SOUTH-CENTRAL NEW MEXICO PROVINCE (026)

By W.C. Butler

INTRODUCTION

This frontier petroleum province covers about 39,900 sq mi, primarily in the easternmost part of the Basin and Range Physiographic Province; it has no production. For a more complete description of this province, see Butler (1988b) and Grant and Foster (1989).

Major present-day geologic and geographic features may be characterized by sector. The northwest sector is in the southeastern Colorado Plateau Physiographic Province (see the description of the Northern Arizona Province 024). Small northeast-trending rift basins and the Zuni Mountains occupy this sector. The southwest sector is a major Cenozoic volcanic terrain (Mogollon Plateau–Datil Volcanic Field) in a zone of transition between the less complex structure of the stable Colorado Plateau and the more complex Basin and Range block-faulted crust of middle and late Cenozoic age. In the eastern sector asymmetrical north-trending horsts, grabens, and half-grabens are superimposed on older structures. Specifically, these features include the Mesilla, Jornada del Muerto, and Tularosa Basins to the south and the Estancia Basin to the north. The Rio Grande River divides this province exactly in half and flows south along the axis of the Rio Grande rift system.

As much as 10,000 ft of alluvium and volcanic rocks fill these extensional basins, obscuring a moderately thick section of Paleozoic strata. The most prominent uplift, and key to the subsurface, is the north-trending Franklin-Organ-San Andres-Oscura Range, which exposes Paleozoic strata and bisects the Orogrande Basin Play (2602). A prominent north-trending stable positive area, the uplifted Pedernal-Diablo-Otero-Hueco landmass or platform, bounds the province's eastern side and separates the Orogrande Basin from the Delaware Basin of west Texas.

This province has a complex geologic history, having been deformed by three major periods of tectonism during Phanerozoic time: (1) Late Paleozoic formation of the ancestral Rocky Mountains, (2) Laramide compression, and (3) Cenozoic relaxation and extension and volcanism. South-central New Mexico was near the terminus of the northeast-trending transcontinental basement arch during the Late Proterozoic and Paleozoic. Within this time span, sediments were deposited in platform, shallow shelf, basinal, and alluvial plain environments. Epeiric seas generally transgressed from the south, and thus a greater thickness of strata was deposited during this time in the southern part of the province. During the mid-Paleozoic, general quiescence of the craton in the equatorial paleo-latitudes resulted in widespread deposition of fossiliferous carbonates accompanied by basin-margin organic buildups. Convergence of the North and South American tectonic plates in the late Paleozoic resulted in intraplate deformation. Deformation included northeast- and northwest-trending shears and northeast-directed thrusts, and

basement uplifts such as the Zuni, Florida-Burro, and Pedernal. Seaways connected new depocenters, such as the Orogrande Basin, which is the principal play of this province, with the Pedregosa, Delaware, and Paradox Basins. Permian redbed sediments encroached toward the Orogrande Basin from the coastal plains on the east, north, and west; coeval basin-centered evaporites were also deposited.

Triassic and Jurassic strata are not well represented in the province, which depositionally represents an erosional surface shifting from highlands to interior lowlands and coastal plains. Nascent opening of the Gulf of Mexico (Chihuahua Trough) deposited as much as 750 ft of marine Jurassic sediments in the southernmost Mesilla Basin. Continued opening near the New Mexico–Mexico border resulted in an east-west Early Cretaceous rift, extending into southeastern Arizona. A thick Late Cretaceous section of marine sands and shales and continental fluvial clastics and paludal coals was deposited as seas transgressed and regressed from the north-northeast and from the south-southwest; about 3,000 ft of this section is preserved. Laramide compression from the southwest rejuvenated older fault-bounded structures and other paleo-zones of weakness (for example thrust faults) and created basement-cored uplifts. Plutons, with attendant rich mineralization, intruded the province. Early Tertiary uplift provided cyclic alluvial–fluvial fan gravels and deltaic clastics to continental interior-drained basins and small lakes.

Clockwise Oligocene rotation of the Colorado Plateau crustal block opened up the Rio Grande rift south of El Paso, Texas; the extensional spreading migrated northward in scissor-style during Neogene and Quaternary time. See Rieker (1979) for a thorough description of the Rio Grande Rift area.

Two hypothetical conventional plays were assessed in this province. They are Orogrande Basin Play (2602) and Mesilla–Mimbres Basins Play (2603).

ACKNOWLEDGMENTS

Scientists affiliated with the American Association of Petroleum Geologists and from various State geological surveys contributed significantly to play concepts and definitions. Their contributions are gratefully acknowledged.

CONVENTIONALPLAYS

2602. OROGRANDE BASIN PLAY (HYPOTHETICAL)

This hypothetical combination oil and nonassociated gas play is in the Basin and Range Physiographic Province (Rio Grande Rift) of south-central New Mexico. It is based on the association of Mississippian through Permian thermally mature source rocks and porous reef reservoir rocks, particularly of the fossiliferous limestones of the Magdalena Group of Pennsylvanian age in the Orogrande Basin. As implied in the introductory section, abundant Paleozoic and Mesozoic structural and stratigraphic traps occur in the deep, under-explored Tertiary rift basins.

The total thickness of Paleozoic, Mesozoic, and Cenozoic rocks in this play may be as much as 25,000 ft. The Paleozoic section is 4,0008,500 ft thick; it wedges out generally northward, but also eastward from basin to shelf, where the number and magnitude of disconformities increase. Alternating source and reservoir beds of Pennsylvanian age, which have the most petroleum potential in the Orogrande Basin, are generally 1,000–3,300 ft thick and are thickest in the central Tularosa Basin. Important lateral and stratigraphic variations are present in the many isolated, disconnected outcrops that expose the key stratigraphic units along the north-south backbone of the play (for example, the Franklin-Organ-San Andres-Oscura Uplift). Important stratigraphic units are also exposed in the Sacramento and Hueco Mountains on the east-central and southeast margins, respectively, of this play. Each uplift has its own local stratigraphic terminology, thus making correlation of units and names throughout this play a complicated endeavor.

Reservoirs: Potential reservoirs are primarily the porous carbonates of the Magdalena Group, including phylloid algal mounds, banks, and bioherms from 75 to 100 ft thick. Other Pennsylvanian reservoir facies include cyclic porous and permeable algal reefs, calcarenites, coquinas, and deltaic quartz sandstones in association with beds of carbonaceous shale and dark, fetid petroliferous limestones. Bioherms also occur in Mississippian (Lake Valley Formation) and Permian strata and reach a maximum thickness of 350 ft; these, as well as other Permian petroliferous carbonates, are considered reservoir quality. Upper Paleozoic evaporite beds or dense impermeable carbonates, well-cemented or tight clastics, and numerous intercalated shale units throughout the Paleozoic section could seal the reservoirs.

Source rocks: The most promising source rocks are organic-rich, brown to black shales of the Pennsylvanian Panther Seep Formation and, secondarily, the Mississippian Helms Formation. Less significant source rocks might include Ordovician and Silurian dolostones and dark basinal Devonian shales, as well as carbonates and shales of the Lower Permian Hueco Group. Vitrinite reflectance data from outcrops in the play range from about R_O 0.6 to 1.2 percent around the play's periphery to 4.0 percent in the central San Andres Mountains uplift. Probably half of the potential Mississippian through Permian source rocks are in the oil window, and the rest are in the thermal dry gas phase.

Timing and migration: Timing of generation and migration are highly speculative, but may have occurred from Early Cretaceous to mid-Tertiary time.

Traps: The complex evolution of this area, as simply outlined in the introduction section of this province, has created many types of traps. Stratigraphic traps are in the form of pinchouts around the basin margin, erosional unconformities, and carbonate-biohermal buildups. Structural traps involve thrusts and folds of primarily Laramide age. Accumulations may also occur along the high-angle listric Tertiary faults, if sealed, or in drag folds; however, this intense late Tertiary to Holocene faulting, in conjunction with possible fresh-water flushing of reservoirs, is likewise a serious deterrent to reservoir and trap integrity. Because of the extensive faulting, depths to targets in the play have a wide range, from 2,000 to 20,000 ft.

Exploration status and resource potential: In spite of the thick alluvial overburden, the eolian dunes, and the pyroclastic rocks that cover 90–95 percent of this play, the number and excellent quality of hydrocarbon shows in the few Pennsylvanian and Permian penetrations indicate the probable existence of commercial hydrocarbons (Pyron and Gray, 1985). Oil seeps are not known in the play. Very sparse borehole data make this play difficult to assess. Military land, about half of the play, is off-limits to exploration and drilling; drilling density is about one borehole per 150 sq mi to an average depth of 4,250 ft. About 0.5 percent of the area has been explored to the level of the play reservoirs. Most shows occurred between 2,430 and 8,600 ft deep. The deepest wildcat well was drilled in the Mesilla Basin; it reached a TD of 21,759 ft, where it tested porous gas-bearing Ordovician strata.

The shelf strata of the Orogrande Basin have been compared to the contemporaneous highly productive reservoirs of the Delaware Basin of west Texas. Mississippian through Permian formations of the Delaware Basin have a cumulative production of more than 3 BBO and 5.0 TCF of nonassociated gas (Robertson and Broadhead, 1993).

2603. MESILLA-MIMBRES BASINS PLAY (HYPOTHETICAL)

This Basin and Range hypothetical oil and nonassociated gas play is primarily in the Mesilla Bolson (Las Cruces Graben). It is west and northwest of El Paso, Texas, and west of the Rio Grande River in the Tertiary- and Quaternary-faulted Rio Grande Rift. Almost all of the surface rocks are Cenozoic volcanics and basin-fill alluvium. Geographically, the play covers both provinces 025 and 026 and the Pennsylvanian Orogrande Basin. Because the play is based solely on one excellent deep gas show in lower Paleozoic carbonates, it is highly speculative and its boundary is purely conjectural.

Reservoirs: The potential for reservoir rocks is as yet poorly understood but is within a 1,000- to 2,000-ft-thick stratigraphic section that increases in thickness from north to south. This section includes units within the Ordovician carbonates of the El Paso and Montoya Dolomite Groups; several thin sandstone

beds may also be included in these groups. The Silurian Fusselman Formation, a carbonate unit that shows good porosity and permeability at a drilling depth of 20,900 ft, and the Cambrian-Ordovician Bliss Formation, a quartz sandstone, are equally important as reservoirs. Tight impermeable carbonates seal the reservoirs.

Source rocks: Source rocks are the same as the reservoir units, except for the Bliss Formation; the thermal maturity of these rocks is about equally divided between the zones for generating oil and dry gas.

Timing and migration: Timing of hydrocarbon generation and migration are unknown but may have been from late Paleozoic to Laramide time. Lateral migration was probably not extensive.

Traps: Reservoir and source rocks are within two arcuate north-south-trending fault-bounded rifts in the southwestern flank of the Rio Grande Rift. An east-west cross-section perpendicular to the bounding faults would show these rift blocks as tilted stair-steps having a maximum combined offset of about 13,000 ft on listric faults. It is conceivable that these normal faults may have also created traps if sealed and if hydrocarbon migration was very late. The most likely potential traps would exist in the fractured and vuggy dolomites and in the lateral porosity pinchouts that may be either stratigraphic or diagenetic. Significant interformational disconformities between the El Paso and Montoya Formations and between the Montoya and Fusselman Formations might be impermeable in places and trap hydrocarbons in the numerous late Paleozoic and Laramide folds. Additional potential traps were created by local Laramide thrusting. Whether the mid-Tertiary to Holocene faulting has ruptured traps and (or) allowed flushing by fresh water is unknown, but is very probable. Targets are from 5,000 to 24,000 ft deep, the deepest being off the southern flanks of the central-basin horst.

Exploration status: This play is poorly explored by drilling. However, Thompson and Bieberman (1975) related that the Grimm, et al. no. 1 Mobil–32 well, drilled in the eastern part of this play, demonstrated a definite petroleum potential for the Rio Grande Rift. It was drilled on a faulted anticline on the basis of seismic data. The Silurian was encountered at 20,900 ft and the Ordovician at 21,555 ft; total depth was 21,759 ft. Shows were found in several units, including the Ordovician section. Because of difficult hole conditions, none of the seven drill-stem tests could be completed. Problems such as drill pipe twisting off and drill collars and tools being lost in the hole prevented a complete evaluation of the drilled section as well as the subjacent El Paso Group and Bliss Formation.

UNCONVENTIONAL PLAYS

There are no unconventional plays described in this province report. However, unconventional plays listed in the surrounding provinces may include parts of this province. Individual unconventional plays are usually discussed under the province in which the play is principally located.

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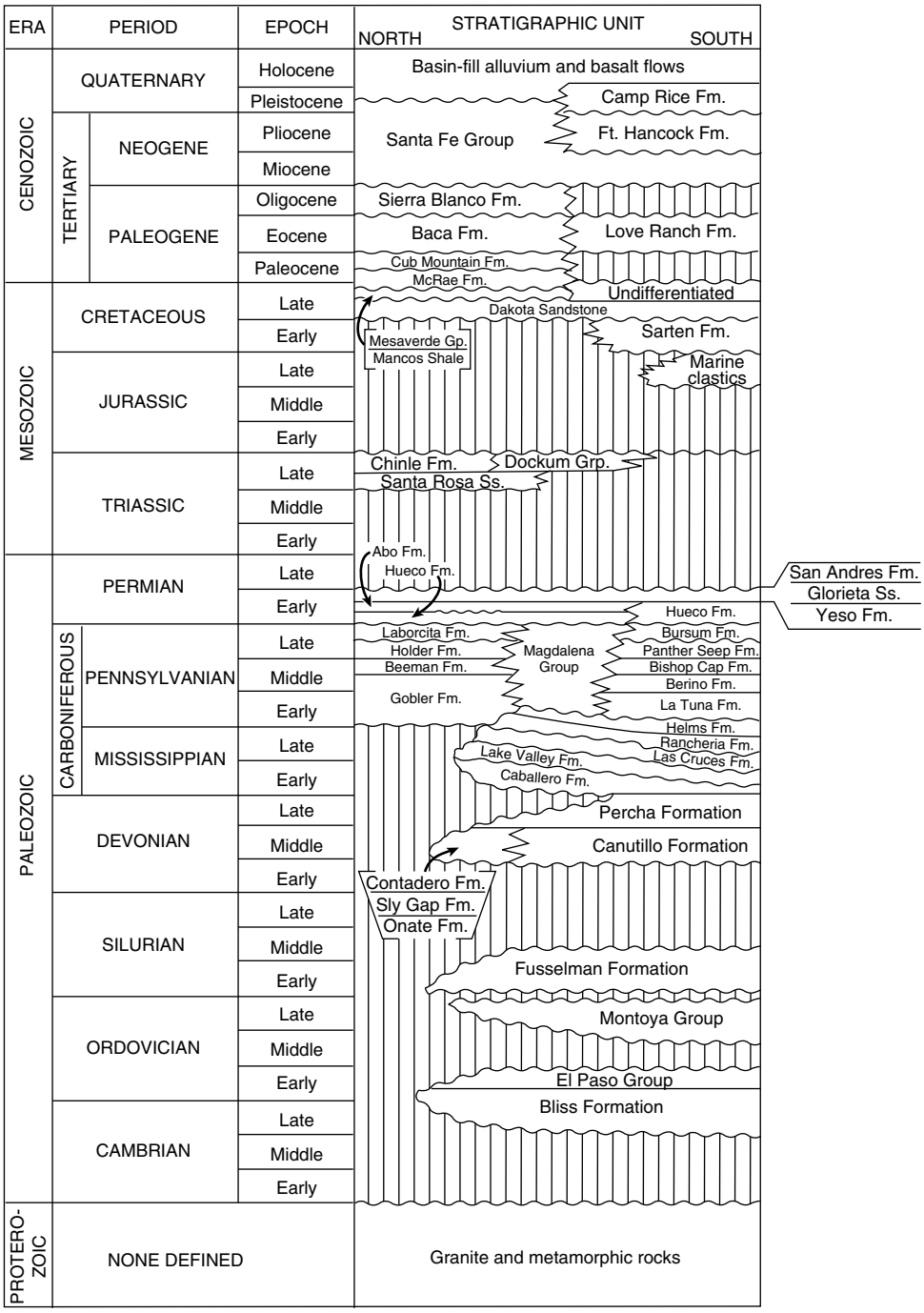
ERA
PERIOD
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STRATIGRAPHIC UNIT
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CENOZOIC
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ORDOVICIAN
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CAMBRIAN
Late
Middle
Early
PROTERO-ZOIC
NONE DEFINED
Basin-fill alluvium and basalt flows
Camp Rice Fm.
Santa Fe Group
Ft. Hancock Fm.
Sierra Blanco Fm.
Baca Fm.
Love Ranch Fm.
Cub Mountain Fm.
McRae Fm.
Undifferentiated
Dakota Sandstone
Mesaverde Gp.
Mancos Shale
Sarten Fm.
Marine clastics
Chinle Fm.
Dockum Grp.
Santa Rosa Ss.
Abo Fm.
Hueco Fm.
San Andres Fm.
Glorieta Ss.
Yeso Fm.
Hueco Fm.
Laborcita Fm.
Holder Fm.
Beeman Fm.
Magdalena Group
Bursum Fm.
Panther Seep Fm.
Bishop Cap Fm.
Berino Fm.
La Tuna Fm.
Gobler Fm.
Helms Fm.
Rancheria Fm.
Las Cruces Fm.
Lake Valley Fm.
Caballero Fm.
Percha Formation
Canutillo Formation
Contadero Fm.
Sly Gap Fm.
Onate Fm.
Fusselman Formation
Montoya Group
El Paso Group
Bliss Formation
Granite and metamorphic rocks