January 13, 1964

PAUL L. LYONS, Sinclair, Tulsa
"The Crust and Mantle of the Earth"

The accumulated geophysical data for the Gulf of Mexico, combined with the known geology, make a number of maps possible which serve to define the modern geosyncline and provide some evidence as to its inception. The velocities and depths of interfaces observed in seismic reflection and refraction profiles may be tied to layers of rock, and the gravity and magnetic data assist in determining the tectonic framework. The inception of the geosyncline appears to be related to widespread collapse in Triassic time; this had been preceded by deposition of Paleozoic sediments and the possible extension Gulfward of the Appalachian orogeny. The problems dealt with are (1) the shallow Jurassic and Cretaceous aspect of the Gulf, (2) the widespread extent of the salt and the resultant domes, (3) the lateral or wrench faults and the restoration of transposed elements, (4) the pattern of shifting depocenters, (5) the tremendous acceleration of depositional rates in Tertiary time culminating in the rapid present day rate of 24.4 cm/century determined by Hardin and Hardin, (6) the engimatic Atlantic trench, (7) the unexpected axial directions of magnetic anomalies and (8) the intermediate (between continent and ocean) depth of the Gulf Moho. The combined result of the complex history is a Mesozoic and Cenozoic geosyncline with a sedimentary thickness of perhaps 60,000 feet. The final problem is why this great prism of rocks does not fold into a mountain range after exceeding the accepted depth limit for other geossynclines.

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January 20, 1964

CHARLES MILTON, USGS, Washington
"Mineralogy and Geology of the Green River Formation of Colorado, Utah, and Wyoming"

The Green River formation of Eocene age outcrops over many thousand square miles in each of the three states, Wyoming, Colorado, and Utah, and underlies similar large areas. It contains the world's largest known accumulation of hydrocarbons as oil shale, and the world's greatest deposits of sodium carbonate minerals, mined to produce soda ash, a basic industrial commodity. Both the hydrocarbons, if converted into marketable fuels, and the soda ash, could fill the nation's needs for centuries to come. At present besides the soda ash, produced in two large mines in Wyoming, gilsonite, a solid hydrocarbon is mined for gasoline production in Utah, and oil and gas are produced in all three states.

The geological history of the formation, essentially a lacustrine deposit in a basin cut off from the sea for millions of years, appears to be unique. Conditions of sedimentation included formation of thousands of feet of rich oil shale, apparently from a lake whose upper waters supported teeming animal and vegetable life, but whose bottom waters were depleted of oxygen and high in hydrogen sulphide. Tremendous quantities of sodium compounds, mostly carbonates, accumulated in the bottom waters or underlying muds with significant boron and barium.

The Green River formation contains an extraordinary variety of authigenic minerals, many found nowhere else in the world, and containing such elements as uranium, niobium, rare-earths, zirconium, and titanium, not normally found in lacustrine sediments. There are likewise many minerals, here formed at temperatures not thought to exceed 200°C, such as pyroxenes, amphiboles, biotite, and feldspars, which ordinarily are formed only under relatively high temperature magmatic or metamorphic conditions.

Recent work has made known extensive apatite deposits, a new type (non-marine) of bedded phosphate, which carries significant uranium. Also the thick series of oil shales in Colorado appear to be vertically zoned mineralogically, a new development in sedimentary petrology.

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February 3, 1964

R. A. BAILE, AAPG Distinguished Lecturer
Independent Exploration Company, Houston
"Some New Concepts in Geophysics"

New methods are rapidly being introduced in geophysical prospecting which are greatly enhancing the oil-finder's ability to discover additional reserves at lower cost. A movie is shown which briefly depicts a method, now in common use, wherein a free-falling weight develops seismic energy sufficient to examine subsurface strata to great depths. In addition to the weight dropping method as shown, other surface initiated energy systems have been developed, notable among which bears the trade name "Vibro-Seis"*. In experimental and initial usage stages are various other methods which offer considerable potential for vastly improved methods of geophysical prospecting. Improvements in magnetic tape recording and processing have provided new impetus to better methods

In a more general sense, consideration must be given to personnel, economic condi-

* Registered trademark of Continental Oil Company.

tions, and how such relate to oil company and contract geophysical efforts. In view of Western Hemisphere reserve position, rising nationalism in foreign areas and in spite of current surpluses along with depressed product prices, a more favorable and stabler climate must be developed for the explorationist in order to keep petroleum competitive in the total energy market.

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February 10, 1964

LOUISE JORDAN, Oklahoma Geol. Survey Norman

"The Geology and Economic Future of the Salt Deposits of Oklahoma"

Permian salt and associated evaporates within a 20,000-square-mile region in western Oklahoma and the Texas Panhandle are Leonardian and Guadalupean, and possibly Ochoan, in age. This report is concerned chiefly with the subsurface geology of the three principal evaporate sequences, each of which is 300 to 1,000 feet thick and consists mainly of rock salt and salty shale interbedded with anhydrite. These evaporite sequences contain all the rock salt known in Oklahoma. The evaporites occur with red clastic sediments in a sequence 4,000 feet thick, embracing all strata from the base of the Wellington formation to the top of the Dog Creek Shale. Four stratigraphic sections accompanying the report illustrate the distribution and facies relationships of these beds. The youngest evaporites of the region—relatively thin anhydrite beds in the Cloud Chief formation, of possible Ochoan age—are not considered herein.

The evaporites are classed in ascending order as Wellington, Cimarron, and Beckham. Wellington and Cimarron evaporite units known in the subsurface of Kansas are here extended and mapped into Oklahoma and the Texas Panhandle. The term "Beckham evaporites" is a new term that includes (ascending) the Flowerpot salt (new), Blaine anhydrite, and Yelton salt (new). Each evaporite sequence is widely distributed, occurring as eastward-thinning tongues or wedges within the framework of Permian clastic sediments. Together the evaporites have a maximum thickness of 2,500 feet. The evaporite strata, excluding clastics, consist of halite (about 80 percent), anhydrite, and thin beds of dolomite (less than 5 percent). No potassium salts were found or were indicated by investigations for the present study.

The oldest halite-anhydrite sequence in Oklahoma, called the Wellington evaporites, is of Leonardian age and normaly ranges in thickness from 1,000 to 1,300 feet. It is divided into a lower anhydrite-salt unit, a shale unit, and an upper anhydrite unit. The salt in the upper part of the lower unit is equivalent to the Hutchinson Salt of Kansas. Depth to the salt in the Wellingon ranges from 800 feet in northwest-central Oklahoma (Grant County) to 3,900 feet near Elk City in Beckham County. Over an area of approximately 16,500 square miles the average aggregate thickness of salt strata in the Wellington is 225 feet.

Above the Wellington are the Hennessey shales, which are overlain by the Cimarron evaporites. The Cimarron evaporites consist of lower and upper salt units separated by the Cimarron anhydrite and have a maximum thickness of 1,000 feet. The lower salt and Cimarron anhydrite are especially persistent, and the anhydrite is a valuable structural datum. Total thickness of Cimarron salt strata over 13,000 square miles of western Oklahoma is generally 500 feet, and the depth range is between 215 and 2,420 feet. The lower salt unit is noteworthy because it locally consists of massive salt more than 400 feet thick, and thus is probably the thickest salt in Oklahoma.

Red shales above the Cimarron are classed as Flowerpot-Hennessey. They are overlain by the Beckham evaporites (Guadalupean), the youngest salt-bearing strata of western Oklahoma and the eastern part of the Texas Panhandle. The middle unit of the Beckham sequence is the well-known Blaine anhydrite, 150 feet thick, which crops out extensively in western Oklahoma and occurs so persistently in subsurface that it is a valuable stratigraphic datum. Salt beds directly below and directly above the Blaine, respectively called Flowerpot and Yelton, have much less geographic distribution, yet each attains a thickness in excess of 250 feet. The Flowerpot salt has an average thickness of 200 feet and a maximum thickness of 625 feet (including salty shale). It occurs over more than 7,000 square miles of western Oklahoma and is found at depths as shallow as 30 feet in northern Oklahoma, and as deep as 1,655 feet in southwestern Oklahoma in the area north of the Wichita Mountains. The Yelton salt occurs chiefly in Beckham and Washita Counties, Oklahoma, and in Wheeler County, Texas, at depths of 390 to 1.285 feet. Much of the Yelton sequence is massive rock salt, reaching a maximum thickness of 287 feet in the eastern part of Beckham County.

Included in the report are maps showing distribution, thickness, and depth from surface of the principal salt beds.

As outlined by structural mapping at the base of the Blaine anhydrite and of the Wellington evaporites, the major structural