Stratigraphy and petroleum potential of Lower Cretaceous Inyan Kara Group in northeastern Wyoming, southeastern Montana, and western South Dakota

WEDNESDAY AFTERNOON, SEPTEMBER 29

Presiding: BRUCE F. CURTIS, JOHN R. SANDERS

JAMES A. BARLOW, JOHN D. HAUN: Stratigraphic accumulation of oil in Salt Creek field, Natrona County, Wyoming

ROBERT J. WEIMER: Patrick Draw field, Sweetwater County, Wyoming—an old stratigraphic trap

J. C. HARMS: Stratigraphic traps in a valley fill, western Nebraska

EARL G. GRIFFITH: Geology of Saber bar, Logan and Weld Counties, Colorado

CURTIS J. LITTLE, THOMAS C. CARLSON: Many Rocks-Gallup field, San Juan basin, northern New Mexico

DONALD I. FOSTER: Trapping mechanisms of selected fields, Cherokee Ridge, Wyoming and Colorado

D. O. ASQUITH: Mesaverde and "Almy" production, Birch Creek Unit, Sublette County, Wyoming

ROBERT E. COVINGTON, RALPH L. MCDONALD: Stratigraphic and structural controls of bituminous sandstone deposits of Utah

JERALD ALLIGER, GILBERT THOMAS: Comprehensive surface mapping in Williston basin

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ABSTRACTS OF PAPERS

(In sequence as presented in technical program)

1. A. I. LEVORSEN, Consulting petroleum geologist, Tulsa, Oklahoma[1]

THE OBSCURE AND SUBTLE TRAP

The tremendous expanding demand for petroleum and its products that continues to develop means that we must take a hard look at where our future supply of petroleum is to be found. In spite of the fact that most exploration has been and is directed toward the search for petroleum in local structural traps, many of the largest oil and gas pools in the Western Hemisphere are trapped by non-structural phenomena. Structural traps are so obvious that they are the first to be tested. But we are now facing the situation where the supply of structural traps in the United States seems to be limited; untested anticlines are becoming more difficult to find. Does this indicate an impending shortage of petroleum? The answer would seem to be *No*—but this means the search will have to be for more obscure and subtle trapping situations. The search will continue for the purely structural trap, but there will be added stratigraphic variations and fluid-flow phenomena, all operating either together or independently.

We have "stumbled" into many great non-structural oil and gas pools while looking for purely structural traps, but the time seems to have arrived when we must start looking directly for combination traps of all kinds involving different proportions of structure, stratigraphic change, and fluid-flow phenomena. Such traps may contain very large petroleum pools as past experience has shown.

There are in the Rocky Mountain region many such untested potential combinations of large and broad structure, stratigraphic change, and favorable fluid-flow conditions to justify the belief in its continuing great future as a petroleum producing region of importance to our national needs. The fact that the Rocky Mountain Section is dedicating a full meeting to the obscure and subtle trap is a sure indication of a change in our thinking. Once we start actively looking for traps that combine structure, stratigraphic change, and fluid phenomena instead of looking only for local structure, there is no reason why discoveries in the United States should not continue to meet the demand. And the Rocky Mountain region has as bright a future for petroleum discovery as any other.

[1] Deceased, July 16, 1965. Paper presented by ORLO E. CHILDS.

2. IRA H. CRAM, Vice president and chairman, Executive Committee, Continental Oil Company, New York City, New York

THE OLDEST IS THE NEWEST

Geologists and other scientists and engineers on the exploration team have the continuous job of improving their performance to the end that oil and gas are found in adequate quantities at the lowest possible cost at all times—come boom or bust. Nobody can know what the future holds, but if present forecasts of domestic and foreign demand for oil and gas down the line materialize, outstanding growth in exploration and production technology is a necessity. Fear that such (or larger) demand cannot be satisfied evaporates once the basic lesson history teaches has been learned. That lesson is our unfortunate tendency to underestimate the magnitude of the world's mineral resources, and further to underestimate man's ability to capture them and use them.

Growth in the importance of geologists to the exploratory process seems definitely assured as the more obvious prospects are taken out of circulation leaving deeper, more far-flung, and altogether more baffling hunting grounds with which to cope. As time passes, geologists will be called upon to make a greater contribution to the exploratory process than they have in the past.

Rocky Mountain geologists have a goodly piece of the domestic hunting grounds as well as a fair cross section of the oil- and gas-finding problems. These include the discovery of fields at great depths, in unusual structural traps, and, in particular, in stratigraphic traps. In effect, the area is a hand specimen of the finding problems of the future. The opportunity of advancing the art of discovery while maintaining or even increasing the area's position in the domestic industry is ever present. Success can hardly be achieved, however, unless Rocky Mountain geologists lead exploratory thinking and action and do not "pass the buck" to the geophysicists and Dad Joiners.

More geology, more imaginative geology, and more geology in geophysics, coupled with more wildcat drilling, will produce surprising results—surprising on the right side of the ledger. The oldest scientific finding tool—geology—becomes the newest, not only in the Rockies but elsewhere.

3. MICHEL T. HALBOUTY, Consulting geologist and petroleum engineer, Houston, Texas

IF THEY HAD NO FEAR, WHY SHOULD WE?

The oil industry was founded by men of imagination and daring who ignored the prophets of doom and employed their enthusiasm and optimism to discover and bring about a world of abundant energy. With this significant observation in mind, a few interesting highlights of petroleum history are traced; particularly, the achievements of Edwin L. Drake, who drilled the first

commercial oil well in the world in 1859 near Titusville, Pennsylvania; the late Pattillo Higgins, whose faith and inspiration led to the discovery of Spindletop and the beginning of the liquid fuel age; and Columbus "Dad" Joiner, the aged and impoverished Oklahoma wildcatter, who proceeded on his goal in the face of "learned" advice to cease drilling and the scornful criticism of earth science leaders, to bring in the greatest oil field in North America—the vast East Texas field where more than six billion barrels of oil eventually will be produced.

There were other great contributors to the abundance of petroleum, such as William Knox D'Arcy, an Englishman, who suffered years of heartaches and hardships, while working in a locale which was so forbidding that other civilized men dared not venture into it, before his discovery led to the opening of the vast Persian Gulf oil reserves; the pioneer geologist, Charles Eckes, whose painstaking and minute geological investigations led to exploration for, and eventual discovery of, the great deposits of oil under Lake Maracaibo in Venezuela; and, Robert DeMares, whose persistence, based on his observations of oil seeps that spouted high into the tall tropical trees, enabled him to attract the wildcatting firm of Benedum and Trees to the rich production in the heart of the Colombian jungles.

These were only a few of the men who sought and found opportunity through faith, determination, and optimism and, by so doing, developed the energy and fuel for a better way of life for all mankind; this suggests that the petro-professionals in the industry should pause and re-evaluate their own contributions toward a better society and a more profitable industry. A look at the past is timely in view of the prevalent pessimism and lack of determined leadership on the part of most industry personnel, especially in the field of exploration. Successful leaders of tomorrow will be individuals in today's petroleum industry who are as dedicated, determined, and purposeful as those illustrated in this paper.

4. HENRY L. OTT, Chevron Oil Company, Western Division, Casper, Wyoming

PALYNOLOGY AND ITS USE IN PETROLEUM EXPLORATION

Palynology is basically the study of pollen and spores, both fossil and recent. Many students of modern pollen are allergists, whereas the fossil pollen student is generally referred to as a palynologist.

Most hayfever suffers become acutely aware of the presence of modern pollen and spores during the summer months. These pesky little bodies have long played key rolls in the annual plague of itchy eyes and runny noses. However, their fossil cousins have received relatively little attention until the last few decades. During this time their presence has been noted in rocks of all geologic ages dating to the Silurian.

Pollen and spores are the male and female reproductive bodies of the flowering and non-flowering plants, respectively. They are produced by the countless trillions by plants everywhere and are distributed to the four corners of the globe by winds and water. Everyone has observed the yellow film on a high mountain lake, or the yellow "smudge" on a garment after contacting the goldenrod blossom. This yellow "smudge" is pollen dust. The individual pollen grain is of microscopic size, about 3,000 of them fitting side by side on the head of a pin. In spite of their extremely small size they are hardy little individuals, being relatively indestructible both physically and chemically. For this reason they have become important to the geologist. They are widely distributed by winds and water to all environments of deposition and then may be buried and preserved to furnish a fossilized record of geologic events of the area.

Palynologists have been able to utilize the pollen record for (1) age determinations, (2) correlations, (3) climatic interpretations, (4) depositional environmental interpretations (associated micro-microfossils), and (5) oil migration and accumulation studies. The application of the science of palynology is relatively new to the petroleum industry and new and better techniques as well as continued experience may yet add other uses to the ever-growing science.

5. LOUIS F. KEATING, Imperial Oil Enterprises Limited, Calgary, Alberta

EXPLORATION IN CANADIAN ROCKIES AND FOOTHILLS

The Canadian Rockies form the most easterly ranges of the Cordilleran system for a distance of more than 1,050 miles, from the Yukon border south into central Montana. They are bounded on the east by the Interior Plains and on the west by the Rocky Mountain trench. The main deformation occurred during the Eocene, resulting in a system of stacked thrust plates which are restricted to the sedimentary section and do not involve the crystalline basement rocks. More than 100 miles of shortening in the sediments occurred as a result of this deformation.

Exploration in this structural belt has resulted in an important oil- and gas-producing province, the major reserves being located in the southern Foothills. The vast amount of information that has been accumulated in the course of this exploration through surface mapping, drilling, and geophysical work has provided excellent structural detail over a large part of the area.

Prospective structures are difficult to locate and require careful integration of all available geological and geophysical control. Reflection and refraction seismic methods have had considerable success in locating many of the presently producing fields and have provided information that is fundamental to our understanding of this complex structural belt.

6. RUDOLPH MARTIN, Rudolph Martin and Associates Limited, Calgary, Alberta

APPLICATION OF PALEOGEOMORPHOLOGY TO EXPLORATION FOR OIL AND GAS

Hydrocarbon traps are customarily subdivided into two main classes: *structural* and *stratigraphic*. A third important class, hitherto not considered separately, includes hydrocarbons trapped in buried hills, ancient sandstone-filled valleys, fossil reefs, and other primarily geomorphological phenomena. These are termed as *paleogeomorphic* traps. The analysis of and prospecting for this type of trap must proceed along purely geomorphological lines of reasoning. These include both *form* and *process:* the form creates the trap, but the process shapes the form. Trapping may be below or above the paleogeomorphological surface, and be either direct or indirect.

Paleogeomorphology includes all geomorphic phenomena recognized in subsurface geology, *i.e.,* all buried-relief features, whether formed on land or under water. Geomorphic processes may be divided into "constructive" and "destructive." Constructive forms of interest to petroleum geologists are dunes, barrier beaches, organic reefs, *etc.* Destructive processes create hills and valleys, underground drainage in carbonates, submarine canyons, *etc.*, and create or destroy porosity by weathering.