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.

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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.

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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.

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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.

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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.

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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