necessary to eliminate this confusion. As an example, the name Cottage Grove is recommended for the section of erratic sandstones variously called "Layton," "Upper Layton," "Osage Layton," "Layton of Ponca City," "Peoples," and "Mussellem"; however, the name Layton should be retained for the sandstone below the Hogshooter.

The most conspicuous aspect of the stratigraphy is the near parallelism of all of the beds, except the erratic sandstones and limestones, in the marine Permian and Pennsylvanian. Local disconformities probably occur in this part of the section, but there are no major angular unconformities, even between series and systems. The two major unconformities shown on the cross section are at the base of the Pennsylvanian and at the base of the Woodford or the Misener.

WARREN BEEBE, Keating Drilling Co., Oklahoma City, Oklahoma
Geology of Northwestern Anadarko Basin

This paper reports the results of several years concentrated study of the northwestern Anadarko basin. Work commenced high on the southwestern flank of the Central Kansas uplift. Although the stratigraphic section of the Lower Pennsylvanian, Mississippian, and Upper Ordovician rocks is not complete in that area, rock units are easily recognized, well defined, and general agreement exists for their precise age and correlation.

Numerous problems, particularly in the Pennsylvanian and Lower Permian, are involved in correlating into the basin, determining age of sediments, and deciphering structural and depositional history. Abrupt facies changes near regional structural features and marked basinward divergence accentuate these difficulties. Series problems are encountered in recognizing, defining, and establishing the boundaries between stages. This is particularly true of the age of the sedimentary sequence subjacent to recognizable Des Moinesian, including strata variously called "Atokan," "Morrowan," "Derryan," "Lampassan," and possibly "Springeran," The boundaries between the Missourian and overlying Virgilian, and the Virgilian and superjacent Permian Wolfcampian, are also confusing. The structural and depositional history inferred in the area is dependent to a large degree on the definition of these stages. Introduction of names or terms, many local in usage, from various parts of the central United States adds to the confusion.

Regional subsidence into the Pennsylvanian Anadarko basin, the later Permian basin of West Texas, and subsequent pronounced tilting into the Mesozoic Denver basin, coupled with at least two major unconformities, numerous less important regional and local unconformities, disconformities, and hiatuses, further complicate the geology of the region.

Structural maps on several readily identifiable markers over most of the basin disclose its present structural configuration. However, the structural and depositional history is best revealed by a series of isopachous maps of the Mississippian, stages of the Pennsylvanian, and Lower Permian. Regional downwarping into the Anadarko basin continued from late Mississippian through the Pennsylvanian into Lower Permian.

Four general but distinct regional structural forms controlled deposition, including the central Kansas uplift and the Souixan landmass characterized by deposits of primarily carbonate rocks; a shelf area with rapid transition from carbonates to clastics along its edges; a deep basin area with finer clastics; and finally high areas such as the Apishapa-Sierra Grande features yielding coarse clastics and washes during much of the time. Reefoid deposits are present along the shelf edges and around major positive elements. Early and Middle Pennsylvanian sediments progressively onlapped onto truncated pre-Pennsylvanian rocks on the flanks of positive tectonic features. Younger Pennsylvanian sediments progressively overlapped those previously deposited as the basin area expanded. These conditions afford the widest variety of traps for accumulations of oil and/or gas. Production has been established in various types of stratigraphic and permeability traps, including biostromes, and structural traps in sandstones and limestones, including Wolfcampian, all Pennsylvanian stages, Chesterian, Meramecian, and Ordovician. No firm conclusions can be reached presently regarding precise age, correlation, and boundaries of many stratigraphic units. The writer deplores confusion resulting from introduction of local terminology from other areas, and urges restricting terminology to that of classic Pennsylvanian stages until more precise terminology can be justified. Cooperation of local geological societies can define and solve many of the stratigraphic problems.

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ABSTRACTS

JOHN W. MERRITT, consultant, Tulsa, Oklahoma
Radiation Surveying for Oil and Gas

For many years geologists and chemists have been aware of the presence of certain significant density patterns developed by analyzing surface soils over oil and gas reservoirs. Geochemists have

made use of this method in studying oil and gas prospects, in addition to structural geology and geophysics.

By use of organic geochemistry there was later developed a new method of semi-direct surveying based on the development of density patterns in the surface soil by analysis for certain inorganic substances. It naturally followed that any radioactive inorganic elements contained in the surface soil would allow the development of a similar concentration pattern which could be mapped by the use of highly sensitive radiation counters.

Serious radiation surveys were begun about ten years ago with the use of an ionization-type instrument of suitable sensitivity and stability. These instruments were built to order and required a considerable period of testing and improvement to prove their reliability.

With the new interest in uranium exploration stimulated by the building of highly sensitive scintillometer devices, these instruments have also become available for oil exploration.

The successful use of all types of sensitive radiation-measuring instruments depends on the proper handling of numerous factors that tend to create false radiation values. Obviously this method, like geochemistry, is not simple. It is the purpose of this paper to attempt to describe and evaluate all factors which must be taken into consideration before a survey can be completed and the correct conclusions reached.

GEORGE B. MANGOLD, Petroleum Engineering Associates, Inc., Pasadena
Differential Thermal Analysis: Correlative Tool Where Other Methods Fail

Differential thermal analysis (DTA) provides a valuable scientific method for determining correlation markers and mineral composition of zones. It is based on the accepted technique of identification of chemical compounds through measurement of thermal reactions as the cuttings or cores are subjected to a controlled temperature rise. The thermal curves, plotted in log form, illustrate changes in formation mineralogy, and graphically point out type and amount of clays, carbonates, oxides, quartz, etc. Mineral trends, breaks, and stringers supply correlative values independent of formation fluids, secondary electrical and radiation properties, and presence of paleontological specimens. Because it depends only on basic mineral composition, DTA can succeed where logs and paleo are not diagnostic. In addition, this technique provides information essential to the full interpretation of in-the-hole logging and of core analysis.

COLE R. MCCLURE, California State Division of Water Resources, Sacramento
Geochemistry and Migration of Meteoric and Connate Waters as Related to Geologic Structure

Data obtained during geologic and geochemical studies in several areas of the Sacramento Valley have suggested correlation between subsurface structure and the occurrence of a type of saline water in the shallow water-bearing deposits. Sufficient data have been collected to permit construction of subsurface contours on the base of fresh water. These contours, which reflect general structure in the Sacramento-San Joaquin Delta area, represent the interface between fresh water and a specific type of saline water. This connate water contains high concentrations of sodium and chloride ions, low concentrations of sulphate and nitrate ions, and approximately equal concentrations of iodide and bromide.

Under hydrodynamic conditions, fresh water in the foothills with considerable head has apparently flushed the saline waters out of a part of the marine sediments. In the Delta area this connate water has been forced upward from the marine sediments to the surface along faults and from truncated marine sediments on anticlinal structures.

There are numerous other ground-water anomalies which may indicate the presence of buried structural features. A characteristic type of water apparently associated with faulting may be noted in the shallow water-bearing deposits. This water commonly has higher temperatures and greater concentrations of silica and boron than the normal ground water. Further geochemical studies of this type may be of value to the petroleum industry.

A. A. HOPKINS, G. R. LAPERLE, J. W. MATHEWS, AND I. T. SCHWADE, Richfield Oil Corporation
Marysville Buttes: Geological and Geophysical Analysis

Marysville Buttes is an extinct complex volcanic plug surrounded by steeply folded and faulted Cretaceous and younger sediments. It occupies a circular outcrop area of approximately 20 square miles, and forms a bold topographic feature rising above the flat low Sacramento Valley.

The Marysville Buttes intrusive developed during post-Eocene time with the piercement and doming of 7,500 feet of Upper Cretaceous and middle and upper Eocene beds by a rhyolite and andesite plug approximately 4 miles in diameter. It is believed later andesite formed the central core and progressively deformed the sedimentary beds. During late Pliocene to Pleistocene, showers of pyroclastics, crudely interbedded with mudflows, were deposited on the denuded dome. This formed a cone, which has subsequently been deeply eroded.

Beneath the valley floor near Colusa, a similar large plug which has been indicated by seismic and well records lies concealed beneath approximately 5,000 feet of Cretaceous and younger sedi-