pane concentrations were separated into regional and anomalous values and contoured along with values of C_3/C_1. Analytical techniques developed to discriminate gas-prone areas from oil-prone areas confirmed the oil-prone nature of this field.

Geochemical anomalies were interpreted in the context of surface fracture distributions and areas of good production. Geochemical anomalies correspond with areas of optimal production from fractured reservoirs having mostly a north-northeast orientation. For this area a predominantly vertical leakage path from reservoir to surface is inferred. Geochemical prospecting using probes can identify oil versus gas-prone areas and can suggest which among many fracture directions are most likely to contain petroleum concentrations.

DULONG, FRANK T., and C. BLAINE CECIL, U.S. Geol. Survey, Reston, VA

Arsenic Concentration Variability and Inorganic Affinity for Selected Coal Beds of Central Appalachian Basin

The mean arsenic concentration on a whole-coal basis, for 613 complete channel samples representing 34 coal beds from the central Appalachian basin, is 14.0 ppm (standard deviation, s.d. = 14.9). An F-test for variance equality and the appropriate t-test on the means can separate stratigraphic units into three categories: (1) Kanawha Formation, which has a mean of 5.04 ppm; (2) New River, Pocahontas, and Monongahela Formations, which have means of 10.1, 10.9, and 12.4 ppm, respectively; and (3) Allegheny Formation, which has a mean of 18.1 ppm.

Data from 40 complete channel samples of the Upper Freeport coal bed (Allegheny Formation) were used for statistical evaluations (F- and t-tests as applied in the stratigraphic comparison) of the regional (western Pennsylvania) versus local (within mine) arsenic variation. The arsenic concentration and variation in whole-coal samples are greater on a regional scale (mean = 40.8 ppm, s.d. = 30.6, n = 21) than on a local scale (mean = 23.8 ppm, s.d. = 18.7, n = 19).

Nine channel samples of the Upper Freeport coal bed were subjected to a 21-part size-gravity washability study. A mean of 86 wt. % of the coal floated at a specific gravity of 1.6. The mean arsenic concentration (6.05 ppm) in this float recovery is 55% less than the mean arsenic concentration in the unprocessed samples (14.3 ppm). The mean arsenic concentration in the remaining 14 wt. % of the coal was 123 ppm. The float-sink analysis verified an inorganic affinity of arsenic and indicated that arsenic is associated with pyritic sulfur in the Upper Freeport coal bed. Three samples with a mean arsenic concentration of 4.20 ppm had a mean of 36.4% reduction of pyritic sulfur, while 6 samples with a mean arsenic concentration of 19.3 ppm had a mean of 63.8% reduction of pyritic sulfur. Concentrations of arsenic in complete channel samples above some threshold, approximately 10 ppm for these samples, appears to be associated with removable pyrite.

EDSON, GARY M., U.S. Dept. Interior, Minerals Management Service, Vienna, VA

The Mid-Atlantic Mesozoic Paleoshelf Edge: Carbonate Buildup or Reef?

An Atlantic Mesozoic paleoshelf-edge reef has been inferred from seismic profiles and Scotian Shelf petroleum exploration. The hypothetical reef forms a discontinuous offshore linear trend from Florida to Nova Scotia.

Data from recent Mid-Atlantic deep-water exploration drilling reveal the local nature of the paleoshelf-edge rim. Lower Cretaceous limestone was encountered at anticipated depths. Visual examination of drill cores and petrographic analysis of core thin sections show bioclastic grainstone, packstone, wackestone, floatstone, and rudstone, as well as a small amount of possible boundstone.

The bioclasts are mostly rounded, coarse sand and have thick or thin rinds. The abundant varieties of bioclasts include sponge, coral, echinoderm, bryozoan, bivalve, and algae fragments, with foraminifera, ostracods, calpionellids, and tubiphytes. Some intervals contain large (several centimeters), lobate stromatoporoids, which may be reefal framework elements.

I conclude that some intervals represent carbonate debris buildups and others represent reefal bioherms. Bioclastic debris intervals may result from in-place destruction of fragile calcareous reefal biota.

EGGLESTON, JANE R., U.S. Geol. Survey, Reston, VA

Pennsylvania Anthracite Mining Industry: A Past—and a Future?

The anthracite region in north-central Pennsylvania was one of the earliest areas of coal mining in the United States. Anthracite was used by blacksmiths in Wilkes-Barre as early as 1769, and by 1808, coal was in demand for home heating and industrial markets. Anthracite production reached a peak of 99.6 million short tons in 1917, but has declined to only 4 million short tons in 1983. Reasons for the decline, during a time when energy demand has generally been increasing, include availability of cheaper fuels, unreliability of anthracite supply, labor-intensive mining, difficulty in mechanization of mines because of geologic conditions, depletion of the more accessible coal beds, and cost of correcting environmental problems.

Many energy analysts believe that the Pennsylvania anthracite industry is facing extinction. The remaining reserves are, however, extensive; a 1984 study funded by the U.S. Bureau of Mines estimated 19 billion tons of anthracite resources, including a reserve base of approximately 7 billion tons. The cost of anthracite leaving the preparation plant is at least 50% higher than that of bituminous coal mined in the East. However, the anthracite region is closer to major eastern markets, so transportation costs are less for anthracite. Because anthracite has a low sulfur value, the costly scrubber equipment required at power plants using higher sulfur bituminous coal usually is not necessary for anthracite-fired plants. Most mining research has been directed toward the bituminous coal industry in the past; similar research is needed in the anthracite industry to develop mechanized, high-productivity mining methods and to improve economic competitiveness.

EICHER, RALPH, Terra Information Processing Services, Ltd., Dulles Airport, VA, GENE TOLBERT, MAPSS Corp., Manassas, VA, WILLIAM SMITH, GeoGraphics, Inc., Champaign, IL, and WILLIAM G. MURRAY, Johnston & Associates, Inc., Haymarket, VA

Microcomputers in Earth Science

Earth scientists and engineers are well advised to consider their long-term repetitive needs for computer support before making a heavy financial commitment in computer hardware. Powerful work stations can now be designed around a personal computer (PC) or microcomputer.

Success with microcomputers results from development of VLSI (very large-scale integrated) circuits and the 5¼-in. diskette (floppy) drive. The latter allows computers with limited memory to swap data rapidly and economically between memory and a storage diskette. Microcomputers benefit from advances in electronic technology and are approaching capabilities of mainframe processors. Equally important to the success of these hardware improvements is the acceptance of common operating systems between machines assembled by different manufacturers and the implementation of compilers for major computer languages. Accompanying compiler development is the development of more powerful, multitasking, multi-user operating systems.

Examples of powerful PC and super-micro systems that are of particular interest to those working in the earth sciences and mineral resource assessment will be presented, as well as improved peripheral equipment such as graphic printers, communication modems, digitizers, and specific software programs.

Such developments in hardware and software, which offer improved speed and responsiveness, are the real keys to improved productivity when microcomputers are used. They permit better management and analysis of data, more meaningful formatting of information, greater alternatives for problem-solving, and with a well-designed system, time and money saved.

ENGLUND, KENNETH J., and ROGER E. THOMAS, U.S. Geol. Survey, Reston, VA

The Richlands Channel—Part of an Early Pennsylvanian Depocenter in East-Central Appalachian Basin

Investigations of Lower Pennsylvanian coal-bearing rocks for the central Appalachian basin analysis program have delineated a broad sinuous channel extending for 30 mi northwestward from Richlands, Virginia.

Named herein the Richlands channel, the bed of this fluvial channel is as much as 6 mi wide and truncates as much as 125 ft of the underlying strata along a regionally significant disconformity. The channel is at the base of the Dismal sandstone member of the New River Formation and is filled with polymictic conglomerate and conglomeratic subgraywacke consisting mainly of well-rounded quartz pebbles that decrease in size toward the northwest. The northwest end of the channel is at a strandline marked by a well-winnowed orthoquartzite of a northeast-trending, barrier-bar complex. The absence of the characteristic deltaic morphologies, which are typical of fluvial sandstones in the underlying Pocahontas Formation, suggests that sediments at the channel terminus may have been reworked and redeposited by the southeastward-transgressing Appalachian seaway. The Richlands channel and other channels in the New River and Pocahontas Formations in the Richlands area define a major depocenter for Early Pennsylvanian clastics that were prograding from the southeast—a relationship that fits the barrier model applied to these strata rather than a braided, southwestward-flowing river system.

FEDOSH, MICHAEL S., U.S. Army Corps of Engineers, New York, NY

Exploratory Drilling in Northern Newark Basin, New Jersey

Extensive drilling is in progress along the right-of-way of a proposed flood diversion tunnel in northern New Jersey. This 21.8-km tunnel would cut across the strike of the Newark basin in an area where rock exposures are few because of glacial deposition.

Approximately 2,400 m of the 6,300-m thick northern portion of the Newark basin is represented in rock cores. The uppermost 870 m of Upper Triassic strata has been drilled along with 1,620 m of Lower Jurassic strata. The Jurassic strata include the three Watchung Mountain sheet basalts sandwiched between fluvial and lacustrine sedimentary deposits.

What emerges for the first time is a continuous picture of the previously poorly exposed Jurassic lacustrine deposits. These cyclic deposits containing kerogen-rich layers are some of the youngest strata found in Mesozoic rift basins. These westernmost Newark basin deposits can be correlated to similar age deposits in outer continental shelf drill holes and possibly help the wildcat exploration starting to appear in the Newark basin.

FILER, JON, West Virginia Geol. and Economic Survey, Morgantown, WV

Upper and Middle Devonian Stratigraphy of Northwestern West Virginia "Devonian Shale" Play

Since 1981, an active oil and gas play has developed in Upper and Middle Devonian fine-grained clastics above the Onondaga Limestone and Huntersville Chert in part of northwestern West Virginia. Activity has been greatest in Ritchie and Pleasants Counties, but Wood, Wirt, Roane, and Calhoun Counties are also involved.

Recent drilling activity has facilitated a more detailed understanding of the Upper and Middle Devonian stratigraphy of the area. The section thickens from west to east, from about 2,000 ft to more than 4,000 ft. To the west, it is composed primarily of interbedded basinal organic dark-brown and gray to black shales and inorganic lighter gray and gray-green shales.

This section is also equivalent to the coarser grained clastic units of the Catskill delta to the east. As the section thickens to the east in the study area, the influence of the delta can be seen in the decrease of organic shale content and the progradation of siltstone bundles into the area. These delta-front siltstones are probably of predominantly turbidite origin and can be correlated with the well-known Upper Devonian drillers' "sands" of central West Virginia.

These facies changes across the area can be used to divide the area into three oil and gas plays: (1) The area west of the Burning Springs anticline, where gas is produced primarily from inorganic and organic shales. (2) The area immediately east of the Burning Springs anticline, where oil and gas are produced from transitional facies including inorganic and organic shales and siltstone. (3) The eastern fringe of the study area, where gas produced primarily from siltstone bundles has been the significant exploration result to date.

FRIEDMAN, GERALD M., Brooklyn College and Rensselaer Center of Applied Geology Affiliated with Brooklyn College of the City Univ. New York, Troy, NY

Setting of Early Ordovician (Arenigian) Carbonate Sedimentation in Appalachian Basin: Arid Climatic Epicontinental Seas Interrupted by Intermittent Conditions of Emergence

Epicontinental seas with sea-marginal sabkhas persisted within the tropic zone of what is now the Appalachian basin. The arid climate and hypersaline conditions influenced the accumulation of carbonate sediments. Conditions of intermittent emergence interrupted cycles of carbonate sedimentation.

Evidence of hypersalinity includes calcitic, dolomitic, or siliceous pseudomorphs of former anhydrite nodules; calcite and euhedral quartz infilling solution-enhanced vugs after evaporite nodules; carbonate pseudomorphs after gypsum and halite; euhedral quartz; authigenic K-feldspar; paucity of skeletal debris; preservation of stromatolites; and length-slow chalcedony, including chalcedonic spherulites, half-moon ooids, and dedolomites. Intermittent emergence is inferred from solution-collapse features, desiccation cracks, eroded surfaces, surfaces of induration such as silcrete, and lag concentrates of micrite chips (flat-pebble conglomerate). Angular clasts of dolostone and limestone resulted from collapse and brecciation of overlying strata, when evaporites underlying them dissolved.

GHAHREMANI, DARIOUSH T., Terra Tech Internatl., Inc., Cleveland, OH, and PHILIP O. BANKS, Case Western Reserve Univ., Cleveland, OH

Applications of Surface Geochemical Prospecting for Shale Gas Exploration in Western Appalachian Basin

Results of a regional radiometric survey in northeastern Ohio revealed several sites where anomalous values of radon, hydrocarbons, and associated gases were found. Laboratory analysis of soil-gas samples and comparisons between radon activities at anomalous sites and scintillometer readings at the same sites indicate that the anomalous gas components are of bedrock origin.

Deeper soil-gas hydrocarbon sampling techniques and various film cups and electronic detectors were used to interpret the significance of radon-hydrocarbon relationship. Highly sensitive FID and TCD gas chromatographs were used to separate and measure soil-gas light hydrocarbons (C_1-C_4) and associated gases.

Results were consistent with earlier anomalous values for total hydrocarbons, C_2/C_1, and C_2/C_3 ratios in areas of higher radon activities, supporting the hypothesis of gases leaking from depth. Gas components considered to be particularly significant in this regard are the light (C_2-C_4) hydrocarbons, He, H_2, H_2S, and CO_2, because the presence of high CH_4 may partly result from microbial or chemical reactions in the soil or subsurface bed rock. Deeper soil-gas hydrocarbon compositions, as measured by ratios of C_1/C_2, C_1/C_n, and $C_3/C_1 \times 1{,}000$, were found to be more consistent with known samples of Devonian shale gas than with Clinton or other gases in Ohio. This compositional relationship offers support for the viability of radon/hydrocarbon soil-gas prospecting. Recent blowouts in eastern Ohio where soil-gas anomalies were discovered prior to actual drillings also support this conclusion.

GIBSON, G. G., Univ. North Carolina at Charlotte, Charlotte, NC

Carolina Slate Belt: A Review of Thoughts of Its Age and Position in Appalachian Orogene

The Carolina slate belt (CSB) is located in the southeastern Appalachian Piedmont, cropping out as a narrow continuous zone extending from central Virginia southwestward to central Georgia. Geologic investigations of the CSB began in the 1820s, shortly after discovery of gold in Cabarrus County, North Carolina. Early workers established the general distribution and character of the CSB relative to adjacent belts, and more recently, mappable units have been delineated. Present interest in the CSB is in part due to recognition of similarities between slate-belt rocks and those associated with sulfide deposits in New Brunswick, and in part to the recent recognition of sedimentary features in the relatively undeformed slate-belt rocks.