equivalents of Palo Duro basin rocks, ranging from the Ordovician to the Permian, produce in fringing areas or in nearby basins.

The region has had a complex geologic history. Source beds, reservoir-quality rocks, and large structures are present, but it appears that most oil to be found will be largely in stratigraphic traps.

12. FRANK E. KOTTLOWSKI, New Mexico State Bureau of Mines and Mineral Resources, Socorro, N.M.

SEDIMENTATIONAL INFLUENCE OF PEDERNAL UPLIFT

Depositional and erosional features outline the late Paleozoic Pedernal uplift as a narrow northward-elongated landmass, connected southward with the Diablo platform and northeastward with the Sierra Grand arch and Amarillo-Wichita uplift. During pre-Pennsylvanian Paleozoic time, north-central and central New Mexico was periodically uplifted epeirogenically, but this "massif" bears little resemblance to late Paleozoic Pedernal uplift. Pedernal should not be applied to the massif in east-central New Mexico (southern part of Sierra Grande arch).

Ordovician, Silurian, and Mississippian strata probably were deposited in most of New Mexico and adjoining areas, and Devonian beds in most of southern and western New Mexico, but were removed from large areas during subsequent erosion periods. Early Ordovician El Paso-Manitou was eroded in Middle Ordovician time; later Ordovician Cable Canyon-Harding and Montoya-Fremont as well as Silurian Fusselman Dolomite were partly removed during Late Silurian-Early Devonian time; and only a remnant of Mississippian was left in central New Mexico by erosion during Late Mississippian-Early Pennsylvanian time. Erosional and sedimentational patterns trend east-west for earlier Paleozoic strata, with a positive-trending feature in north-central New Mexico, contrasting with Pennsylvanian and early Permian northward trends related to the Pedernal uplift and its adjoining basins, Orogrande and Estancia on the west, and Delaware on the southeast.

The northern New Mexico massif supplied some Cambrian sands, some Middle Ordovician Simpson sand and silt, and Late Devonian and Early Mississippian silt and clay. The Pedernal uplift area in south-central New Mexico was covered by early and middle Paleozoic seas, and did not become a detritus-source upland until Early Pennsylvanian time. During Pennsylvanian and early Wolfcampian time it provided much sediment to flanking basins; most of the uplift was worn down and was buried by floods of northern redbed material during late Wolfcampian time. Only remnant hills remained in the sandy seas of Leonardian time.

13. ARTHUR S. RITCHIE, The University of Georgia, Athens, Ga. (on sabbatical leave from University of Newcastle, N.S.W., Australia)

NATURAL CHROMATOGRAPHY—A FACTOR IN PETROLEUM MIGRATION

The essential elements of chromatography are defined as (1) a mixture which becomes separated, (2) the stationary phase (a medium, usually fine-grained, with large surface area), and (3) the mobile phase (a fluid that carries the mixture with it over or through the stationary phase during separation). One or more of such specific processes as ion-exchange, partition, diffusion, and absorption may participate in a chromatographic separation, which, however, is more complex than any one of them.

The permeability of rock involved in petroleum migration ranges from a maximum in uncemented uniformly graded sandstone to a minimum in shaly rocks. At the lower limits of permeability, the petroleum must flow past or through fine-grained rocks of great surface area. Within more permeable strata some fine-grained material is encountered. Petroleum colloids probably also act as chromatographic stationary phases.

In the laboratory, when mixed hydrocarbons are passed over fine-grained materials, the paraffins always advance at a greater rate than the cycloparaffins which, in turn, move faster than the aromatics. In addition trace metals are retained selectively in a certain order on the stationary phases.

In natural occurrences of petroleum in multiple pools, it is commonly reported that the upper pools are paraffin-rich, the intermediate pools cycloparaffin-rich, and the lower pools are richer in aromatics. In these cases chromatographic separation during migration is offered as an alternative to hypotheses of separate origins for the pools. Chromatographic separation of trace metals in petroleum fields is reviewed.

14. WILLIAM V. TROLLINGER, Consulting Geologist, Denver, Colo.

SURFACE EVIDENCE OF DEEP STRUCTURE IN ANADARKO BASIN

Surface geology has been neglected largely in the search for oil and gas in the Anadarko basin. This is understandable because the surface is composed essentially of upper Permian strata laid down after the major mountain-building activities in the region. In places the Permian rocks are mantled by moderately indurated Tertiary continental beds and unconsolidated Quaternary deposits.

A recently completed detailed photogeologic-geomorphic evaluation study revealed considerable evidence that the surface offers numerous clues to subsurface geologic conditions. The study involved comprehensive stratigraphic and structural mapping by conventional photogeologic techniques supplemented by detailed geomorphic structural analysis.

This phase, or "applied geomorphology," deals with determining the degree of influence that structure and lithology have had on the morphologic development of the region. Basic geologic-geomorphic relations are established and "interruptions" to the regional geomorphic "norm" are interpreted commonly as diagnostic clues to anomalous subsurface geologic conditions. The results in the Anadarko basin indicate that many deep-seated structural anomalies are reflected at the surface in the *drainage*, *landform*, *erosional*, *photo-tonal*, and (or) *fracture patterns*.

The study was enhanced by the use of a special-purpose aerial photography, taken with the Wild RC-9 camera. This photography has many advantages over conventional aerial photography and is especially well suited to low-dip areas. As a result of its 6.5 × exaggeration factor, an actual dip of 1° is exaggerated in the stereoscopic view to about 6.5°. This permitted reliable mapping of very low-relief features in the Andarko basin, where the dip exceeds 1° in very few places.

Four producing areas, with subsurface control used for comparative purposes, are examined as ex-

amples of surface reflections of deep structure. These are the (1) Cement, (2) Apache (3) Gageby Creek, and (4) Washita Creek fields.

The close correlations between surface and subsurface structure in these and several other areas reviewed indicate that the surface should no longer be ignored as a source for clues to potential oil/gas traps.

15. DONALD C. SWANSON, Esso Production Research Co., Houston, Tex.

GEOLOGIC DEVELOPMENT OF ANADARKO BASIN AND ITS DEPOSITS OF HYDROCARBONS

In the Anadarko basin, economic deposits of oil and gas are found in strata which range in age from Cambrian-Ordovician through Permian. The reservoirs range in composition from siltstone to dolomite and represent environmental facies as diverse as alluvial-stream deposits and shallow-marine carbonate banks.

A progressive analysis—through time—of the depositional and structural events which formed and filled the basin demonstrate the major factors controlling the occurrence of hydrocarbon deposits and how these deposits relate both to regional geologic phenomena and to local environmental events.

Comparisons made with the Anadarko basin could help exploration and exploitation in similar basins throughout the world.

16. DAN E. FERAY, Texas Technological College, Lubbock, Tex.

NATURE OF MARGINS OF SEDIMENTARY BASINS

Sedimentary basins, a subject of vital interest to economic geologists, differ to such a large degree that consideration of the origin of the variations is significant to economic geologists. The margin of the sedimentary basin, being the most variable part, merits special consideration.

Several factors control the nature of a sedimentary basin and its geologic history. Primary among these factors are (1) the tectonic history, including the intensity of uplift of the adjacent source area and subsidence of the depositional site, (2) the physiography of the basin and adjacent source area, (3) the climate of the basin and adjacent source area, (4) the eustatic conditions of sea level during the basin's history, and (5) the biological activity, faunal and floral, in the basin and adjacent source area. Secondary factors, controlled by the interplay of the primary factors, are (1) nature of terrigenous clastics produced in the source area, (2) rate of influx of terrigenous clastics into the basin, (3) energy relations in the depositional site related to transport and deposition of sediments, (4) stage of evolution of flora and fauna, and (5) the amount of time involved in the basin's history.

These factors, if evaluated in regard to basins of different ages and geographic locations, demonstrate why both modern and ancient basin margins are highly variable in regard to (1) thickness of sediment, (2) type and sequence of sediment, (3) facies relations of the sediment, and (4) tectonic history. In addition, this type of evaluation demonstrates the need for regional analysis as a framework for local analysis of any basin.

17. CHARLES E. MEAR, Louisiana Land and Exploration Co., Midland, Tex.

STRATIGRAPHY OF PERMIAN BASIN

(No abstract submitted)

17TH ANNUAL MEETING, ROCKY MOUNTAIN SECTION, AAPG, CASPER, WYOMING, OCTOBER 8–11, 1967

Approximately 800 geologists and their wives attended a very successful and thoroughly enjoyable 17th Annual Meeting of the AAPG's Rocky Mountain Section in Casper, Wyoming, October 8–11, 1967. The weather was warm and sunny and the 3-day program, whose theme was "Breaking Barrier Boundaries," was superb. AAPG National President, J. BEN CARSEY, gave a timely talk on AAPG affairs. Governor STANLEY K. HATHAWAY presented an enthusiastic Address of Welcome. THOMAS D. BARROW, Senior Vice President and Director, Humble Oil & Refining Co., Houston, Texas, delivered a thought-provoking Keynote Address on the responsibilities of a geologist to his management as well as to his profession. Retiring Rocky Mountain Section President, JOHN B. CARRIER, gave an extremely pointed and