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

	decrease in abundance of primary dolomite grains
Transgressive	Upward decrease in maximum and median grain diameter; upward increase in abundance of primary dolomite grains
Non-marine	Wide range of grain sizes; primary dolomite grains absent; abundant carbonaceous material

These petrographic properties may be used to identify and correlate units in problem areas.

8. DONALD R. BAKER, Marathon Oil Company, Littleton, Colorado

PETROLEUM EVOLUTION: PROGRESS AND PROBLEMS

The three-fold concept of the ***origin*** of hydrocarbons from organic materials in a source bed, their primary ***migration*** from the source rock during compaction, and their ***accumulation*** in traps, has been a part of geological philosophy since the early days of petroleum exploration. But except for adding some substantiating geologic evidence, it was not until the talents of chemists, biologists, and physicists were directed at these problems that new information with profound implications to concepts of petroleum evolution was obtained.

For example, studies of carbon isotopes in sediments and crude oils suggest that terrestrial plants, instead of marine plants and animals, may be the principal primary substance from which petroleum is derived. Further, the discovery of hydrocarbons in Recent sediments demonstrated the early formation and availability of petroliferous materials in depositional basins. However, characterization has revealed differences in the nature and abundance of hydrocarbons in Recent sediments compared with crudes and ancient rocks, indicating that modification and formation of hydrocarbons during diagenesis may be essential for the development of a source rock. Further, the distribution and character of hydrocarbons in ancient sediments indicate that some environments lead to the generation of more hydrocarbons than others, confirming the geologic opinion that there is a considerable range of variation in the nature of petroleum source beds. However, the recognition and evaluation of source rocks on the basis of absolute hydrocarbon content may be an oversimplification in that the hydrocarbons may not be indigenous, or may have formed subsequent to primary migration, or that some rocks may have yielded only a small part of their indigenous hydrocarbons. Finally, comparison of crude oil-source rock pairs indicates that the development of geochemical correlation techniques will be difficult and complicated by the likelihood that primary migration is inefficient, selective, and probably causes considerable modification of hydrocarbons en route.

Although contributions of non-geologists are essential, laboratory results will probably remain obscure unless interpreted in the light of a thorough knowledge of geological factors. The problem of petroleum evolution seems ripe for an integrated attack by geologists supported by physicists, chemists, biologists, and geochemists. The belief that an ultimate comprehension of petroleum evolution can only be developed by the interpretation of experimental and analytical data on a sound geological basis should be the underlying philosophy of future research on petroleum evolution.

9. J. D. LOVE AND W. R. KEEFER, U. S. Geological Survey, Laramie, Wyoming

CONTRASTING TECTONICS OF CRUSTAL BLOCKS IN CENTRAL AND NORTHWESTERN WYOMING

In northwestern Wyoming the northern part of the Green River basin was overridden first by the Hoback Range from the west and later by the Gros Ventre Mountains from the northeast. The fault plane underlying the Hoback Range dips 10–30° westward and southwestward; that under the Gros Ventre Mountains, where observed, dips north and northeast about 45°. Eastward displacement of the rocks in the Hoback Range was of such magnitude that it brought markedly contrasting facies within 2 to 4 miles of one another at the northern end of the Green River basin.

Major folding and faulting of most basin margins occurred during Paleocene and earliest Eocene time, but major deformation of the Gros Ventre Mountains was post-early Eocene. Magnitudes and types of movement are interpreted as follows.

Subsidence (in feet)	*Uplift*	*Heave along basin margin fault (in miles)*
Wind River basin (north-central) 16,000	Owl Creek Mtns. 17,500	2
Wind River basin (northeastern) 16,000	Bighorn Mtns. (south. margin) 16,000	3
Wind River basin (central-eastern) 14,000	Casper arch 7,500	1
Great Divide basin (northeastern) 12,000	Granite Mtns. 20,000	4
Great Divide basin (northwestern) 11,000	Wind River Mtns. (southern margin) 18,000	3?
Green River basin (north-N.E. margin) 17,000	Gros Ventre Mtns. (southeast end) 18,000	4
Green River basin (N.W. margin) 15,000	Gros Ventre Mtns. (west-S.W. margin) 20,000	5
Green River basin (N.W. margin) 15,000	Hoback Range (northeast end) 15,000	15+

10. WILLIAM C. PENTTILA, Atlantic Refining Company, Durango, Colorado

PRE-NIOBRARA UNCONFORMITY AND ITS RELATIONSHIP TO OIL ACCUMULATION—SAN JUAN BASIN

Major oil production in the San Juan basin is from isolated sandstone lenses in the Mancos shale of Upper Cretaceous age. These oil-productive sandstones have been termed Gallup, Tocito, or Horseshoe Gallup and have been described as offshore bars or strand-line features related to the regressive Gallup formation.

Detailed measured surface sections, electric log correlations, and faunal data indicate that the oil production is not from sandstones of the Gallup formation of