years after discovery. This rapid development results from a coordinated development program with modular plant design.

PARK, RICHARD A., Dept. Geology, Rensselaer Polytech. Inst., Troy, N.Y.

QUANTITATIVE ENVIRONMENTAL GRADIENT MODEL FOR INTERPRETING HABITATS OF MICROFOSSIL ASSEMBLAGES

A robust Q-mode ordination model has been derived from samples of diverse microfossils from Atlantic, Gulf, and Pacific coastal localities representing many different Cenozoic marine environments. Major environmental-gradient complexes are defined on the basis of their relations to major microfossil ecoclines; gradient complexes include depth of water, distance offshore, and rate of sedimentation/nutrient enrichment. By using principal taxonomic and bionomic groups that differ widely in ecologic requirements and tolerances, it is possible to obtain maximum information in spite of "noise" occasioned by heterogeneous groups. Because the groups are not restricted in time or geographic area, it is also possible to compare assemblages from different eras and provinces. Easily recognized groups that are used include several types of foraminifers, ostracodes, and ectoprocts, radiolarians, diatoms, sponge spicules, echinoid spines, holothurian sclerites, fish scales, and alcyonarian spicules.

Q-mode-cluster analysis defines discrete microfossil biotopes that can be arrayed in the model, and these can be related to well-known depositional environments such as lagoons, beaches, deltas, carbonate banks, outer continental shelves, and deep-water borderland basins. However, unknown samples are interpreted best in light of the multidimensional model, recognizing the influences of independent gradients; in this way anomalous assemblages usually can be resolved readily. Present microorganism death assemblages are used to validate the model and confirm interpretations based on indicator microfossil groups and independent sedimentological and stratigraphic evidence.

PAWLEY, JULIAN K., Teledyne Exploration Co., Houston, Tex.

HIGH-RESOLUTION MARINE SEISMIC PROFILING

A small seismic system (Mini-Sparker) has been developed to use frequencies in the 200-2,000 Hz band for highly detailed marine profiling. Reflections down to 500- to 800-ft depths are recorded in clastic sediments, with resolution of 6-8 ft.

The Mini-Sparker profile is recorded as a single channel on facsimile paper. The equipment is man-portable, and the acoustic source is equally effective in freshwater or saltwater areas.

A procedure has been developed for high resolution recording at variable offsets between source and receiver, thus providing the information for a $T^2 - X^2$ computation of average velocities to various reflection levels.

Examples illustrated include profiles from (1) a freshwater lake in a glaciated area, (2) the Gulf Coast continental shelf, and (3) the North Sea. The first and last examples include velocity-determination sections as well as structure sections.

PEAKE, ERIC, and GORDON W. HODGSON, Faculty Environmental Design, Univ. Calgary, Alta.

ORIGIN OF PETROLEUM—STERANES AS PRODUCTS OF EARLY DIAGENESIS IN RECENT MARINE AND FRESHWATER SEDIMENTS

Steranes are minor hydrocarbon components of crude oil which are derived from the sterols of living systems and provide a vehicle for the study of the origin and chemical development of petroleum. Sterols, the precursors of steranes, were found in a number of freshwater and marine sedimentary environments exhibiting a range of redox conditions. Up to 10 ppm of the plant sterols beta-sitosterol, stigmasterol, cholesterol, and campesterol were found in the sediments by using gas chromatography and mass spectrometry. Steranols, which are intermediate between the oxygenated unsaturated plant sterols and the reduced crude-oil steranes, were found in modern Arctic marine sediments, as were hydrocarbon steranes similar in structure to those of petroleum. Steranols were about half as abundant as the corresponding sterols. The steranes totaled about 0.1 ppm. The presence of steranols and steranes in such recent sediments indicates that some processes which are necessary for the formation of petroleum constituents—in this case reduction—occur very early in the diagenetic conversion of organic debris to crude oil.

PEARSON, E. P., Dept. Geology, Univ. Pacific, Stockton, Calif.

DOLOMITIZATION OF CARBONATE MEMBERS IN LOWER GOOSE EGG FORMATION (PERMIAN) OF SOUTHEASTERN WYOMING

The lower part of the Goose Egg Formation (Permian) of southeastern Wyoming consists of carbonate members interstratified with thicker, red clastic members. The carbonates are interpreted as having been deposited in subtidal, intertidal, and supratidal environments during transgressions of the Phosphoria sea.

Evidence of at least 2 periods of dolomitization is present in the carbonates. The first stage is represented by fine-grained dolomite, 5-20 microns in diameter. Abundant in strata interpreted as peritidal, this fine-grained dolomite is uncommon in strata interpreted as subtidal. This stratigraphic distribution suggests that the fine-grained dolomite formed in the depositional environment rather than later, in a postdepositional site. This conclusion is further supported by comparisons of features common to recent, as well as to other ancient, fine-grained dolomite which has been interpreted as penecontemporaneous in origin. Dolomitized Foraminifera tests and peloids indicate that at least some of the penecontemporaneous dolomite is a replacement phenomenon; however, the possibility that some is "primary" cannot be eliminated. The penecontemporaneous dolomite in the Goose Egg carbonates may have been formed by capillary concentration of hypersaline brines.

A later, postdepositional period of dolomitization is represented by euhedral and subhedral dolomite rhombs, 50-200 microns in diameter. Unlike the fine-grained, penecontemporaneous dolomite, the coarse dolomite is more evenly distributed throughout the carbonate members, contains numerous inclusions, and cross cuts other grains and crystals. This second period of dolomitization occurred during a late stage of diagenesis and was probably caused by circulation of ground waters rich in magnesium.

PEDERSON, JOHN A., Dept. Min. Econ., Colo. School of Mines, Golden, Colo.

MINERALS AND ENERGY—THEIR ECONOMIC IMPACT ON A REGION

A knowledge of the interrelations of the mineral and energy industry with the total national or regional economy is critical for formulation of fuels and minerals policies. The scope of the Colorado mineral industry starts with raw natural resources, their discovery by exploratory effort, and their production by extraction industries. These materials enter the mineral processing industries to yield energy and processed materials of mineral origin.

Traditional measurements of the mineral industry's contribution to the economy are based on the U.S. Bureau of Mines' tabulation of production at the mineral raw-material stage. However, the commonly accepted view of the mineral industry's contribution is much broader in scope.

The particular industry parameters assessed in this study are the amount of investment, level of employment, quantity and

value of mineral commodities produced, and the magnitude of state and local taxes. The quantity and value of the flows of mineral materials into and out of the state are measured and their impact assessed in this study.

The study for the State of Colorado can be visualized as a prototype of a large-scale study of a region or the entire United States. The use of data obtained by a comprehensive study of mineral commodity flows will allow formulation of a systems approach to the mineral and energy policy.

PEGRUM, R. M., G. REES, S. M. MOUNTENEY, and D. NAYLOR, Exploration Consultants Ltd., London WIX 9HG, United Kingdom

NEW GEOPHYSICAL AND GEOLOGIC DATA ON NORTHWEST EUROPEAN SHELF AND THEIR BEARING ON SEA-FLOOR SPREADING AND OIL AND GAS EXPLORATION

Geologic and geophysical data acquired on the northwest European shelf, mainly resulting from the search for oil and gas, reveal a fundamental system of tensional rifts and horsts which form the framework controlling post-Paleozoic deposition. Deep grabens filled with Mesozoic and Tertiary strata can be traced from the northernmost North Sea through the North Netherlands trough into Holland, to link up with the Rhine and Rhone grabens. Another rift system, west of Britain includes the West Scotland, Hebridean, Irish Sea, Celtic Sea, and Western Approaches basins. Similar thick sedimentary basins occur in the Porcupine Seabight and Rockall troughs. Selected geophysical profiles illustrate the basic rift framework. The rift system is considered to be a response to crustal stresses in the northwest European plate, related to the opening of the southern part of the North Atlantic, which began in the Triassic. The Celtic Sea-Hebridean, Porcupine Seabight and Rockall basins represent abortive attempts to extend the spreading ridge northward.

The tensional rifting and faulting of the northwest European shelf control the distribution and facies of the infilling sediments and the location of several of the large oil and gas fields recently discovered in the northern North Sea.

PERRY, W. J., J. P. MYNARD, E. G. A. WEED, E. I. ROBBINS, and E. C. RHODEHAMEL, U.S. Geol. Survey, Washington, D.C.

STRATIGRAPHIC FRAMEWORK OF ATLANTIC CONTINENTAL MARGIN

No abstract available.

PHILIPPI, GEORGE T., retired, 1042 Magnolia, Colorado Springs, Colo.

SUBSURFACE, TEMPERATURE-CONTROLLED ORIGIN OF SAN JOAQUIN VALLEY CRUDE OILS OF CALIFORNIA

Many Tertiary oil basins are convenient for studying the fundamentals of the oil generation process, because the full stratigraphic section from very young to mature source rock commonly is represented, and all stages of the oil generation process can be investigated, except advanced, postmature stages. A study was made of the origin of crude oils in the San Joaquin Valley. Shale cores ranging in age from upper Miocene to Upper Cretaceous were analyzed from depths of 1,000 ft to more than 15,000 ft. Crude oils were analyzed from producing reservoirs ranging in age from Plio-Pleistocene through Late Cretaceous. A gradual change in composition of the shale hydrocarbons was observed from unlike petroleum (immature) in shallow strata, to like petroleum (mature) in deep and warmer strata (diagenesis of the shale organic matter).

Lower Miocene and upper Eocene shales were identified as the major source rocks of the San Joaquin Valley on the basis of relatively high organic content of the shales, shale hydrocarbon maturity, and the great similarity of shale and crude oil hydrocarbons.

In the San Joaquin Valley, as in the Los Angeles and Ventura basins earlier studied, the bulk of petroleum was formed at subsurface temperatures above 100°C (212°F), where the shales are sterile to bacteria. In the San Joaquin Valley, as in the other two basins, petroleum was formed by a nonbiologic chemical process which is strongly temperature-dependent.

PHILIPS, JOHN N., Eastern Gas and Fuel Associates, Boston, Mass.

COAL—OUR MOST ABUNDANT ENERGY SOURCE

Coal is this nation's most abundant source of energy. It represents 88% of the proved national fuel reserves now and 74% of all we can ultimately hope to recover. Yet coal now accounts for only about 19% of the nation's energy production and use, whereas the much more limited oil and natural gas are carrying about 78% of the energy load. In the face of an accelerating national energy demand, that fuel mix simply cannot be maintained.

It is essential that the public recognize that trade-offs are necessary between our energy and our environmental goals. We need to strike a workable balance between reasonably environmental restrictions and the total well-being of an energy-based society. In our efforts to merge our energy and environmental goals, the nation must start thinking about coal not so much as part of the problem but as part of the solution.

PLAFKER, GEORGE, U.S. Geol. Survey, Menlo Park, Calif.

YAKUTAT GROUP, AN UPPER MESOZOIC FLYSCH AND MÉLANGE SEQUENCE IN SOUTHERN ALASKA

The Yakutat Group, part of a belt of highly deformed late Mesozoic rocks deposited in deep water and extending for more than 1,600 km along the Gulf of Alaska margin, underlies an area 200 km long by 15-30 km wide of the Saint Elias Mountains foothills and adjacent coastal plain. Bedded rocks of the Yakutat Group are dominantly Cretaceous graywacke and pelite with local pebble-cobble conglomerate and sparse pods of oolitic chert-nodule limestone. Interspersed with the bedded rocks are mélanges composed of large blocks of competent rocks up to several kilometers in size engulfed in a pervasively sheared matrix of pelite or tuffaceous pelite. These clasts include externally derived or exotic greenstone, marble, metagraywacke, metachert, and diorite that are at least in part of Triassic(?) and Middle Jurassic age. Following deposition, the Yakutat was subjected to (1) pre-late Eocene compressive folding and thrusting, (2) regional zeolite to low greenschist-facies metamorphism with emplacement of early Tertiary granitic plutons, and (3) disruption by large-scale dextral shearing.

Available data suggest that the Yakutat was deposited in an oceanic trench associated with a volcano-plutonic arc. Large exotic clasts were presumably incorporated in the mélange by tectonic disruption and submarine sliding of older rocks exposed along the inner wall of the trench. A source for the sediments and exotic clasts does not exist in contiguous parts of the Saint Elias Mountains. The most probable provenance lies roughly 240 km southeast in the Chichagof-Baranof-Admiralty Islands area of southeastern Alaska. Large-scale post-middle Eocene dextral slip on the Fairweather fault is postulated to explain separation of the Yakutat Group from its source area.

POOLE, F. G., U.S. Geol. Survey, Denver, Colo.

FLYSCH DEPOSITS OF ANTLER FORELAND BASIN, WESTERN UNITED STATES

In Late Devonian and Mississippian times, well-bedded, shallow- to deep-water marine, flysch-like mudstone, siltstone, sandstone, conglomerate, and minor impure limestone were deposited in a subsiding, elongate, structural foreland basin (exogeosyncline) on the continental shelf (Cordilleran miogeo-