the best targets for exploration.

A modified fit between the facing margins of the South Atlantic, based on the correlation of geologic features, shows oil provinces to alternate between the two continents, indicating a segmented rather than symmetrical partition of the underlying rift sequence. Basement highs on one margin correspond to base lows on the other, filled with a rift sequence acting variously as heat conductor, source rock, and reservoir.

The breakup of Africa and South America resulted from their differential rotation. Ductile deformation at the tip of the northward propagating rift increased sharply where transversel "tough" tectonic elements held up and eventually deflected the propagating rift. In such areas, as in the Campos and Reconcavo oil provinces, continued differential rotation of the separating continents, without corresponding rates of rift propagation, created anomalous stress concentrations resulting in horizontal rotation and translation of small crustal blocks. The higher oil reserves of these areas, compared to the low averages of the South Atlantic, and their pattern of oil field distribution reflect the tectonic movement of these crustal blocks.

TANNER, JAMES C., Petroleum Information International, Houston, TX

Politics and Hydrocarbon Resources

Politics has been a major factor in many countries' development and use of hydrocarbon resources. Not generally known is that proved and potential hydrocarbon resource appraisals may be inflated or deflated because of political as well as economic considerations. For petroleum and natural gas, some producing countries have long used political means to establish "proved" reserves that may be far higher, or lower, than might be considered prudent. The case of Mexico (where oil and gas reserve estimates were inflated through political maneuvers because of that country's major borrowing needs) and others will be examined.

TEUFEL, L. W., N. R. WARPINSKI, and J. C. LORENZ, Sandia National Laboratories, Albuquerque, NM

A Model for Fracture Genesis—Application to Mesaverde Group, Piceance Creek Basin, Colorado

Natural fractures play an important role in determining gas production from the low-permeability reservoirs of the Mesaverde Group in the Piceance Creek basin, Colorado. The importance of natural fractures is evident from the number of natural fractures observed in core and from the high in-situ permeabilities measured in well tests as compared to the low permeabilities measured in core. An understanding of the natural fracture systems requires knowledge of variations in the state of stress and changes in the physical and mechanical properties of the different sedimentary layers during the evolution of the basin. Geologic processes such as burial, diagenesis, tectonics, uplift, and erosion, and their resultant effects on the overburden, pore pressure, temperature, and strain were included in an elastic-plastic model to approximate the stress history of the basin. These data, coupled with an extended von Mises failure criterion derived from laboratory experiments of the rocks in question, were used to predict the relative time and type of fracturing, and the lithologic layers in which a fracture was likely to occur. Observations of fractures in 4,200 ft (1,280 m) of core (1,200 ft, 365 m, of oriented core) from the Mesaverde Group taken from the United States Department of Energy's 3 closely spaced wells near Rifle, Colorado, have been used to document the genesis of natural fractures and substantiate the model results. Empirical information such as the present state of in-situ stress determined from hydraulic fracture stress tests and anelastic strain recovery measurements of oriented core, paleostrain directions and magnitudes determined from analysis of calcite twin lamallae, and current temperature and pore pressure provided data as well as checks on the accuracy of the model.

THOMSON, JAMES A., Sabine Production Co., Denver, CO

COGS—Computer Oriented Geological Society

The Computer Oriented Geological Society (COGS), based in Denver, Colorado, is a professional organization of geologists and geophysicists that actively encourages application of computers to natural resource exploration and development. Founded in December 1982 as a user-oriented group, COGS is a network of earth scientists who both gain and contribute ideas and information regarding geologic computer applications. Dedicated to self-help and low-cost solutions, COGS offers a forum for discussion of common problems and allows new members to benefit from others' experience.

COGS membership ranges from geologists who are merely curious about the use of computers to geologist/programmers who write and market commercial geologic software. Most members own or have access to a computer, most often a microcomputer. The rapidly growing membership consists of more than 160 geologists and geophysicists in 12 states and 2 countries.

Monthly meetings feature a technical presentation followed by discussion. COGS has heard presentations concerning computer-aided mapping, species-diversity statistics, interactive geophysical modeling, double-Fourier analysis, and telecommunications, among others. Future presentations will include expert systems, geologic data-base management, well-log analysis, trend-surface analysis, and economic analysis of oil and gas prospects.

In addition to the monthly technical meeting, COGS publishes a catalog of all known geologic software for microcomputers, a membership directory, and a monthly newsletter. It also sponsors occasional workshops addressing some aspect of geologic computer work, co-sponsors the conference "GeoTech '84: Personal Computers in Geology," and distributes a diskette of public domain programs of interest to the geologist.

The diskette features 13 programs, for generating an oil well decline curve, printing a township plat map, analyzing well logs, and others. As more programs are incorporated, it is likely that the diskette will be replaced by a collection of 3-4 diskettes providing a core of general purpose geologic programs available to all geologists.

THOR, DEVIN R., Exxon Production Research Co., Houston, TX

Eustatic and Structural Control of Submarine-Fan Sedimentation, Conception Fan, Santa Barbara Basin, California

Eustatic sea level lows provide an opportunity for submarine-fan development; topography and structure, however, can control depositional-sequence geometry. Analysis of high-resolution seismic data provides a basis to evaluate the evolution and geometry of the Pleistocene-Holocene Conception fan. The fan formed in the restricted, tectonically active Santa Barbara basin. It consists of 4 vertically stacked depositional sequences, each bounded by nondepositional unconformities. The unconformities are defined by seismic-sequence boundaries and were formed during sea-level falls that are related to Pleistocene glacio-eustatic changes. Each depositional sequence consists of lowstand, sand-rich facies (fan channel, levee, and lobe) topped by highstand, mud-rich facies. The geometry of the depositional sequences tends to be rectilinear, not arcuate, because lateral progradation is restricted by topographically high structures.

The modern fan surface and the Holocene depositional sequence provide a good analog for the older, underlying depositional sequences. The fan surface is characterized by 4 main channels, 2 of which head into submarine canyons incised into the shelf. Submarine canyons that fed the other 2 channels are now filled and have no topographic expression. In addition, numerous partially buried channel segments occur in the interchannel areas. The Holocene depositional sequence consists of lenticular and sheet-drape deposits interpreted to be channel, levee, and lobe facies. The facies geometry suggests that Mutti's topographic compensation, channel migration, and avulsion were typical processes on Conception fan.

THURWACHTER, JEFFREY E., Univ. Texas, Austin, TX

Sedimentology and Depositional History of Neogene Gravel Deposits in Lower Tornillo Creek Area of Big Bend National Park, Texas

Neogene gravel deposits in the lower Tornillo Creek area of Big Bend National Park, Texas, record the filling of a small structural basin formed during Basin and Range tectonism. Four lithofacies are recognized in the Late Miocene La Noria member (informal name): (1) a medial braided-stream lithofacies consisting of upward-fining packages of cross-bedded gravel, sandstone, and siltstone; (2) a distal braided-stream lithofacies consisting of poorly-defined upward-fining packages of fine gravel, sandstone, and mudstone; (3) a calcrete-rich gravel and sandstone lithofacies representing strike-valley and alluvial-fan deposition, and (4) and ephemeral lake-plain lithofacies consisting of massive and burrowed mudstones with sheet-like sandstone interbeds.

Upward-fining packages in the braided-stream lithofacies represent the lateral migration and avulsion of the stream tract across the basin; together with the strike-valley and alluvial-fan deposits, these record the initial stages of basin filling. Provenance studies show that much of this sediment was derived from northern Mexico. Overlying ephemeral-lake deposits record the structural tilting and closing of the downstream (north) end of the basin.

Gravels and minor sandstones of the Pleistocene Estufa member (informal name) represent basinward progradation of alluvial fans. Deposition of the Estufa member resulted from: (1) Quaternary tectonic activity in the Chisos Mountains area; (2) lowering of local base level by post-Miocene development of the Rio Grande drainage through the area; and (3) Pleistocene pluvial-period climatic changes. Subsequent Quaternary faulting has caused minor deformation of the deposits.

TING, FRANCIS T. C., and P. B. WANG, West Virginia Univ., Morgantown, WV

Coal Anisotropism and its Relationship to Methane Concentration in Coal

Variations of methane concentration in coal appear to correlate well with the optical anisotropic properties of the coal. Some medium- and low-volatile bituminous coal beds in the Appalachian coal basin vary in methane concentration by 5 to 10 times; their optical anisotropy also varies by 2 to 3 times. High-volatile bituminous coals of Appalachian basin tend to contain more methane than bituminous coals of similar rank in the Rocky Mountain region. The Pennsylvanian Appalachian coals are also more anisotropic than the Cretaceous Tertiary Rocky Mountain coals. The technique can thus be used as an exploration tool for potential coal gas reservoirs.

TOUBORG, JENS F., Touborg Consultants, Inc., Toronto, Canada

Precambrian Shield and Basement Tectonics in Sedimentary Basin Analysis

This study focused on the use of (1) regional structural analysis of basement and Precambrian rocks surrounding a sedimentary basin, and (2) tracing basement structures into the sedimentary basin.

A large-scale regional study (supported by the Geological Survey of Canada) was carried out in Ontario and parts of Manitoba and Quebec using Landsat imagery analysis as a geologic mapping tool.

One hundred Landsat images at a scale of 1:500,000 covering the greater parts of the Archean Superior-Proterozoic, Churchill, Grenville, and Keeweenawan plates and the Paleozoic Hudson's Bay and Williston platforms were analyzed for geologic structure and lithology with the following techniques: (1) Detailed lineament mapping using visual analysis of multiseasonal and multispectral imagery. In particular, low sun illumination and light snow covered scenes permit delineation of subtle structures in heavy forest cover, and burned and glaciated terrains. (2) Using published geologic maps as a base, the integration and correlation of the lineament data with aeromagnetic and gravity trends.

Within the complexly deformed and reworked Precambrian shield, such analysis permits reconstruction of the outcrop pattern and delineation of major fold, fault, dyke, and other intrusive structures.

The structural analysis of the Precambrian shield has a fundamental bearing on interpretation of overlying sedimentary cover rocks. This is expressed in the southern part of the Hudson's Bay basin and its southeastern arm, the Moose River basin. For instance, the rims of both basins are controlled by faults or graben structures. Approximately 13 major fault systems with strike lengths of 200–300 km (125–186 mi) or more can be traced from the exposed Precambrian shield into the basin in terms of lineament arrays and/or aeromagnetic and/or gravity signature. The data suggest reactivation of faults during basin sedimentation.

This type of basement structural analysis in areas adjacent to sedimentary basins can provide a valuable interpretation base for subsequent seismic surveys and basin evaluation.

TRACY, LONNIE N., Chevron Resources Co., Hobson, TX

Mine Design Using Column Analysis— A Tool for the Incremental Evaluation of Open-Pit Mining Deposits

Column analysis is a method whereby down-hole drill data can be assessed for open-pit mining potential. This technique enables a single hole to be evaluated as a small pit, and can serve as a basis for preliminary mine design. Specific operating costs are assigned to intervals of material as they are encountered from the surface to the base of mining. Summed operating costs are then divided by the units of recoverable product anticipated. The resulting value (on a per unit basis) is then assigned to the individual hole being evaluated, and can be used directly in preliminary mine planning. Profitability can also be determined for each hole by multiplying the difference between the unit cost and the market value of the recovered product by the amount of recovered product. Mine planning can then proceed by evaluating the quantity of favorable holes within a given area, their continuity, and the overall cost and profitability relative to desired or available market and production conditions.

TROGER, UWE, Technical Univ. Berlin, Berlin, Federal Republic of Germany

Oil Shales of Europe, North Africa, and the Near East

Oil shale deposits are known from almost all countries in Europe and range in age from Paleozoic to Eocene. The geology of Europe is well known, and the discovery of new and significant oil shale deposits is not anticipated. A considerably different situation exists in North Africa and the Near East, where sparsely tested areas in the Sahara and desert fringe might contain important oil shale deposits. Most of the oil shale deposits in these areas (1) are of Cretaceous age, (2) occur with phosphate deposits, and (3) owe their origin to sedimentary processes associated with upwelling. Oil shales can be found from Turkey to Morocco along a paleocoastline, and better definition of this feature could result in new discoveries. In contrast to the United States, oil shale deposits in Europe are being used as energy sources and will probably serve the same purpose in North Africa and the Near East.

Two deposits in Europe that are being developed actively are Puertollano (Spain) and Dotternhausen (Germany). The oil shales at Puertollano occur in Carboniferous shales, yield up to 45 gal/ton, and have been used as fuel for an electric power plant since 1922. In-place reserves are estimated at 100 million tons of oil. The deposit at Dotternhausen is exploited for fuel for a power plant and the spent shale is used in the manufacture of cement. The oil shale is in the Posidonia Shale (Liassic) and is estimated at 1 billion tons. Three power plants are under construction in Romania and will utilize a 200-ft (60-m) thick shale that is estimated to contain a few hundred million tons of reserves. Similar plans exist for an operation in Bulgaria, near the Yugoslavian border.

Upper Cretaceous shales in Timahdit, central Morocco, will serve as feed stock for a 100 ton/day semicontinuous-flow pilot plant, which is scheduled for 1984 completion. The oil shale deposit in El Lajjun, Jordan, contains 130 million tons of oil in place and, if exploited, could furnish a 35-yr supply of oil for the country. Development of the deposit in the Oren Efe syncline in Israel could help move this country toward energy independence. The bituminous shales of Turkey contain an estimated few billion tons of oil in place. The Neqr Izmir shales in the eastern Mediterranean provinces have oil yields of 45-68 gal/ton and are currently being studied by the German Geological Survey. Recent oil shale studies in Egypt indicate approximately 500 million tons of oil in place, and these deposits could be used as energy sources related to phosphate and cement production.

TRUMBLY, NANCY I., and JOHN D. PIGOTT., Univ. Oklahoma, Norman, OK

Wrench Fault Tectonics in Northern New Guinea Basin, Papua New Guinea

New Guinea lies on the northern Australian plate boundary and has been a sensitive tectonic recorder of Cenozoic plate interactions between the Australian and Pacific plates. The specific plate interactions are documented by the evolution of the Northern New Guinea fault system and