unexplored area suggest a shift in major sources of supply. Thus in the future, the Tertiary Gulf Coast embayment and the Rocky Mountain area will be the major source of new gas reserves in the United States, excluding Alaska.

The importance of Alaska, this great new frontier, as a source of natural gas can not be predicted at this time, but tremendous physical obstacles, both in exploration and transmission must be surmounted before Alaska can be exploited for the benefit of our ever increasing demands.

Vast untapped reserves exist in both Canada and Mexico, but only a small fraction of these reserves will be available to consumers in the United States.

The ever increasing demand in our own country must depend on new discoveries within the contiguous 48 states of our country. The geologist responsible for discovering the necessary reserves to satiate an ever increasing demand faces a unique and unprecedented challenge. Not only must he deal with and understand the problems and risks inherent in all exploration, but he is beset by the series of confusing and contradictory economic conditions which often appear to defy solution.

38. Oil Accumulations along Abo Reefing, Southeastern New Mexico: William J. Le May, Hondo Oil and Gas Company, Roswell, New Mexico

During Abo (lower Leonard) time, clastic deposition in the Delaware basin was separated from the lagoonal deposits on the Northwest shelf by a transgressive barrier reef. A lithologic study within the Abo formation reveals facies changes from shelf to reef to basin. Shelf, or back-reef deposits, consist of interbedded green shale and light gray to tan, fine crystalline, anhydritic dolomite. The interfingering of shelf and reef dolomites forms an effective permeability barrier to the migration of fluids back-reef. The Abo reef is a clean white to light tan, anhydritic, fine to coarse crystalline dolomite exhibiting secondary porosity development due to fracturing and solution activity. Interconnecting vertical fractures and vugs give the reef excellent reservoir characteristics which would otherwise be absent in the tight reef matrix. Basin deposits (fore-reef) include black to dark brown argillaceous and cherty dolomites and limestones interbedded with fine-grained sandstones. Fore-reef deposits are called "Bone Spring formation" and are believed to be Abo equivalent.

Hydrocarbons are trapped where porosity has been well developed in relatively high structural areas along the reef. At present there have been four fields discovered along the Abo reef trend in New Mexico: (1) Lovington Abo, (2) Empire Abo, (3) Corbin Abo, and (4) Turner Abo. The latter three are currently being developed. The size and reserves of these fields are dependent on the following factors: (1) thickness of reef above water, (2) structural configuration of the reef, and (3) quality of the reef pay. In the Corbin and Turner Abo fields, oil is trapped along the crest of an elongate reef ridge, one or two locations wide. The productive limits are defined by their respective water tables. The reef in Empire and Lovington is characterized by the same steep dip toward the basin (10°–30°) but has a gentle slope toward the shelf; thus, the productive limits are wider (3–6 locations wide) and production is limited shelfward by an effective permeability barrier.

A successful exploratory procedure has been to estimate a well's proximity to the reef crest by defining its relative stratigraphic position through correlation with areas of close control which traverse the reef. The intermediate drilling depth (4,000–8,500 feet) and high reserves (average 500,000 barrels per location) account for the acceleration of activity along the Abo reef trend.

39. Faulting Associated with Deep-Seated Salt Domes in Northeast Part of Mississippi Salt Basin: Dudley J. Hughes, Triad Oil and Gas Company, Jackson, Mississippi

Faulting in the northeast part of the Mississippi salt basin is principally local graben-type resulting from salt doming. On deep-seated salt-dome structures, the faulting has common characteristics throughout the area which can be applied to great advantage in subsurface interpretations.

Faults are localized over each dome. The general fault strike is usually parallel with the long axis of the deep-seated dome with which it is associated. Faulting over deep-seated salt domes can usually be related to derivative gravity minimums which are expressions of the salt uplifts causing the faulting. Generally, the relative intensity of the derivative gravity minimum becomes greater as the complexity of the faulting becomes greater.

Fault dips over deep-seated domes in the northeast part of the Mississippi salt basin average approximately 45° in the Upper Cretaceous and 60° in the Lower Cretaceous.

The increase in throw with depth is principally a result of lengthening of stratigraphic section in the downthrown block relative to the same section in the upthrown block. This lengthening of section is caused by thickening of the downthrown beds, and by preserved wedges below unconformities in the downthrown block which are absent in the upthrown block.

The crests of structures at Lower Cretaceous horizons through this area are commonly located near one side of a graben system. The faults on this side, termed "axial faults," generally bisect the anticlinal crest so that closure is present on both their upthrown and downthrown sides. Lower Cretaceous production is most commonly found along the structural crest on both sides of the axial faults.

Faults with opposing dip on the opposite side of the graben, termed "flank faults," are farther removed from the structural crest and exhibit closure only on the upthrown side. Flank faults provide potential traps if upthrown reservoir beds remain against impervious strata in the downthrown segment during growth of the fault.

40. Geomorphic Expression of Selected Concealed Structures in Western Canada: Robert H. Barton* and Andy J. Broscoe, Geophoto Services, Ltd., Calgary, Alberta, Canada

Analysis of drainage patterns can be used to delineate concealed structures. To do this effectively, a thorough understanding of the regional geology and general geomorphic history is necessary. In glaciated areas, air photographs and mosaics can be used to determine the general glacial history so that glacially controlled patterns are not confused with structurally controlled patterns. As with any unconventional technique, drainage pattern interpretation has been misunderstood, misused, and handicapped by the lack of a generally acceptable theory to explain the reflection of buried structures in surface stream patterns.

Geomorphic analyses are used in both regional and detailed studies. Regionally, the area between Fort St. John and Fort Nelson in northeastern British Columbia exhibited a pre-Pleistocene trellis drainage pattern, adjusted to structural conditions. Glaciation altered the existing base-level equilibrium. After the ice melted, large-scale stream piracy took place. Due to glaciation and subsequent piracy, non-structurally controlled

* Denotes speaker.

anomalous drainage patterns exist which must not be confused with structurally controlled patterns.

The West Drumheller, Drumheller, Homeglen-Rimbey, and Redwater Devonian reef oil fields, all located in Alberta, were studied in detail. The drainage configuration above the West Drumheller oil field consists of a pronounced arc in the otherwise straight southeasterly course of the Red Deer River, and a repeated right-angular diversion of a tributary. The Drumheller oil field is reflected by a marked diversion and arcuate pattern of Michichi Creek. The Homeglen-Rimbey oil field is in the Blindman River system in which the tributaries flow southeasterly. At the oil field all streams are diverted toward the west, resuming the southeasterly flow at the south end of the field. These three drainage anomalies are not related to glacial landforms. Finally, the Redwater oil field is an example of a structurally controlled drainage anomaly which has been partly masked by a complex glacial history.

Other oil fields exist which are not reflected in the drainage pattern. This does not weaken the technique of drainage analysis, but indicates that in the present state of knowledge not all possible types of drainage anomalies can be recognized. It is only through continued use and research that this technique, proved to be a fast and economical exploration tool in mantled areas, can be refined.

41. Geophysical Studies of Basin Structures along Eastern Sierra Nevada: JOHN H. HEALY, California Institute of Technology, Pasadena, California.

The results of seismic refraction and gravity surveys along the eastern Sierra Nevada are presented and a preliminary interpretation in terms of the regional structure and tectonics is given. Preliminary results indicate that the basin floors dip westward reaching depths of 5,000–6,000 feet near the mountain front. Experience in numerous basins indicates that gravity data combined with a limited number of refraction profiles to check the density assumptions can yield important facts needed to understand the tectonic processes in this area. The methods of machine computation used to reduce the data and analyze the anomalies are discussed. A terrane correction program was developed from the Bendix G15 computer, and programs to compute the gravitational attraction of two- and three-dimensional bodies were written, by using the computing schemes developed by Talwani. The efficiency and accuracy of these machine computing techniques are compared with the efficiency and accuracy of the manual computing techniques.

A.A.P.G.-R.M.S. Program Co-Chairmen:
ORLO E. CHILDS
B. W. BEEBE

## S.E.P.M.

*Monday Afternoon, April 24*

RESEARCH COMMITTEE SYMPOSIUM: WATER MOVEMENTS AND SEDIMENTATION, PART I

*Presiding:* ROBERT N. GINSBURG, HOWARD R. GOULD

1. Sedimentation in Tidal Flat Areas of the Netherlands: L. M. J. U. VAN STRAATEN, Geological Institute, Groningen, Netherlands
2. Genesis of Barrier Island and Chenier Sand Bodies as Related to Sediment Influx and Processes: H. A. BERNARD,* C. F. MAJOR, and B. S. PARROTT, Shell Development Company, Houston, Texas

* Denotes speaker.

3. Relations of Reefs to Water Circulation: JOSHUA I. TRACEY, JR., U. S. Geological Survey, Washington, D. C.

*Tuesday Afternoon, April 25*

RESEARCH COMMITTEE SYMPOSIUM, PART II

4. Effect of Wind-Driven Water Movement on Sediment Distribution, Gulf of Batabano, Cuba: ALBERT L. KIDWELL, Jersey Production Research Company, Tulsa, Oklahoma
5. Salinity of Florida Bay: JOHN S. MCCALLUM, Shell Oil Company, Roswell, New Mexico, and KENNETH W. STOCKMAN,* Shell Oil Company, Coral Gables, Florida
6. Molluscan Distribution in Florida Bay: W. J. TURNEY, Shell Oil Company, Roswell, New Mexico
7. Variations in $O^{18}/O^{16}$ Ratios of Florida Bay Mollusks and Their Application to Paleogeographic Studies: R. MICHAEL LLOYD, Shell Development Company, Houston, Texas.

*Tuesday Evening, April 25*

RESEARCH COMMITTEE PANEL DISCUSSION

*Wednesday Morning, April 26*

SEDIMENTATION AND SEDIMENTARY PETROLOGY I

*Presiding:* WALTER D. KELLER, HAROLD J. BISSELL

8. Laboratory Synthesis of Sedimentary Rocks: SHERMAN A. WENGERD, University of New Mexico, Albuquerque, New Mexico
9. Depositional Environment of Dakota Sandstone of Southeastern Colorado: DONALD G. MCCUBBIN, The Ohio Oil Company, Littleton, Colorado
10. Montchauve Group, Product of Pennsylvanian Epeirogeny in Wyoming: THOMAS W. TODD, California Research Corporation, La Habra, California
11. Sedimentary Petrology and Sedimentation of Miocene Browns Park Formation: WAYNE A. CHISHOLM,* The Pure Oil Company, Crystal Lake, Illinois; MARION J. BERGIN, U. S. Geological Survey, Washington, D. C.; GEORGE E. PRICHARD, U. S. Geological Survey, Denver, Colorado
12. Rapid Methods for Dimensional Grain Orientation Measurements: W. ZIMMERLE, Deutsche Erdöl—Aktiengesellschaft, Erdölwerke Wietze, Kreise Celle, Germany; L. C. BONHAM,* California Research Corporation, La Habra, California
13. Differentiation of Dune, Beach, and River Sands from Their Textural Characteristics: GERLAD M. FRIEDMAN, Pan American Petroleum Corporation, Tulsa, Oklahoma
14. Petrology of Two Turbidite Formations: GERALD V. MIDDLETON, McMaster University, Hamilton, Ontario
15. Quartz and Feldspar Content of Sands from South Platte, Platte, and Missouri Rivers: JOHN R. HAYES, Colorado School of Mines, Golden, Colorado
16. Problems of Diffusion and Accumulation of Oil: ROBERT WEYNSCHENK, Innsbruck, Austria

*Wednesday Morning, April 26*

*Presiding:* WILLIAM A. COBBAN, MANLEY L. NATLAND

PALEONTOLOGY AND STRATIGRAPHY I

17. Distribution of Recent Near-Shore Foraminifera, Western United States and Northwest Mexico: ROBERT R. LANKFORD, Pan American Petroleum Corporation, Houston, Texas

* Denotes speaker.