PETROLEUM POTENTIAL OF DEEPER LEWIS AND MESAVERDE SANDSTONES IN THE RED DESERT, WASHAKIE AND SAND WASH BASINS, WYOMING AND COLORADO

by

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INTRODUCTION

The Red Desert, Washakie and Sand Wash basins together comprise an overall basinal area approximately 120 miles long (north-south) and 80 miles wide (east-west). Outcrops of Mesaverde or older rocks bound this basinal area on all sides except for relatively small areas at the north and south ends of the Rock Springs uplift. The individual basins are separated by two cross-basin arches. The east-plunging Wamsutter arch and the west-plunging Creston nose combine to separate the Red Desert basin on the north from the Washakie basin in the center. Farther south, State Line ridge (Cherokee arch) separates the Washakie basin in Wyoming from the Sand Wash basin in Colorado. Since neither of these cross-basin arches brings Lewis or Mesaverde rocks to the surface, it is convenient to treat the three basins as one area of exploration for these rocks.

Petroleum production was first established in this area in 1926 with the discovery of relatively shallow gas in the Wasatch Formation at Hiawatha. The first significant Mesaverde or Lewis discovery was that of gas at Canyon Creek in the Ericson Sandstone (Mesaverde Group) in 1941. Since that time, major fields have been discovered in these units at Table Rock in 1946, Trail and Desert Springs in 1958, and Patrick Draw in 1959 (Roehler, 1973). The cumulative production from significant Lewis and Mesaverde fields in the area exceeds 50 million barrels of oil and 675 billion cubic feet of gas. Most of the oil and about half of the gas produced have been from the Almond Formation at the top of the Mesaverde Group. The Lewis has produced about one-fourth of the gas, and the remainder has been produced from the Ericson Sandstone near the middle of the Mesaverde. Sandstones at the base of the Mesaverde, or in the transition zone between the Mesaverde and the underlying marine shale and siltstone section, have so far yielded only small quantities of oil and gas.

Petroleum exploration and development in this region have been relatively slow in comparison to other parts of Wyoming and Colorado. There was a strong surge of activity following the Desert Springs and Patrick Draw discoveries, but subsequent activity has been slow and sporadic. This lack of activity has been attributed to a number of factors (e.g. Miller, 1973), the most important of which are:

(1) The Lewis and Mesaverde production in the area is primarily gas. Federal regulation of price for gas at the wellhead has discouraged exploration generally, and particularly in areas where pipeline facilities are not available.

(2) Thick Tertiary sections mask the structure of underlying Cretaceous and older rocks, resulting in drilling depths that have been considered excessive in comparison to other opportunities in the region.

(3) Most reserves found to date are in stratigraphic traps. Major structural elements such as the Wamsutter arch bring objective horizons closer to the surface, but they appear to have little control over accumulation. Oil companies have, in general, been unwilling to engage in stratigraphic exploration for gas at the depths involved.

Recent increases in the allowed price of gas at the wellhead suggest that a trend may have begun which will allow gas to reach a price commensurate with the value of its heat content. Such a change could have a profound effect on exploration for gas. Deeper wells could be justified, and pipelines could be constructed to smaller fields. Also, the added well control would facilitate the development of stratigraphic plays.

The petroleum potential of the deeper Mesaverde and Lewis sandstones in the Washakie, Red Desert and Sand Wash basins, as discussed in the following sections, is based on existing information and is intended only as a place to begin. The deeper parts of these basins are almost completely unexplored and, given an adequate economic environment, substantial volumes of gas and oil could yet be discovered.

LEWIS SHALE

The exploitation of the deep potential of sandstones in the Lewis Shale will be based on a better understanding of the source and distribution patterns of the deltaic portions of this unit. Well control available in the late 1960's was sufficient to allow the reinterpretation (Asquith, 1975) of this unit as having a source to the northeast with thick sand-

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stones pinching out southward (Fig. 1) on the north flank of the Wamsutter arch and the Creston nose. Younger sandstones extend southward into the Washakie basin (Fig. 2) and may pinchout updip on the east, south and west flanks of the basin.

ALMOND FORMATION

Production of oil and gas from the Almond Formation (upper Mesaverde) is from stratigraphic traps in sandstones deposited during a local regression in the overall transgression of the marine Lewis over the Mesaverde. The trend which includes Patrick Draw, Table Rock and Desert Springs on the western flank of the Washakie and Red Desert basins has been extensively explored. Similar local regressions are present in the eastern Washakie basin in Wyoming and in the Sand Wash basin in Colorado. Reliable maps are not available because of the large gaps in control in the deeper parts of the basins, but considerable additional potential remains in this established producing unit.

ERICSON SANDSTONE

The Ericson Sandstone produces on structure at Canyon Creek and Trail fields in the southwestern Washakie basin. The thick sandstone units in this formation are generally continuous on the east flank of the Rock Springs uplift and have only limited stratigraphic potential in this area. However, their time equivalents to the east are thick non-marine and marginal marine units (Fig. 3) that pinch-out into the

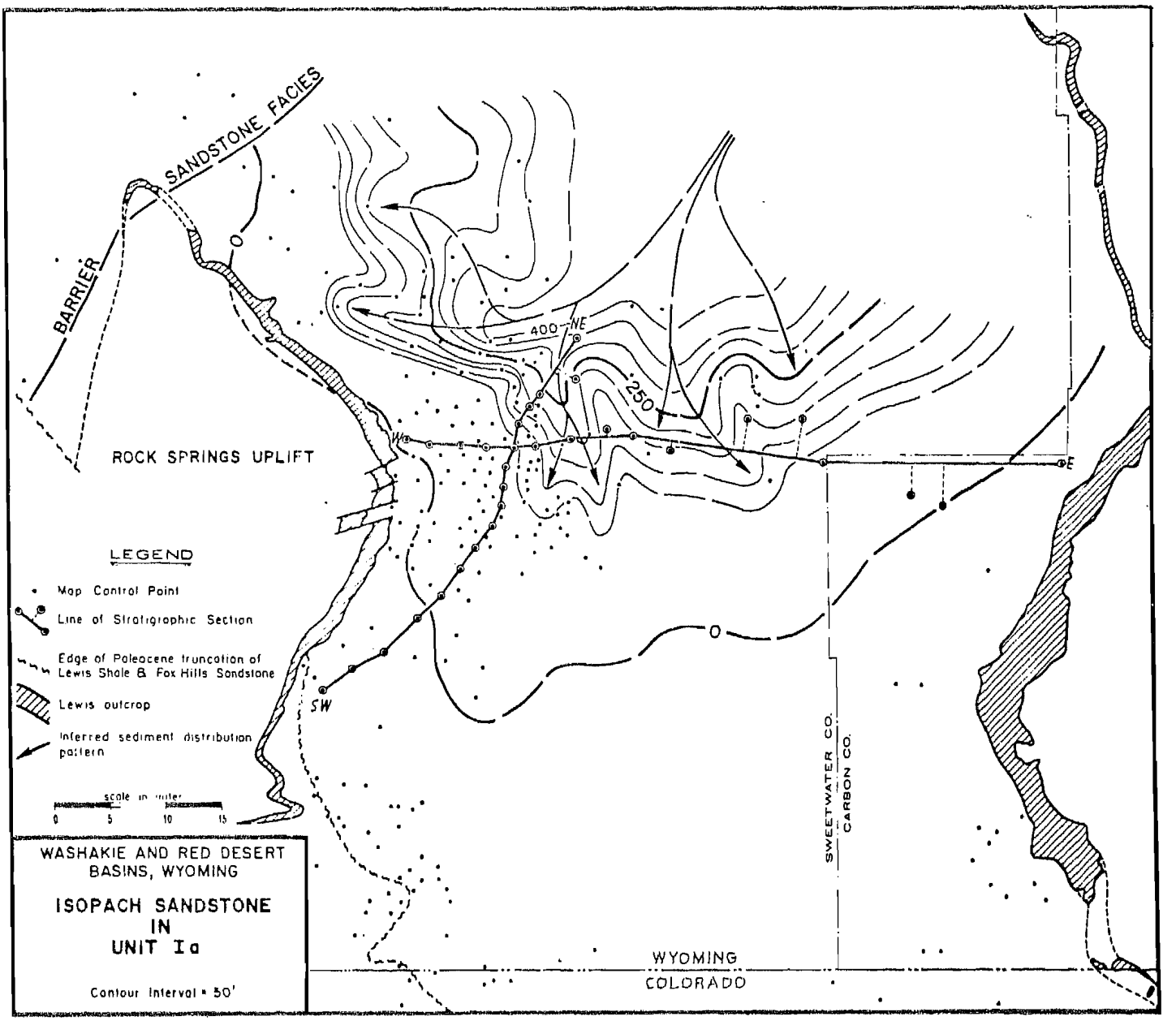


Fig. 1 — Distribution of lowest sandstone in Lewis Shale (Unit Ia of Asquith, 1970) in Red Desert and Washakie basins. Cross sections shown are included in Asquith (1970).

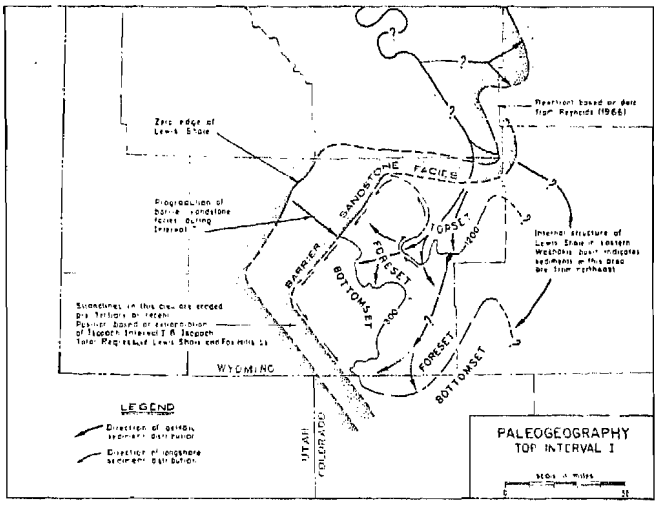


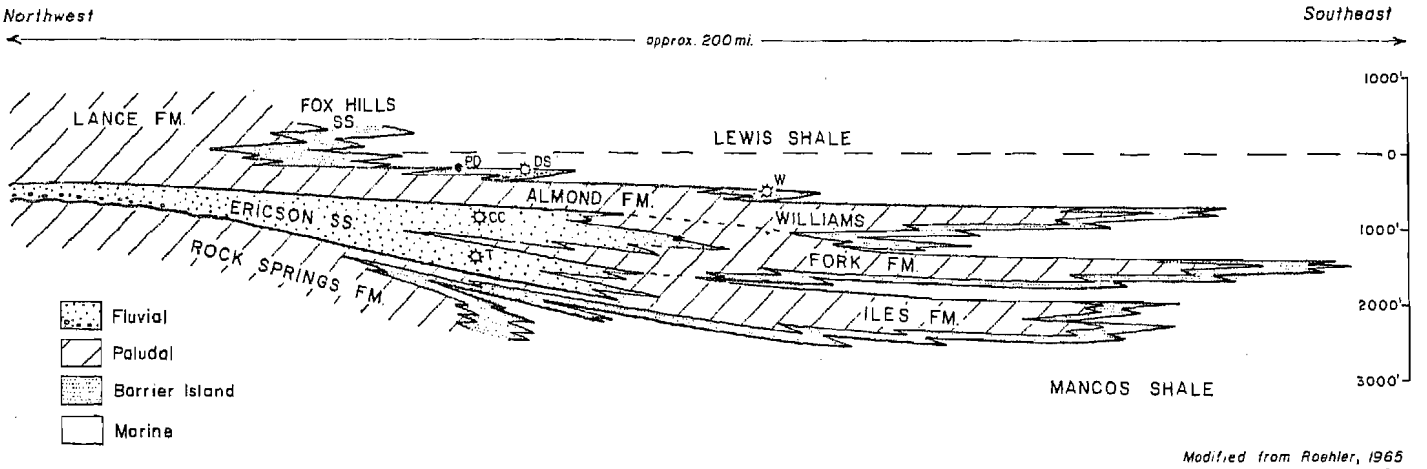
Fig. 2 — Paleogeographic map of a portion of the Lewis Shale (Interval I of Asquith, 1970) in southwestern Wyoming.

marine Mancos Shale. The overall pattern of deposition of the upper and lower Ericson at maximum regression are shown in Figures 4 and 5. These regressions extend to the east, beyond the limits of the three basins, but potentially productive sandstones are present in an updip pinchout position (Fig. 3) across the Creston nose, State Line arch, and generally on the east flank of the Washakie and Sand Wash basins.

ROCK SPRINGS FORMATION

The main body of the Rock Springs Formation pinches out eastward and downdip along the east flank of the Rock Springs uplift. While no production has been established in this unit, despite the presence of thick marginal marine sandstones at locations such as Jackknife Springs, deep tests along this trend are limited and major production could yet be established.

An additional objective in this interval is Blair-type offshore sandstones in the deeper parts of the Washakie



Modified from Roehler, 1965

Fig. 3 — Northwest-southeast stratigraphic cross section from central Green River basin, Wyoming, to southeast Sand Wash basin, Colorado, showing producing intervals at Patrick Draw (PD), Desert Springs and Table Rock (DS), Wamsutter (W), Canyon Creek (CC), and Trail (T).

basin, and possibly also in the Red Desert basin. Tests of this interval will require deep wells, but offshore sandstone equivalents of the Rock Springs Formation could be major producers on the east flank of the Washakie basin or the north flank of State Line arch.

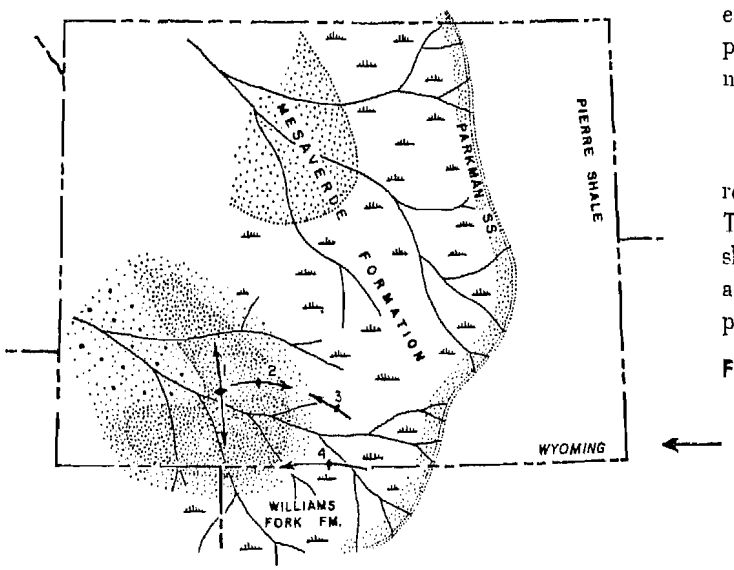


Fig. 4 — Paleogeographic map showing distribution of sedimentary environments at maximum regression of upper Ericson and time equivalents in Wyoming and northern Colorado. Major structural features in southwestern Wyoming are 1) Rock Springs uplift, 2) Wamsutter arch, 3) Creston nose, and 4) State Line ridge. Modified from Asquith (1974).

SUMMARY

The Mesaverde Group and the overlying Lewis Shale record a major cycle of marine regression and transgression. These upper Cretaceous strata were deposited in response to shifting deltas and associated patterns of marginal marine and marine sedimentation. Various types of sandstone deposits produce gas and oil in numerous fields around the

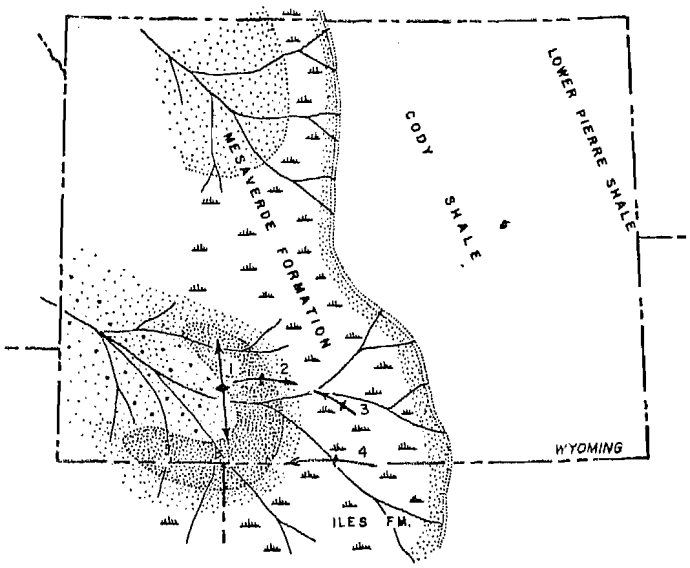


Fig. 5 — Paleogeographic map showing distribution of sedimentary environments at maximum regression of lower Ericson and time equivalents in Wyoming and northern Colorado. Major structural features in southwestern Wyoming are 1) Rock Springs uplift, 2) Wamsutter arch, 3) Creston nose, and 4) State Line ridge. Modified from Asquith (1974).

margins of the Red Desert, Washakie and Sand Wash basins.

The deeper parts of these basins are essentially unexplored because the hydrocarbons discovered so far are mainly gas in stratigraphic traps. Since gas is subject to artificially low prices which are largely controlled by the federal government, there has been little incentive to explore the deeper parts of these basins. However, if prices for gas were allowed to compete with oil on the basis of heating value, significant new reserves undoubtedly would be discovered in the Lewis and Mesaverde sandstones of this area.

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