ment on oceanic crust are found throughout the province. Other significant findings include: (1) seismic evidence for underthrusting and for deeply buried folded sedimentary rock at the base of the slope, (2) geologic evidence for 2 to 4 km of differential subsidence, and (3) the discovery of uplifted and deformed Mesozoic(?) oceanic crust beneath Umnak Plateau.

The abyssal-basin province lies entirely in water depths greater than 3,000 m and is underlain by (igneous) oceanic crust. This Mesozoic crust may be a piece of trapped oceanic plate that since early Tertiary time has been covered by a 3 to 8 km-thick sedimentary section. Recent observations include the delineation of regionally thick and locally deformed sediment bodies, discovery of numerous velocity-amplitude features (deep-water "bright spots"), and geologic and geophysical evidence for extensive, potential reservoir beds.

COOPER, ALAN K., MICHAEL S. MARLOW, and DAVIS W. SCHOLL, U.S. Geol. Survey, Menlo Park, CA

Multifold Seismic Data Across Outer Bering Sea Continental Margin

Recent U.S. Geological Survey multifold seismic reflection records from the outer edge of the Bering Sea shelf show that a thick sedimentary section underlies the continental slope and rise. The subject segment of the Bering Sea margin extends from Cape Navarin in Siberia south to Pribilof Canyon, a distance of 700 km. This part of the margin is covered by 200 to 3,400 m of water, is incised by several large submarine canyons, and is underlain by up to 10 km of strata. The strata are thickest (7 to 10 km thick) at the base of the slope near Cape Navarin and near Zhemchug Canyon. A maximum thickness of 10 km (5.9 s two-way time) occurs in uplifted rise and slope deposits that lie in 800 m of water near the mouth of Zhemchug Canyon.

Rocks dredged from the continental slope indicate that upper Eocene or lower Oligocene rocks rest unconformably on Mesozoic (Upper Jurassic and Lower and Upper Cretaceous) rocks that form the acoustic basement. The reflection profiles and dredge data obtained from the sediment-draped areas of the margin suggest that the upper half of the thick sedimentary section at the base of the slope is younger than early Oligocene age. The age of deeper rocks may be as old as Mesozoic.

Several aspects of sediment wedges along the Bering Sea margin make them favorable targets for future hydrocarbon exploration: (1) the large total thickness of Cenozoic rocks; (2) the presence of structural and stratigraphic features such as diapirs, faults, crustal warps, onlaps, and pinch-outs; and (3) the possibility that Cenozoic sediment source areas may be rich in organic and coarse-grained detrital debris.

CORBO, SALVATORE, New York State Geol. Survey, Alfred, NY

Paleoenvironmental Control of Biogenic Structures in Upper Devonian Prodeltaic Turbidite Deposit

The Rock Stream Formation near Ithaca, New York, is a proximal, submarine fan-like deposit of an epicratonic sea. Turbidites and interbedded shale were deposited in alternating channel and interchannel facies. This lithology is in sharp contact with overlying mudstones which were probably deposited on a progradational slope.

The complex environmental parameters which affect the distribution of trace-making organisms is shown by their ichnologic distribution. Three associations occur within the submarine fan. (1) The *Paleodictyon* association consists of five ichnogenera representing pascichnia. These are followed stratigraphically by (2) the *Arenicolites* association consisting of 12 ichnogenera representing domichnia and fodinichnia. Two repichnia compose (3) the *Pteridichnites* association. This last association is ubiquitous to the study section. Food resources significantly influenced behavior as the population shows a trophic shift within a lithologically consistent section, from grazing (like *Nereites*) to the endobenthic feeding and dwelling behavior of a shallow-water assemblage. Within the *Arenicolites* association, substrate texture and cohesion differentially influence the distribution of suspension-feeders and deposit-feeders through a trophically consistent assemblage. Multiple ichnogenera among any one behavioral class rarely occur in the same bed. Ecologic competition affects the distribution of individual phylotaxa within a behavioral class. Ecologic competition may have depended mostly on spot concentration at the time of substrate availability. On muddy substrates which may vary widely in cohesiveness, trophic group ammensalism allows fodinichnia to inherit a similar lithology from domichnia. The complexity of ichnogeneric distribution is produced by ichnotaxa ambiguities as well as ecological controls.

CORDELL, ROBERT J., Cordell Reports, Inc., Dallas, TX

Introduction (to SEPM Research Symposium): Source Beds—Depositional Environments and Early Diagenesis

In recent years, symposia and publications on hydrocarbon source beds have dealt primarily with organic geochemical and late diagenetic aspects. The present symposium is designed to balance the source-bed approach with treatment of depositional-environmental and early diagenetic factors.

The first two presentations discuss kerogen as an indicator of depositional environments; and the next three topics examine, respectively, source type shales, source type carbonates, and the evaporitic environment.

Subsequent papers are arranged by geologic age, commencing with studies in the Holocene to late Tertiary, and moving to progressively older strata. This younger-to-older stratigraphic order permits the coverage to begin with examples in which direct or quasi-direct environmental verification is possible, and to follow with investigations in which the evidence is indirect. In this sequence of stratigraphically restricted papers, most of the lithic examples are shales, mudstones, or other argillaceous rocks.

CURRAN, H. ALLEN, Smith College, Northampton, MA, and RONALD L. MARTINO, Marshall Univ., Huntington, WV

Trace Fossil Assemblages of Upper Cretaceous Sand Units, Delaware and New Jersey

Siliciclastic formations of Upper Cretaceous age on the Delaware-New Jersey coastal plain contain diverse trace fossil assemblages. When used with physical sedimentary structures and textural data, the assemblages can differentiate intertidal and shallow subtidal depositional environments. Most close modern analogs can be recognized for the Cretaceous trace makers.

The Englishtown Formation (Campanian) crops out along the C & D Canal in Delaware. The basal part of the unit is characterized by mottling due to dense concentrations of gently meandering, essentially horizontal *Planolites* burrows outlined by rims of dark organic-rich material. Other zones are mottled primarily by small-diameter branched shafts of *Chondrites*. Clumps of quartz sand-lined tubes of *Terebellina* are dispersed throughout. These tubes have gently curved shafts which form tunnels with distinctive feeding-probe structures at their distal ends. At the top of the unit, the assemblage is dominated by stacked *Ophiomorpha nodosa* systems with basal mazes. Also present are several types of *Chondrites*, which commonly surround and/or infest the walls of *Ophiomorpha* shafts, and delicate *Skolithos* shafts.

In New Jersey, the Wenonah Formation, Mt. Laurel Formation, and Shrewsbury Member of the Red Bank Formation (all Maestrichtian) each contain a distinctive trace fossil assemblage. The Wenonah Formation is characterized by *Cylindrichnus*, large concentrically laminated, subvertical, and tapering clay tubes. The Mt. Laurel Formation exhibits two facies, one characterized by small-diameter *Ophiomorpha* shafts and associated *Chondrites* forms and the other containing an *Ophiomorpha, Chondrites, Skolithos,* and *Cylindrichnus* assemblage. Large-diameter *Ophiomorpha nodosa* systems and associated *Chondrites* characterize sands of the Shrewsbury Member of the Red Bank Formation.

The trace fossil assemblages and primary sedimentary characteristics suggest the following depositonal environments: Englishtown Formation, shallow subtidal shoals transitional to lower foreshore; Wenonah Formation, subtidal, inner shelf; Mt. Laurel Formation, shoreface and transition zones to shallow shoal complex; and Shrewsbury Member of Red Bank Formation, offshore bar complex.

CZARNECKI, ROBERT F., JOHN C. PACER, and ROBERT W. FREEMAN, Bendix Field Engineering Corp., Grand Junction, CO

Advances in Radon Exploration Techniques for Uranium

In an effort to evaluate several radon measurement methods, Bendix Field Engineering Corp., as part of the Department of Energy's National Uranium Resource Evaluation (NURE) program, has performed radon measurements using a variety of new techniques at a uranium occurrence located in the Red Desert area of south-central Wyoming. The site had 100 sampling locations over a 1.5-sq km area.

The radon techniques used were: a prototype microprocessor-controlled emanometer; alpha-track detectors with two types of detector material, with and without membranes for thoron separation; radon adsorption on activated charcoal with the measurement of the gamma-emitting radon decay products; thermoluminescence detectors; partial extraction of lead-210 from soil samples; and an established emanometer. The radon measurements obtained by these techniques at the sample locations are compared for their sensitivity, variability, signal enhancement, and the correlation between the radon techniques. The radon techniques were also correlated to the equivalent uranium in the soil samples.

The prototype emanometer was found to exhibit less variability than the established emanometer. One alpha-track material was 15 times more sensitive than the other material. The thoron membranes decreased the number of alpha tracks by 47% in the more sensitive material and increased the number of alpha tracks in the less sensitive material by 27%. Signal enhancement obtained for all the radon techniques was similar for this research site and ranged from 2.5 to 3.5. Correlation coefficients between the techniques ranged from 0.32 to 0.70 and from 0.3 to 0.9 with equivalent uranium.

D'ANDREA, RALPH D., JR., DON L. SHETTEL, JR., and RICHARD J. ZINKL, Bendix Field Engineering Corp., Grand Junction, CO

Application of Regional Geochemical Data to Uranium Exploration

Hydrogeochemical and stream-sediment reconnaissance data generated by the U.S. Department of Energy's National Uranium Resource Evaluation program can be used to identify geologic environments favorable for uranium or base metal deposits.

Open-filed analytical data for 1 × 2° NTMS quadrangles are obtained on magnetic tape from Oak Ridge National Laboratory and transferred to disk for interactive computer use. Data may then be organized into subsets according to sample type, geologic, or physiographic units; smoothed using block or nearest-neighbor averaging techniques; and power transformed to normalize frequency distributions. Multivariate statistical techniques, including principal component, discriminant, and multiple regression analyses, aid in interpretation. A contrast filter may be used to identify areas that are significantly different from their local background.

Machine-generated color or black and white maps are produced from raw elemental analyses, elemental ratios, and statistical parameters such as factor scores and multiple regression residuals. The data may be represented at any scale, using a variety of symbol or color schemes designed to cartographically enhance the appearance of anomalous areas.

Results of the geochemical interpretation are used to select target areas several tens of square kilometers in size. Examples from the Colorado Plateau and other areas illustrate how the interpretive techniques are used.

Both the data and data analysis techniques have wide application in mineral exploration. Because of the extensive suite of elements represented, the data can be