14. R. W. STAPP, Phillips Petroleum Company, Denver, Colorado

RELATION OF LOWER CRETACEOUS DEPOSITIONAL ENVIRONMENT TO OIL ACCUMULATION, NORTHEASTERN POWDER RIVER BASIN, WYOMING

The Lower Cretaceous rocks produce oil from stratigraphic traps in the northeast Powder River basin. Density of subsurface data allows reconstruction of paleodepositional environments. Through detailed subsurface studies it is possible to relate time-equivalent sandstone bodies to depositional patterns. Structure has little or no bearing on petroleum accumulation in this area.

Identification of paleodepositional environments by means of subsurface studies depends on precise electric-log correlations and a geomorphic interpretation.

The depositional trends of the Lower Cretaceous Fall River sandstone bodies and the so-called "Muddy" sandstone beds are determined readily by selective isopachous mapping. Care must be exercised to recognize unconformities, disconformities, or other breaks in an apparently continuous cycle of deposition. Isopachous maps are constructed by using a lithologic time marker as the upper boundary and either a lithologic time marker or an unconformity as the lower boundary. These continuous cycles of deposition indicate a genetically related depositional environment.

The Fall River contains three sandstone bodies that are mappable as separate units in a complex marginal-marine shoreline environment. These sandstone beds thicken locally in a vertical direction and, in places, merge into a single unit. The Fall River does not have channel characteristics in this area.

The "Muddy" contains two sandstone bodies previously named Newcastle and Dynneson. These sandstone units have distinctly different depositional patterns. Channeling is present in both, and the Newcastle shows a pronounced dendritic drainage pattern.

Oil production is from the eastern updip edges of maximum sandstone development in both the Fall River and "Muddy" sandstone units. By detailed subsurface mapping it is possible to relate time-equivalent sandstone bodies to the depositional environments which control oil accumulation.

15. MILTON O. CHILDERS, Consulting geologist, Salt Lake City, Utah

RESERVOIRS OF LACUSTRINE ORIGIN IN ROCKY MOUNTAINS—EXPLORATION CRITERIA

Large reserves of oil and gas have been found in rocks of lacustrine origin in Rocky Mountain basins, and these strata remain largely unexplored.

Except for the productive limestone of the Sheep Pass Formation (eastern Nevada), lacustrine carbonate reservoir rocks found to date have poor porosity and permeability. Sandstone is the best reservoir rock of the lacustrine suite.

Most of the productive sandstone beds originated in deltaic complexes. Sandstone bodies paralleling old lake shores are much poorer objectives than their marine counterparts because of lower transport energy and relatively unstable water level in lakes. Large deltaic complexes are prime objectives, and directional criteria can be observed within the lacustrine facies as well as in the equivalent fluvial facies.

The oil- and gas-producing sandstone units of the western Green River basin (commonly interpreted to have originated as beaches and bars along the west shore of a Paleocene-Eocene lake) are almost certainly of fluvial origin. These sandstone beds have no low-energy lateral facies equivalents which are characteristic of lacustrine deposits.

Typically the main body of lacustrine deposits consists of very finely and uniformly laminated, well-indurated shale and very argillaceous microcrystalline carbonate rocks. Brown bituminous shale and oil shale are common. Proximal to the deltaic facies, shale becomes more variable. Induration decreases, sorting decreases, lamination and fissility decrease, siltstone is common, and slump structures and load casts are present in some places.

The *distal* margins of sandstone bodies are well-cemented, well-sorted, very fine-grained (grading to siltstone), and thinly and horizontally bedded with abundant small ripple marks. They contain abundant shale partings on well-defined bedding planes. The *main body* of a typical lacustrine sandstone contains well-cemented oölitic laminae and thin beds alternating with thick to massive beds of porous, friable sandstone. Sorting is fair to good. *Proximal to the fluvial facies,* sandstone beds are poorly sorted with abundant clay matrix in many beds. "Soft" clasts (*e.g.*, shale fragments) are common.

16. JOSEPH R. CLAIR, Geological consultant, Denver, Colorado, AND RICHARD W. VOLK, Plains Exploration Company, Denver, Colorado

PRE-PERMIAN PALEOZOICS OF LAS ANIMAS ARCH—NEW OIL PROVINCE

The Las Animas arch has been the site of intermittent exploration during nearly 40 years but still is virtually untouched. Despite two recent, significant discoveries, the arch is a "cold area." The writers believe that this is the result of a lack of careful study of the rocks and the total absence of a planned exploration program.

Detailed analysis of the Pennsylvanian and Mississippian sections indicates that parts of the arch are more favorable than others, although sparcity of control in large areas of the arch precludes eliminating any part of it from consideration.

The results of recent drilling have provided new evidence on the structural history of the Las Animas arch and indicate that it is considerably more complex than has been considered previously. The arch actually is a compound structure with an older axis considerably east of the present axis which originated during the Laramide orogeny.

Each of the five series of the Pennsylvanian System (Virgilian, Missourian, Desmoinesian, Atokan, and Morrowan) is productive on or adjacent to the Las Animas arch, but none of the discoveries to date has been of sufficient magnitude to provide impetus for a concerted exploration effort.

Two discoveries, both producing oil from the Osagean (Mississippian), are very significant, though neither is, of itself, sufficiently large to excite much attention. The significance lies in the fact that both are productive beneath a younger Mississippian rock cover (*i.e.*, within the Mississippian). Heretofore, it was believed that a productive Mississippian reservoir had to be in subcrop contact with overlying Pennsylvanian in order to produce. However, discoveries during the past 6 years in southwestern Kansas and