ABSTRACTS OF ROCKY MOUNTAIN SECTION PAPERS

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(Numbered in sequence of technical program)

1. L. C. BONHAM, California Research Corporation, La Habra, California
B. D. KLINE, Standard Oil Company of California, Western Operations, Inc., Oildale, California

Experience with Mechanized Well Data System

Interest in electronic data processing as a supplementary exploration tool is growing throughout the oil industry. The volume of well data is increasing exponentially. Before any data retrieval or processing can be done, the most important data items must be converted to a machine form. Converting the current data is a small problem. Converting the useful backlog data is a large and costly problem. Many companies are approaching this problem through individual and group efforts. The Standard Oil Company of California has developed a mechanized well data system for the storage, updating, correcting and retrieval of useful well data and information.

A team of geologists surveyed the Corporation's exploration offices to define the most used well data and the major problems related to manual retrieval. An area in California was chosen for a test which involved data conversion and the development of computer programs to utilize magnetic tape files and the IBM 1401 computer. The system was designed to include all wells, a high percentage of data types, a low percentage of errors, minimum coding, readable output, provisions for expansion, update and correction procedures, and simple query construction. The system was developed in two phases. Phase I included the well biography and an index to data. Phase II included selected numerical and tabular well data as well as interpretative data. Experienced technical assistants under the supervision of a geologist transcribed the data from complete well files. The average per well costs for conversion to magnetic tape ranged from $5 to $15 depending on the amount of information included. To search the magnetic tape file, a computer query is formulated from a geologist's specific question. The computer search results in readable, uncoded lists. The cost to answer typical geological requests varies from $3 to $10 per thousand wells depending on the complexity of the question. The savings of professional search time and the volume of pertinent data made available is gratifying. But problems still exist—data conversion costs are high, more suitable machines are needed, true value of such systems are difficult to assess.

Computer systems have many potential exploration applications which will have to be originated by enlightened, experienced, competitive, and imaginative oil finders at all levels. The storage-and-retrieval of basic well data is the logical starting point.

2. MARK E. HENNES, British American Oil Producing Company, Casper

Lithoporosity: Integrated Technique for Mapping Lithology, Environment, and Effective Porosity

Three basic stratigraphic problems, lithology, environment, and porosity, confront most geologists working with sedimentary rocks. An evaluation of any time or rock unit should involve all three problems with an economic focus on distribution of porosity—effective porosity. Conventionally, a complete evaluation would be accomplished by an integration of the conclusions of the separate problem analyses. A more desirable approach, prior to map interpretation, would be the integration of the basic data of these problems into an objective form, numerical units, common to each problem. With roots in a foundation of common measurement the solution to the separate analyses would be well coordinated and would result in greater accuracy with the integrated conclusions than that achieved by compounding interpretations based on diverse units of measurement.

Lithoporosity is a technique which evaluates effective porosity by use of the lithologic factors which retard its development. These "retarding factors," derived from sample descriptions and other data, are given numerical values from a standard scale determined for the study unit. Such a derivation is part of a definite data synthesis to be followed. By this synthesis, preparation for a study must include exact correlations of the unit concerned and the establishment of certain standards for evaluation by lithoporosity. A tabulation of descriptive data in each well must then be made involving lithology, environment, fluids, and porosity from which retarding factors are to be estimated. Finally, specific data are extracted for map compilation.

By mapping retarding factors we obtain quality control and distribution of critical *lithologic* phenomena. With such control together with our mapping of other pertinent data from the tabulation we achieve an *environmental* concept of the unit. If we composite the retarding-factor maps and convert the resulting values to porosity equivalents we find that we have developed an areal distribution of *effective porosity*.

Utilizing standard subsurface information only, lithoporosity offers many advantages. Mainly, it can be used to evaluate single or multiple zones in any effectively porous sedimentary rock in situations where time and simplicity are of utmost importance. Above all, it is a complete synthesis intended to serve better the foremost geologic need—predictability.

3. DAVID W. ELIAS, Mountain Fuel Supply Company, Vernal, Utah

Paleogeography Applied to Exploration

Paleogeography, the mapping of seas, shorelines, rivers, deltas etc., at some time in the past, is a valuable tool in exploring for reservoir rocks in the Cretaceous section of the Rocky Mountain region. Paleogeographic mapping is accomplished by means of stratigraphic studies to determine two essential factors—environment of deposition and correlation. Classification of the Rocky Mountain Cretaceous rocks into four broad facies (Inland, Shoreline, Sandy Offshore, and Shaly Offshore) is a useful device which aids in the study of the complex intertonguing of varying lithologies. An understanding of shoreline movements (transgression and regression) is the key to correlation in the Cretaceous section. The

Cretaceous sequence of most of the Rocky Mountain region can be considered to be the result of superimposition of many paleogeographic settings. Analysis of a hypothetical time-stratigraphic unit shows the variation in location, shape, and size of potential reservoir rocks deposited in various paleogeographic locations. In one example, correlation of an inland facies and an offshore facies suggests an intervening shoreline facies. Paleogeographic considerations are fundamental in stratigraphic analysis and consequently paleogeography is the base on which stratigraphic exploration is built.

4. BURL A. TULLER, Pan American Petroleum Corporation, Casper

UTILIZATION OF GEOLOGIC DATA IN PLANNING SEISMIC PROGRAM

The pertinent aspects of seismic program planning are developed within the framework of the following three-phase outline.

I. Geologic Pre-Seismic Prospect Analysis.
II. Geophysical Pre-Seismic Prospect Analysis.
III. Management—Geological—Geophysical Pre-Seismic—Prospect Analysis.

Phase I considers the available data which the geologist must assemble into a logical geological picture before a possible exploration prospect is feasible. The importance of these geologic data to proper seismic planning is stressed.

Phase II discusses the basic problems which the geophysicist must consider in developing realistic estimates for proper utilization of the seismic tool. One should consider the type of seismic processing, expected resolution, type of equipment, and time and cost estimates.

Phase III considers the interrelated functions of geology, geophysics, and management in the final phase of seismic program planning. For example, one must consider the probable benefit of the seismic tool with regard to its fulfillment of the geologic objectives. Other items which must be clarified are the type of seismic control patterns as well as the cost and time factors involved in processing the prospect.

5. GEORGES PARDO, Gulf Research & Development Company, Pittsburgh, Pennsylvania

DATA PROCESSING TECHNIQUES APPLIED TO PETROLEUM EXPLORATION

The possible uses and applications of data processing techniques and equipment in petroleum exploration are reviewed. Such systems can be used for entering and storing geological and geophysical information, and recommendations are presented in ways and means of recording the data. The advantage of such systems for the retrieval of information and preparation of necessary reports is pointed out. Some typical examples of organized data presentation, such as geological field descriptions, paleontological reports and logs, preparation of base maps with spotting of geological information, and contour map preparation are shown. In addition, a practical example of the use of statistical techniques in correlation of paleontological well information is discussed, and some considerations are given to the role of a data-processing system in relation to an exploration staff.

6. J. RULIE TAYLOR, Shell Oil Company, Casper, Wyoming

VALUE OF WELL SAMPLES AND CORES AS EXPLORATION TOOL

Due to the decreasing number of unexplored structural traps, survival of the exploration effort in the oil industry depends on an increased emphasis on stratigraphically trapped oil. Detailed descriptions of rock properties from well cuttings and cores is the basic tool for the delineation of favorable stratigraphic accumulations. Any complete stratigraphic analysis of an area must include not only the facies and thickness relationships but also such parameters as the relationship of oil occurrence to facies, sedimentary structures and environments, and the geometry and pore space distribution of potential reservoirs. Well samples and cores are the best tool for both a qualitative and quantitative definition of these relationships. Rock properties from samples and cores coupled with fluid and pressure data from mechanical logs and testing information equip the geologist with all the necessary information to delimit favorable stratigraphic areas for hydrocarbon accumulation.

The value of the information that can be gained from well samples and cores is directly proportional to the quality of the samples and cores. The geologist has a responsibility not only to his employer but also to the whole oil industry to see that adequate steps are taken to secure and to store usable well cuttings and cores.

7. FLOYD F. SABINS, JR., California Research Corporation, La Habra, California

SYMMETRY, STRATIGRAPHY, AND PETROGRAPHY OF CYCLIC CRETACEOUS DEPOSITS OF SAN JUAN BASIN

Late Cretaceous strata of the San Juan basin consist of cyclically interstratified non-marine, nearshore marine, and offshore marine clastic sediments which were deposited during marine transgressions and regressions. Thickness of the transgressive and regressive parts of these cyclic sequences varies, permitting subdivision into two types of cycles: symmetrical and asymmetrical. In symmetrical cycles the thickness of transgressive and regressive parts are nearly equal; in asymmetrical cycles the transgressive sandstone is thin or absent.

The Hosta-Point Lookout wedge is an example of a symmetrical cycle. At its base the transgressive marine Hosta Sandstone overlies non-marine strata of the Crevasse Canyon Formation. The Hosta Sandstone grades upward into the offshore marine Satan Shale. The Satan Shale marks the mid-point of the cycle and the maximum marine inundation; it grades upward into the regressive marine Point Lookout Sandstone. The Point Lookout is overlain by the non-marine Menefee Formation. Southwestward, toward the former shoreline, the Satan Shale pinches out and the transgressive and regressive sandstones merge into a single massive sandstone, which is also called the Point Lookout Sandstone. Still farther southwestward this massive sandstone grades into non-marine strata of the Crevasse Canyon and Menefee Formations.

The Mulatto-Dalton cycle is asymmetrical for it lacks a basal transgressive sandstone. Instead, the offshore Mulatto Shale directly overlies the non-marine Dilco Coal with only scattered marine sand lenses at the contact. The Mulatto Shale grades southwestward (toward the former shoreline) and upward into the regressive marine Dalton Sandstone, which in turn grades southwestward into, and is overlain by, non-marine deposits of the Crevasse Canyon Formation.

Petrography is closely related to the sandstone depositional environments as follows.

Sandstone Type	*Petrography*
Regressive	Upward increase in maximum and median grain diameter; upward