and the upward transition from flood to ebb dominance are interpreted as reflecting the onlap of estuary-mouth sands over inner estuarine channel/shoal deposits.

The closest modern analogs to this type of transgressive sequence are the estuarine retreat sand complexes on the eastern United States shelf.

JOHNSON, J. P., Texaco Inc., New Orleans, LA, and M. R. BONE, Geophysical Service Inc., Dallas, TX

Understanding Field Development History Using 3-D Seismic Survey

A mature oil and gas field in south Louisiana produces from multiple pay zones having various fault-related traps, simple closures, and stratigraphically controlled sands. Seismic understanding of the field is complicated by an ancestral river channel, its tributaries, and surface variances such as lakes, marshes, and canal levees. Surface access restrictions include wells, flow lines, tank batteries, and oyster beds. A careful study indicated the field to be complex, thus opening the possibility of further development if the significant subsurface parameters could be better defined. A 3-D seismic survey was planned and conducted to explore this possibility.

The 3-D survey was implemented using dynamite as the source with a "3-D swath" layout of shot-and-receiver locations. Approximately 4 sq mi (10.4 sq km) of 6-fold subsurface control was obtained with depth-point spacing equal to 82 ft (25 m) in both directions. This closely spaced control provided adequate subsurface definition of the proposed objectives. A 3-D migration algorithm was used for proper subsurface imaging of the data and yielded good fault definition. The regularly spaced 3-D migrated data were displayed in a series of equally spaced horizontal sections and printed in a movie format. These data were used by interpretive personnel to generate a set of depth maps that compare favorably with those generated in a conventional manner. Subsequent drilling in the field has demonstrated the validity of the technique.

JOHNSON, MARCUS W., ALLEN W. ARCHER, and DONALD E. HATTIN, Indiana Univ., Bloomington, IN

Trace-Makers as Historians in Large-Scale Cycles of Western Interior Cretaceous Strata

Previously established stratigraphic framework and gross depositional history have permitted analysis of nature and distribution of trace fossil assemblages from western margin to basin center for upper Albian to lower Maestrichtian deposits of the western interior sea. Cluster analysis of trace variety and density reveals distribution patterns which represent habitats similar to those determined previously for mollusks. Trace fossil "habitats" were, however, controlled more closely by substrate nature and events related directly to sedimentation than were the habitats determined by body fossil analysis. Changes in sediment type, depositional rate, and early diagenetic phenomena were recorded with greater accuracy by these groups of trace-makers, which may be used to elucidate the more detailed history of the study interval. The analytical method was applied to several bioturbated carbonate beds of the Greenhorn Limestone that are traceable over large areas of the basin. Bed-by-bed analysis suggests that subtle changes in depositional parameters and/or nature of overlying water column were imparted to certain beds with distinct and characteristic trace fossil assemblages. Basin-wide analysis and mapping of trace fossil assemblages from such beds can be used to improve environmental resolution of this part of the Upper Cretaceous.

Despite great utility of these trace fossil assemblages for environmental analysis, gross interpretations (e.g., water depth) based on trace fossil assemblages alone, must be made with caution. Traces from "deep-water" Upper Cretaceous carbonate rocks are compared to traces in texturally similar but clearly shallow-water Illinois basin Mississippian carbonate rocks. Environmental parameters such as salinity or oxygen availability, that are less readily suggested by lithology, may be largely responsible for such trace fossil assemblage similarities.

JONES, R. W., Chevron Oil Field Research Co., La Habra, CA, and G. J. DEMAISON, Chevron Overseas Petroleum Inc., San Francisco, CA

Organic Facies—Stratigraphic Concept and Exploration Tool

An organic facies is a mappable subdivision of a stratigraphic unit, distinguished from the adjacent subdivisions on the basis of its organic matter (OM), without regard to the inorganic aspects of the sediment. Both the concept of organic facies and its usefulness to explorationists are based on the following facts: (1) OM in sediments consists of several types which can be distinguished by microscopic and geochemical techniques; (2) different types of OM generate and migrate different amounts and types of oil and gas; (3) the same types of OM, and consequently similar generation products, commonly extend over thousands of square miles laterally and hundreds of feet vertically; (4) the distribution of organic facies is not capricious, but is determined by the origin of the organic remains and the free oxygen of the depositional environment; (5) organic facies can be mapped and extrapolated; and (6) the organic facies concept is a major exploration tool because it aids in understanding and predicting both the location and types of oil and gas deposits.

Several organic facies are defined by the microscopic, geochemical, generation, and migration characteristics of their OM, and examples are given of their geologic setting, vertical and horizontal distribution, and their economic significance.

JORDAN, DOUGLAS W., Cities Service Co., Tulsa, OK

Trace Fossils and Stratigraphy of Devonian Black Shale in East-Central Kentucky

In recent years trace fossils have been studied in carbonate and siliceous rocks. Shales have largely been ignored. This study describes trace fossils from the "anoxic" Upper Devonian black shale in east-central

Kentucky along the western margin of the Appalachian basin.

Trace fossils occur where dolomite overlies black shale in the lower part of the Huron Member (basal New Albany or Ohio Shale). *Cruziana, Zoophycos, Planolites, Phycodes, Chondrites* (Type A), *Trichichnus, Teichichnus, Laevicyclus*, and a newly described large burrow form are common. Up section, trace fossils are found where gray shale overlies black shale in the upper lower part of the Huron Member (*Teichichnus, Planolites, Chondrites*-Type B, *Rhizocorallium*, and *Zoophycos*) and the Three Lick Bed (*Chondrites*-Types C and D, *Planolites*-like burrows, *Zoophycos*, and pyritic burrows).

A combination of interpretations based on the stratigraphy, lithology sedimentary structures, and trace fossils suggests that the Devonian black shale was deposited in an upward-deepening sequence transgressive over the axis of the present Cincinnati arch in east-central Kentucky. The carbonate environment of the underlying Middle Devonian Boyle dolomite contains trace fossils and features suggestive of shallow water. At the beginning of the Upper Devonian, migration of black muds onto the platform rimming the Cincinnati arch allowed interbedding with the carbonates.

Up section, the carbonate-black shale environment was replaced by entirely black shale deposition. Periodic oxygenation allowed brief periods of burrowing.

Trace fossil correlation will be helpful in understanding the detailed stratigraphy within the mid-continent Upper Devonian black shale.

JORDAN, TERESA E., Cornell Univ., Ithaca, NY, and RAYMOND C. DOUGLASS, U.S. Geol. Survey, Washington, D.C.

Paleogeography and Structural Development of Late Pennsylvanian–Early Permian Oquirrh Basin, Northwest Utah

Deposition in the late Paleozoic Oquirrh basin of northwest Utah produced as much as 7.5 km of limestone and sandstone. Study of Upper Pennsylvanian and Lower Permian lithofacies, trace fossils, and body fossils relative to a time framework determined by fusulinid biostratigraphy reveals a spatial mosaic of depositional environments which shifted through time.

The Oquirrh basin changed in form from a broad, topographically subdued, shelf area in the Middle Pennsylvanian to a northwest-trending topographic basin in the Late Pennsylvanian. Water depths may have reached 300 to 400 m. Coarse conglomerates, commonly composed of older Oquirrh Group clasts, are common in latest Pennsylvanian and early Wolfcampian deep-water deposits. They record rapid lithification, uplift, and erosion of the margins of the trough, and imply that the Oquirrh basin was bounded by active northwest-trending high angle faults. The faults, with offset rates of about 25 cm/1,000 years, were apparently initiated in the Late Pennsylvanian, and became inactive by the late Wolfcampian. The upper Oquirrh Group records the passive filling of the remnant graben-like trough.

The histories of the Oquirrh basin and of basement uplifts and yoked basins throughout the region to the south and east are similar. The northwest trend, high angle fault margins, and rapid structural development in the latest Pennsylvanian and early Wolfcampian demonstrate the Oquirrh basin's tectonic association with the regional deformation responsible for the Ancestral Rocky Mountains.

JUDD, JAMES B., WILLIAM R. SACRISON, ad ROBERT A. BISHOP, Amoco Production Co., Denver, CO

Whitney Canyon Field—Potential Gas Giant in Wyoming Thrust Belt

Recent drilling in the Absaroka plate of the Wyoming thrust belt has confirmed the presence of a major gas-condensate accumulation in the Whitney Canyon area of Uinta County, Wyoming. Reserves are primarily in porous and/or fractured Paleozoic carbonate formations. Triassic carbonate rocks also appear to be commercially productive.

The discovery well, which was scheduled as a 13,400-ft (4,084 m) test, was spudded in October 1976. Mechanical problems were encountered at 10,691 ft (3,259 m) in the Permian Phosphoria Formation and the well was subsequently completed in the Triassic Thaynes Formation. Paleozoic gas production was established in 1978 by the Amoco-Chevron-Gulf No. 2 well, which was drilled into a nearly normal stratigraphic section of Jurassic Twin Creek Limestone through Ordovician Bighorn Dolomite before crossing the Absaroka thrust at a true vertical depth (TVD) of 15,516 ft (4,729 m). Cretaceous sandstones and shales were drilled to a total depth of 16,224 ft (4,945 m) or 15,894 ft (4,845 m) TVD. A development well located approximately one mile north of the No. 2 well was drilled into a similar stratigraphic sequence.

The Whitney Canyon structure is a north-trending geophysical anomaly with little or no surface expression. Its general shape can be defined well with reflection seismic data. At the Phosphoria level, the structure is approximately 10 mi (16 km) long and 2 mi (3.2 km) wide with 2,500 ft (762 m) of closure.

Gas tested to date from the Triassic Thaynes Formation is sweet, whereas the Paleozoic gas is sour with a maximum H_2S content of 18%. Environmental considerations and gas treatment plant construction will delay Paleozoic gas production until late 1981.

Although reserve estimates for the Whitney Canyon structure are quite speculative at this time, it appears to be a giant field.

KAPLAN, SANFORD S., and J. DONAHUE, Univ. Pittsburgh, Pittsburgh, PA

Sedimentologic Description of Part of Coal-Bearing Carboniferous Sequence Exposed Near Joggins, Nova Scotia

A 300-m section of the upper Cumberland Group exposed south of M'Cairn's Brook near the village of Joggins, Nova Scotia, includes five lithologies, including sandstones, siltstones, claystones, carbonaceous shales, and coal. The sandstones and siltstones display one or