

SIoux ARCH PROVINCE (032)

By James A. Peterson

INTRODUCTION

The Sioux Arch Province is located in southeastern South Dakota adjoining the Williston Basin on the north and west, and the Denver and Salina Basins on the south in Colorado and Nebraska

(fig. 1). Paleozoic sedimentary rocks, which contain important reservoir and source rock facies in the Williston Basin, are truncated by the sub-Cretaceous unconformity in the western part of the Sioux Arch Province. Cretaceous rocks rest on Precambrian in the eastern part of the province. Two tectonic subdivisions are recognized, from east to west: The Sioux Arch proper or Sioux Ridge, and the Kennedy Basin. Each subdivision is characterized by different structural styles and by different Precambrian basement rocks. The Sioux Ridge is a broadly positive feature underlain by the Proterozoic Sioux Quartzite; the Kennedy Basin is a slight downward warp lying west of the main arch and probably underlain by granite and gneiss. A northwesterly-projecting tectonic trend, the Pierre Arch, more or less separates the Kennedy Basin from the main uplift to the east. Two hypothetical plays are recognized in the province. The one, Truncated Paleozoic Play (3202), is a hypothetical conventional play in truncated Paleozoic rocks that thin eastward and pinch out around the Sioux Ridge and Pierre Arch paleotectonic trends. The other, the unconventional continuous-type Southern Williston Basin Margin–Niobrara Shallow Biogenic Play (3113) is described under the Williston Basin Province (031), and defined by the potential for shallow biogenic gas in Cretaceous rocks present in the Williston Basin, the Sioux Ridge area, the Pierre Arch, and the Kennedy Basin.

ACKNOWLEDGMENTS

G.W. Shurr of St. Cloud State University, St. Cloud, Minn., provided helpful information and discussions for this study. 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.

CONVENTIONAL PLAY

3202. TRUNCATED PALEOZOICS PLAY (HYPOTHETICAL)

This is a hypothetical play based on the subsurface belt of eroded and overlapped Paleozoic marine carbonate and clastic beds on the southeastern flank of the Williston Basin and around the main Sioux Ridge and Pierre Arch highs. The main targets for exploration are the Ordovician Red River and Mississippian Madison Formations, the major productive units in the Williston Basin Province to the northwest, and the Pennsylvanian-Permian Minnelusa Formation, an important productive unit in the Powder River Basin to the west.

Reservoirs: The reservoirs are Red River and Madison marine carbonates and Minnelusa marine and nearshore sandstones, in part isolated.

Source rocks, timing, and migration: Organic-rich Paleozoic rocks are not known in the area of the province. A few dark-gray marine shales are reported in wells penetrating the Minnelusa Formation in the western part of the province. No data are available on source-rock quality of these rocks, and burial depth estimates indicate that these rocks are probably immature. The rich Williston Basin source rocks of Mississippian and Ordovician age pinch out about 250 to 300 mi to the northwest of the province. The probability is great that long-distance updip migration from the Williston or Powder River Basin areas would be necessary for hydrocarbon accumulation to take place in the truncated beds of the province. The area is heavily flushed by ground water from the Black Hills uplift, where the entire section of Phanerozoic rocks is exposed. Downey, 1984 (his figures 38 and 39) presents a conceptual model of groundwater flow in Paleozoic aquifers of the northern Great Plains and graphically summarizes the flushing action of water from the Black Hills, which may be the most important factor in determining the absence or presence of hydrocarbon accumulations in the province.

Traps: Traps would be updip pinchouts, and small folds or fault blocks sealed by overlapping Cretaceous clastics.

Exploration status and resource potential: The area is lightly explored, although several Paleozoic tests have been drilled without success. Drilling depths are in the range of 2,000 ft to 4,000 ft. The potential for significant oil or gas accumulations is considered marginal, because of severe flushing of reservoirs, lack of evidence for good source rocks, and relatively shallow original depths of burial.

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.

REFERENCES

- Downey, J.S., 1984, Geohydrology of the Madison and associated aquifers in parts of Montana, North Dakota, South Dakota, and Wyoming: U.S. Geological Survey Professional Paper 1273-G, p. G1-G47.
- MacCary, L.M., 1981, Apparent water resistivity, porosity and ground-water temperature of the Madison Limestone and underlying rocks in parts of Montana, Nebraska, North Dakota, South Dakota, and Wyoming: U.S. Geological Survey Open-File Report 81-629, 36 p.
- Peterson, J.A., 1987, Subsurface stratigraphy and depositional history of type Madison Group (Mississippian), U.S. portion of Williston basin and adjacent area, *in* Peterson, J.A., Longman, M.W., Anderson, S.B., Pilatzke, R.H., and Kent, D.M., eds., Williston basin--Anatomy of a cratonic oil province: Rocky Mountain Association of Geologists, p. 171-191.
- Peterson, J.A., 1987, Geologic summary and hydrocarbon plays, Williston basin, Montana, North and South Dakota, and Sioux Arch, South Dakota and Nebraska, U.S.: U.S. Geological Survey, Open-File Report 87-450-N, 43p.