles to the north where Tertiary rocks rest on Precambrian granites, Wilpolt and others (1946), and Read and Wood (1947) suggested that the Joyita uplift was a southern extension of the Penasco uplift.

Compared with nearby sections the clastic member of the Sandia formation - the basal Pennsylvanian - is thin in the Joyita Hills. In the Los Pinos Mountains to the east (sections 45, 46, 48, fig. 3) Derryan beds thicken and become more arkosic and somewhat coarser grained southwestward (roughly toward the Joyita Hills), whereas Desmoinesian strata thin but contain more clastics southwestward. The combination, summarizing the rocks of Middle Pennsylvanian time, shows (fig. 3) a sand-lime lithofacies east and northeast of the Joyita Hills (section 47, fig. 3) grading northeastward into lime-sand, then into lime-shale, and near Mountainair into shale-lime. To the west the Derryan-Desmoinesian interval is represented chiefly by shale-lime and lime-shale lithofacies typical of the Middle Pennsylvanian rocks of the Lucero basin (east of Riley) and of the northeastern maximum extension of the San Mateo basin (near Socorro). West of Mesa Sarca and Mesa Aparejo (sections 35 and 34, fig. 3), sandy lithofacies (chiefly shown by wells 33 and 36, fig. 1) dominate the middle Pennsylvanian, suggesting nearness to the Pennsylvanian uplift.

PENNSYLVANIAN ROCKS IN THE ZUNI MOUNTAINS

Local limestone lenses are numerous in the lower part of the Abo redbeds of the Zuni Mountains. Most of the fossils (fusulinids, brachiopods, bryozoans) reported from these beds are of Pennsylvanian age, and as much as 125 feet of the basal redbeds may be of various parts of the Pennsylvanian with Desmoinesian, Missourian, and Virgilian probably present locally. The Pennsylvanian-Permian boundary must vary within short distances from hillock to valley on the pre-redbed surface, and possibly only some of the basal noncalcareous beds are of Pennsylvanian age. Whereas the present area of the Zuni Mountains appears to have been near the shoreline during most of Pennsylvanian time, the higher part of the Pennsylvanian Zuni uplift was probably to the southwest as sketched on figure 1. Wengerd and Matheny's (1958) report of Pennsylvanian redbeds and black shale in the Marshall-Miller oil test (no. 1, fig. 1) suggested that periodically the Pennsylvanian Zuni uplift was cut off from the Defiance landmass which is northwest of this test, by a shallow southwest-trending strait.

Pennsylvanian sedimentation in the Zuni area was similar to that around Pedernal Mountain in eastern Torrance County. There tan sandstones (most of the Precambrian of the Pedernals is quartzite, in contrast with the red gneissic granite of the Zuni Mountains) and some thin fossiliferous limestones (attributed to the Yeso formation on a lithic basis) fill valleys between hills of Precambrian rocks. Talus breccias and slump blocks cemented by tan sandstone occur on the edges of the resistant quartzite hills, and lenses of breccia-conglomerate extend away from the hillsides into the valley fill of tan crossbedded to evenly bedded sandstone. The outcrops show a vivid picture of the sedimentation.

SUMMARY

The sparse data from scattered oil tests and outcrops of the Pennsylvanian rocks on the northeast edge of the Datil Plateau indicate a low upland - the Zuni uplift - present in the Salt Lake-Ramah area throughout most of Pennsylvanian time and a series of marine basins and sags - the Cabezon sag, Lucero basin, and San Mateo basin - to the east. Farther east, controlling deposition along this central New Mexico marine channel, there appears to have been a shallow shoal area - the Joyita sill as termed by Wengerd (1959) or the Joyita axis of Read and Wood (1947). This shoal was a southward extension of the Penasco axis.

One may contour the scattered points on figure 1 in many different ways, thus reconstructing possible regional thickness of the Pennsylvanian at the end of Pennsylvanian time, but two facts are clear: (1) there was an area of erosion and nondeposition southwest of the present Zuni Mountains, and (2) there was an area of relatively thick marine deposition between Correo and Socorro. Is it coincidence that the Cenozoic Rio Grande structural depression parallels the belt of thick Pennsylvanian sedimentation? Whatever the case, the flanks between the deeps and shorelines, the nature habitat of oil, are relatively undisturbed structurally and challenge the geologist to explore along the north edge of the Datil Plateau and on the edges of the Acoma sag northward into the San Juan Basin.

The academician and petroleum geologist will learn more about the Pennsylvanian from the oil tests spudded July 1, 1959, near Brown Mountain (no. 27, fig. 1) and to the east near Mesa del Oro. Are there structural or stratigraphic petroleum traps? We may never know, although some structures may be tested. As yet, the west-central New Mexico Pennsylvanian sequence provides more puzzles than proofs, more possible legerdemain than probable fact, and more questions than answers!

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