Title: Analysis of Oil-Bearing Cretaceous Sandstone Hydrocarbon Reservoirs, Exclusive of the Dakota Sandstone, on the Jicarilla Apache Indian Reservation, New Mexico

Quarterly Report
January 1, 2000 through May 8, 2000
Jennie Ridgley
May 21, 2000
DE-A126-98BC15026--01

Jennie Ridgley
U.S. Geological Survey
MS 939 Box 25046 DFC
Denver, CO 80225
303-236-9048
303-236-0459 fax
This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, makes any warranty, expressed or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed., or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.
ABSTRACT

A goal of the Mesaverde project was to better define the depositional system of the Mesaverde in hopes that it would provide insight to new or by-passed targets for oil exploration. The new, detailed studies of the Mesaverde give us a better understanding of the lateral variability in depositional environments and facies. Recognition of this lateral variability and establishment of the criteria for separating deltaic, strandplain-barrier, and estuarine deposits from each other permit development of better hydrocarbon exploration models, because the sandstone geometry differs in each depositional system. Although these insights will provide better exploration models for gas exploration, it does not appear that they will be instrumental in finding more oil.

Oil in the Mesaverde Group is produced from isolated fields on the Chaco slope; only a few wells define each field. Production is from sandstone beds in the upper part of the Point Lookout Sandstone or from individual fluvial channel sandstones in the Menefee. Stratigraphic traps rather than structural traps are more important. Source of the oil in the Menefee and Point Lookout may be from interbedded organic-rich mudstones or coals rather than from the Lewis Shale. The Lewis Shale appears to contain more type III organic matter and, hence, should produce mainly gas. Outcrop studies have not documented oil staining that might point to past oil migration through the sandstones of the Mesaverde. The lack of oil production may be related to the following: 1) lack of abundant organic matter of the type I or II variety in the Lewis Shale needed to produce oil, 2) ineffective migration pathways due to discontinuities in sandstone reservoir geometries, 3) cementation or early formation of gas prior to oil generation that reduced effective permeabilities and served as barriers to updip migration of oil, or 4) erosion of oil-bearing reservoirs from the southern part of the basin. Any new production should mimic that of the past, i.e. be confined to small fields in isolated sandstone beds.

SEQUENCE STRATIGRAPHY

A principal focus of the Mesaverde study was to subdivide the Mesaverde Group interval into its component formations using sequence stratigraphic principals and within these formations identify currently oil and gas productive facies as well as define potentially productive facies that have been overlooked by past drilling. The outcrop studies of the Mesaverde indicated the presence of two unconformities or sequence boundaries in the northern part of the study area, north from Township 28. The basal boundary occurs between the Point Lookout and the Menefee Formation in the northern part of the study area (Wright Dunbar, 2000a). The lower sequence boundary rises stratigraphically to the southwest where it is present only within the Menefee Formation. This sequence boundary incises more deeply to the northeast and actually cuts into shoreface sandstone of the Point Lookout. From south to north this surface sequentially cuts out fluvial deposits of the Menefee and shoreface sandstone of the Point Lookout (Wright Dunbar, 2000a). Strata overlying the sequence boundary are thus younger and genetically unrelated to rocks below the sequence boundary. The upper sequence boundary occurs only within the Menefee (Wright Dunbar, 2000a) and has not been defined in the southern part of the study area. In the northern part of the study area, the incised surface cuts deep channels in the Menefee. Younger and genetically unrelated fluvial and estuarine rocks fill these channels. Because the channel fill is depositionally similar to the underlying strata of the Menefee (especially in the northern part of the study area), detailed studies of the stratal stacking patterns is necessary in order to delineate the geometry of the second sequence boundary. However, both sequence boundaries appear to represent incised surfaces that locally are of considerable relief, especially in the northern part of the study area where downcutting was more pronounced. The underlying causes for base level lowering and the seaward shift of the deposition systems, resulting in bypass
sedimentation, is not known at this time. A more complete discussion is found in the final Mesaverde subsurface report.

Subsurface correlations of the Mesaverde attempted to link outcrop observations, especially the location and orientation of the sequence boundaries, with wireline log responses. Two south-north cross sections and three west-east cross sections through the Reservation show the results of the subdivision of the Mesaverde and the oil and gas producing intervals in the control wells. Given the limited amount of time for the subsurface Mesaverde study and the complexity of the depositional system defined at the outcrop, it was not possible to completely extrapolate outcrop observations to the subsurface. As a result, the subsurface correlations, principally define the boundaries between the Point Lookout Sandstone, Menefee Formation, and Cliff House sandstone. However, one incised surface in the Menefee Formation was noted in the subsurface correlations. It is not clear exactly how this surface relates to the incised surfaces observed at the outcrop, however, it is recognized only in the northern half of the study area. The northern part of the study area is within the gas generation part of the basin. The sequence boundaries do not extend to the southern part of the basin where the potential oil reservoirs are found. The juxtaposition of facies across the sequence boundaries is not important in trapping oil because no oil occurs in the Mesaverde in this part of the basin. However, the spatial distribution of the facies can present barriers to efficient oil migration pathways because of the lateral discontinuities of sandstones and the elongation of these sandstones parallel to depositional strike rather than to depositional dip.

OIL AND GAS FIELDS

There are 24 small oil fields in the Mesaverde (Fassett, 1991) in the San Juan Basin; these have an aggregate cumulative production of about 2 MBO. All, but one of the oil fields are located on the Chaco slope in the southeast part of the basin and all the fields are defined by a small number of wells. Most of the oil fields are found to the west and south of the study area. Oil production from these fields occurs mostly in isolated channel sandstones in the Menefee Formation. Production is mainly from stratigraphic traps. There is some production from shoreface sandstone of the Point Lookout Sandstone or from combined Point Lookout and the transition sandstone-mudstone sequence of the upper Mancos Shale. In a few wells, perforated intervals extend from the Menefee into the top of the Mancos, and oil production is reported as coming from the entire interval.

For this study, seven oil fields and two gas fields (fig. 1) on and near the Jicarilla Apache Indian Reservation were evaluated with respect to the sequence stratigraphic model that has been constructed for Mesaverde. The principal reason for this evaluation was to determine currently producing facies and the areal extent of production from these facies within field boundaries. This spatial distribution could then be used to highlight areas where similar facies are present but from which there is no current production. The field name, location, type of hydrocarbon production, type of drive, field API gravity, producing interval, and structural setting for each oil and gas field are listed in table 1. Data for the fields were taken from individual field descriptions in Fassett (1978); references for individual field descriptions are also in table 1. Observations as to producing intervals and field boundaries are from field descriptions in Fassett (1978); these have not been updated since the original descriptions. However, the contacts as shown on the cross sections between the various productive intervals discussed below can be used in conjunction with data available for individual wells drilled since the original descriptions to expand our knowledge of currently productive units. The distribution of oil and gas producing
wells with respect to structure are shown in figure 2. A complete discussion of the individual oil and gas fields are found in the final Mesaverde subsurface report.

References
Fassett, J.E., 1978, ed., Oil and gas fields of the Four Corners area; Four Corners Geological Society, v. 1 and 2, p. 177-568.


Table 1. Location and producing characteristics of oil and gas field in the Mesaverde Group on and near the Jicarilla Apache Indian Reservation.

<table>
<thead>
<tr>
<th>Field Name</th>
<th>Location</th>
<th>Type of Hydrocarbon Production</th>
<th>Type of Drive</th>
<th>Field API Gravity</th>
<th>Producing Formation</th>
<th>Structural Setting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chaco Wash Mesaverde</td>
<td>T. 20 N., R. 9 W.</td>
<td>Oil</td>
<td>Low pressure water drive</td>
<td>46°</td>
<td>Menefee</td>
<td>Broad double NE--plunging anticline</td>
</tr>
<tr>
<td>Cuervo Mesaverde</td>
<td>T. 24 N., R. 8 W.</td>
<td>Oil</td>
<td>Fluid expansion</td>
<td>38°</td>
<td>Point Lookout Sandstone</td>
<td>Broad NE-dipping flexure in the NW-SE regional structure</td>
</tr>
<tr>
<td>Devils Fork Mesaverde</td>
<td>T. 24 N., R. 6W.</td>
<td>Oil</td>
<td>Solution gas</td>
<td>42°</td>
<td>Point Lookout Sandstone</td>
<td>Broad NE-dipping flexure in the NW-SE regional structure</td>
</tr>
<tr>
<td>Franciscan Lake Mesaverde</td>
<td>T. 20 N., R. 5-6 W.</td>
<td>Oil</td>
<td>Fluid expansion and water drive</td>
<td>42°</td>
<td>Menefee and Point Lookout</td>
<td>Broad NE-dipping anticline on the NW-SE regional structure</td>
</tr>
<tr>
<td>Gonzalez Mesaverde</td>
<td>T. 25-26 N., R. 5-6 W.</td>
<td>Gas</td>
<td>Solution gas</td>
<td>38.5°</td>
<td>Menefee and Point Lookout</td>
<td>Broad NE-dipping flexure on NW-SE regional structure</td>
</tr>
<tr>
<td>Parlay Mesaverde</td>
<td>T. 22 N., R. 3 W.</td>
<td>Oil</td>
<td>Solution gas, minor gas cap expansion</td>
<td>44.2°</td>
<td>Menefee</td>
<td>Broad north-dipping flexure in the NW-SE regional structure</td>
</tr>
<tr>
<td>Rusty Menefee</td>
<td>T. 22 N., R. 7 W.</td>
<td>Oil</td>
<td></td>
<td>46°</td>
<td>Menefee</td>
<td>Broad flexure in the NW-SE regional structure</td>
</tr>
<tr>
<td>Venado Mesaverde</td>
<td>T. 22 N., R. 5 W.</td>
<td>Oil</td>
<td>Gravity flow</td>
<td>46°</td>
<td>Menefee</td>
<td>E-W regional structure</td>
</tr>
<tr>
<td>Blanco Mesaverde</td>
<td>T. 25-32 N., R. 2 -13 W.</td>
<td>Gas/minor oil</td>
<td>Gas expansion</td>
<td>33-60°</td>
<td>Point Lookout, Menefee, Cliff House</td>
<td>Broad, low-amplitude folds on NW-SE regional structure</td>
</tr>
</tbody>
</table>

Figure 1. Map showing distribution of oil and gas fields in the Mesaverde Group on and adjacent to the Jicarilla Apache Indian Reservation (data from Fassett, 1978).
Figure 2. Map showing distribution of oil and gas producing wells in the Mesaverde Group on and adjacent to the Jicarilla Apache Indian Reservation superimposed on the regional structure.