and physical factors, including depth of water, temperature, salinity, food supply, chemical effects, turbidity, biologic competition, currents, and circulation. The benthonic Foraminifera are the most reliable ecologic indicators, but a more detailed ecologic framework can be ascertained by the use of both benthonic and planktonic Foraminifera.

20. C. E. HOTTMAN, Shell Development Company, Houston, Texas, AND R. K. JOHNSON, Shell Oil Company, New Orleans, Louisiana

ESTIMATION OF FORMATION PRESSURES FROM LOG-DERIVED SHALE PROPERTIES[1]

Sedimentary rocks during burial maintain hydrostatic fluid pressure within their pore space if the fluids within the sediment can escape as the sediment compacts. If the fluid can not escape, compaction is retarded, and the fluid pressure rises (the sediment becomes overpressured), ultimately approaching the pressure exerted by the overlying rocks and contained fluids. The actual fluid pressure existing in a permeable formation can be determined by standard pressure-bomb measurements. The determination of the fluid pressure in shales, with their low permeability, previously has been difficult or impossible.

The fluid pressure within the pore space of shales can be determined by using data obtained from both acoustic and resistivity logs. The method involves establishing relations between the common logarithm of shale transit time or shale resistivity, and depth for hydrostatic-pressured formations. On a plot of transit time vs. depth, a linear relationship generally is observed, whereas on a plot of resistivity vs. depth, a non-linear trend exists. Divergence of observed transit times or resistivity values from those obtained from established normal compaction trends under hydrostatic pressure conditions is a measure of the pre-fluid pressure in the shale and thus in adjacent isolated permeable formations. This relation has been established empirically with actual pressure measurements in adjacent permeable formations. The use of these data and this method permits the interpretation of fluid pressure from acoustic and resistivity measurements with an accuracy of approximately 0.04 psi per ft., or about 400 psi at 10,000 ft. The standard deviation for the resistivity method is 0.022 psi per ft. and for the acoustic method 0.020 psi per ft.

Knowledge of the first occurrence of overpressures, and indeed of the precise pressure-depth relation in a geologic province, enables improvements in drilling techniques, casing programs, completion methods, and reservoir evaluations.

21. G. L. MARQUIS, P. A. WICHMANN, AND C. W. MILLIS, Lane-Wells Company, Division of Dresser Industries, Inc., Houston, Texas

STUDIES OF PRODUCING RESERVOIRS WITH NEUTRON LIFETIME LOG[2]

Reservoir evaluations are based on information obtained at the time wells are drilled and completed and on reservoir performance. Important data normally available from open-hole measurements include gas-oil contacts, water saturations, and water-table levels. These parameters change as a reservoir is produced and the results manifest themselves as changes or a combination of changes in oil produced, water produced, gas-oil ratio, or bottom-hole pressure. Many perplexing reservoir problems could be solved if changes in these parameters could be observed as the reservoir is produced to complement data observed in the bore hole from the results of production. Such measurements in the hands of the reservoir engineer would be a powerful tool for refinement of reservoir evaluation.

The Neutron Lifetime Log gives a cased-hole measurement of a formation parameter sensitive to the amount and type of fluid in the formations. This parameter, thermal neutron capture cross section, qualitatively distinguishes potentially productive intervals from non-productive intervals through a wide range of well-bore conditions.

A single mathematical expression relates the contributions of the formation fluids in the pore volume and of the rock matrix to the capture cross section of the formation. Under favorable conditions, quantitative water saturations can be determined. Aside from the obvious application of capture cross section for identifying potentially productive intervals behind casing, this measurement has proved most valuable in reservoir analysis.

Well studies are presented indicating results observed from applying cased-hole measurements of capture cross section to reservoir evaluation.

22. EDWARD F. ZAGST AND CHARLES L. ROBINSON, Ray Geophysical Division, Mandrel Industries, Inc., Houston, Texas

SOME RECENT ADVANCES IN EXPLORATION GEOPHYSICAL TECHNIQUES AND DATA PROCESSING

The geophysical industry has made significant advances in the past 2–3 years, changes which have altered the exploration programs of many companies. Some of the more conspicuous areas of new advances in present-day geophysical exploration techniques and data-processing procedures are discussed in this presentation.

The common depth point, or CDP, technique of field operations is one of the most important changes in procedures of recent years. This operation is discussed in some detail. Of equal importance is the rapid emergence of the use of digital recording in the field and the use of the digital computer in playback operations. The use of these concepts allows the geophysicist to determine the parameters of the problems of deghosting, deconvolution, dereverberation, and optimum filtering much more efficiently than the present-day analog method. Present-day high-speed analog-to-digital converters are now available which allow the digital computer playback programs to be applied to the old seismic data now in the files of many companies.

23. FREDERICK E. ROMBERG, Geophysical Service Inc., Dallas, Texas

OPTIMUM USE OF GRAVITY IN EXPLORATION

The techniques and philosophy of gravity in oil exploration are reviewed for the purpose of determining whether better use can be made of the method than has been usual in practice. Suggestions are presented for determining whether gravity will be useful in a particular case. The elements of optimum field practice are listed. Interpretation methods are defined and recommendations are made in favor of better understanding between geologists and geophysicists, in favor of the quantitative approach in interpretation, and against too great a dependence on automatic data processing.

[1] Patents pending. Shell Development Company Publication No. 395. This paper has been published in *Jour. Petroleum Technology*, June, 1965.

[2] This abstract is from Society of Petroleum Engineers of A.I.M.E. Preprint Paper No. SPE-1216. The paper is to be presented at the 40th annual fall meeting of the S.P.E. of A.I.M.E. to be held in Denver, Colorado, October 3–6, 1965.