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 the basin it overprints, the Northern New Guinea basin. Consideration of plate kinematics suggests convergence became increasingly oblique during the Cenozoic. We have calculated an average convergence of N6°E at 11.9 cm/year (4.7 in./year) during the Paleocene to Eocene, N60°E at 6.8 cm/year (2.7 in./year) during the Eocene to Miocene, and N60°E at 9.3 cm/year (3.7 in./year) during the Miocene to Holocene. Present-day Australian and Pacific plate vectors indicate predominantly left-lateral strike-slip motion in northern New Guinea.

The sinistral Northern New Guinea fault system defines this zone of plate interaction and represents a suture between continental crust to the south and intermediate crust to the north. The fault system extends more than 3,000 km (1,900 mi) from the Huon Gulf of Papua westward into eastern Indonesia, and is comprised of the Ramu-Markham (Papua) and Sorong (Indonesia) faults. This system is particularly well defined along the Ramu-Markham valley by recent earthquakes of focal depths between 41 and 300 km (25 and 186 mi). First motion studies of these earthquakes indicate both compressional and strike-slip events. Maximum compressive stresses delineated from conjugate shear fractures studied in the field closely agree with the first motion solutions. When combined with the trend analyses of surface fold axes and reflective seismic structural information, these data are consistent with the regional left-lateral deformation of this Tertiary basin.

Hydrocarbon exploration strategies within the Northern New Guinea basin must address not only sedimentation, but also must deal with the basin's complex structural and tectonic evolution. A static tectonic classification will not adequately define the Northern New Guinea basin. It is better described as an evolving basin being overprinted by wrenching.

TURLEY, ROBERT D., GEOWARE, Littleton, CO

Microcomputer Geoscience Software

As an increasing number of geoscientists acquire microcomputers, it becomes evident that most geoscientists do not have time to learn to program or to write programs specific to their professional tasks.

Acting as a worldwide clearing house, GEOWARE solicits descriptions of geoscience software and will publish catalogs of private, commercial, and public domain software descriptions. The catalogs will include the name, address, and phone number of the owner of the software so he may be contacted directly to discuss the software, negotiate for purchase, or arrange for custom programming.

Geoprogrammers are encouraged to contact GEOWARE to receive forms for describing their software.

TYLER, NOEL, Bur. Economic Geology, Univ. Texas, Austin, TX

Architecture and Production Characteristics of Strand-Plain Reservoir Facies, Matagorda County, Texas

The North Markham-North Bay City field, Matagorda County, Texas, is one of the major multiple-reservoir oil fields of the central Texas Coastal Plain that produce from stacked Frio barrier/strand-plain sandstones. The three principal oil reservoirs in the field are interpreted to be transgressed strand-plain (Carlson), progradational strand-plain (Cornelius), and composite progradational strand-plain/wave-dominated delta (Cayce) systems. Production characteristics of strand-plain facies are modeled using these reservoirs as examples.

Reservoir continuity is greatest in transgressed and progradational strand-plain sandstones where crosscutting channel facies are of minor importance. Hydrocarbon distribution is laterally continuous in both reservoir types. Broad edgewater incursion indicates an absence of internal facies barriers. Progradation of the Cornelius strand plain resulted in a composite reservoir in which the older sands and contained hydrocarbons pinch out against the overlying offlapping sequence.

In contrast, reservoir continuity in the Cayce is poor. Crosscutting fluvial sands produce oil at lower rates, act as conduits for early water influx, and provide facies boundaries against which hydrocarbons in adjacent progradational facies are pooled. Facies changes and pinchouts in heterogeneous reservoirs such as the Cayce are in part responsible for limiting ultimate recovery from major clastic reservoirs along the Texas Gulf Coast to approximately 50 % of the original oil in place.

ULMER, DANA S., Southern Methodist Univ., Dallas, TX

Dedolomitization and Calcitization of Gypsum in Mississippian Arroyo Penasco Group, North-Central New Mexico

The Espiritu Santo Formation of the Mississippian Arroyo Penasco Group represents the oldest Paleozoic stratigraphic unit preserved in north-central New Mexico. The Espiritu Santo Formation is a diagenetically complex carbonate unit that exhibits a well-developed cement stratigraphy reflecting changes from meteoric fresh to marine-phreatic environments. Recrystallization of the algal-laminated sediments occurred during subaerial exposure of the overlying Macho Member of the Tererro Formation, a collapse breccia produced by the dissolution and removal of gypsum. The breccia and recrystallized limestone are indicative of broad, low-relief topography and shallow water table.

Cathodoluminescent petrography reveals the presence of pseudomorphs of dolomite and gypsum throughout the Espiritu Santo carbonates. Typical dedolomite morphologies are: inclusion-rich cores surrounded by limpid rims; corroded Mn-rich rhombs within calcite pseudospar; highly zoned rhombs; and uniformly luminescent rhombs enclosed in gypsum pseudomorphs. Calcitized gypsum, occurring as bladed to hexagonal crystals and nodules, varies from highly zoned to uniformly luminescent crystals. The varying luminosity is a possible relict of the original trace-element distribution and/or the diagenetic environment.

Meteoric waters migrating from the Macho Member were enriched, but undersaturated, in dissolved $CaSO_4$ and have low Mg/Ca ratio. Thus these pore fluids within the Espiritu Santo carbonates dissolved gypsum and dolomite. The solution, supersaturated with respect to $CaCO_3$, precipitated calcite. Therefore, the dissolution of gypsum and dolomite and the precipitation of calcite occurred simultaneously during diagenesis. The reaction terminated once the supply of gypsum was exhausted.

URIEN, CARLOS M., Urien & Associates, Buenos Aires, Argentina

South American Sedimentary Basins

More than 64 sedimentary basins have been identified on the South American continent. According to their regional structural character and tectonic setting, they are classified in 4 super groups.

(1) About 20 interior or intracratonic basins occur on South American cratons (Guayanas, Brazilian, and Patagonian). In most cases, their sedimentary fill is Paleozoic or early Mesozoic. Rift or transverse grabens resulting from incipient sea floor spreading extend towards the continental margin.

(2) 17 basins are located along the Atlantic stable margin, and consist primarily of half grabens with downfaulted seaward blocks. These rifts (or pull-apart basins) were separated as results of the migration of the African and American continental blocks. Therefore the sedimentation is chiefly Cretaceous and Tertiary.

(3) On the western edge of South American cratons, almost 20 basins of downwarped blocks extend from Orinoco down to the Malvinas plateau in a relatively uninterrupted chain of retroarc basins, bordered by the Andean orogen. They lie on a flexured Precambrian and Paleozoic basement, and are highly deformed in the west (Subandean belt) due to the action of compressional forces caused by the tectonic influence of the Mesozoic Andean batholith.

(4) Westward, the Pacific margin is bordered by 27 foreland and forearc basins, which alternate from north to south on an unstable or quasi-stable margin, fringed by a trench and slope complex where the ocean crust is subducted beneath the continental plate.

VAIL, PETER R., Esso Production Research Co., Houston, TX

Episodic and Cyclic Sedimentation

At the 1982 meeting of the SEPM in Calgary, Robert H. Dott, Jr., of the University of Wisconsin gave a very thought-provoking presidential address on episodic sedimentation. He defined episodic sedimentation as punctuated or discontinuous deposition. He concluded that sediments are deposited episodically and are controlled by such factors as the local storms, floods, and tides. Considered by itself, the concept implies that one basin has no predictable relation to another. Thus, when applying the