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

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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.

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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.

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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.

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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.

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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