Formation and Mogollon Rim gravels of Arizona comprise an Eocene–early Oligocene sequence of claystone, mudstone, sandstone, and conglomerate which crops out in discontinuous exposures along an east-west-trending belt from Socorro, New Mexico, to Show Low, Arizona. The maximum exposed thickness is about 1,200 ft (365 m).

The outcrop belt transects the southern part of the east-west-trending Baca-Eagar basin. The basin is bounded on the north by the Defiance and Zuni uplifts, on the south by the Mogollon highland of Arizona and New Mexico, and on the east by the Sierra-Sandia uplift. These uplifts were the primary sources of sediments for the basin. Measurement of maximum clast size, gravel lithology counts, thin-section data, and paleocurrents were used to determine source areas and sediment dispersal patterns. Southward tilting and erosional stripping of the northern part of the basin resulted from uplift of the Colorado Plateau in Miocene-Pliocene time.

A depositional model is presented which consists of a braided alluvial plain–meander-belt–lacustrine facies tract. The meander-belt facies includes both fine- and coarse-grained point-bar deposits. The lacustrine facies contains both the classical Gilbert-type delta and the fine-grained marine-type delta. High concentrations of calcium carbonate in the lacustrine sediments indicate a closed-lake system.

CAVAROC, VICTOR V., JR., North Carolina State Univ., Raleigh, NC, and ROMEO M. FLORES, U.S. Geol. Survey, Denver, CO

Variations in Cretaceous Coal-Bearing Strata, Gallup Coal Field, New Mexico

Cretaceous coals of the western Gallup field, New Mexico, occur with detrital wedges that interfinger to the northwest with brackish-marine sediments of the San Juan basin. This study documents detailed stratigraphic relations and the relation of coal occurrence to depositional environments of the Gallup, Crevasse Canyon, and Menefee formations. One hundred and fifteen sections form the basis for three-dimensional reconstructions of a 30-sq km area northwest of Gallup.

The regressive Gallup Sandstone represents reworking of river-mouth sands into coastal barriers where coals accumulated in back-barrier subfacies. This formation grades upward into the Dilco Coal Member of the Crevasse Canyon Formation characterized by varve-like fine-grained sediments, thin sandstones, and coals, which pass upward into thick, northwesterly transported fluvial sandstones. These merge laterally and upward into northerly oriented, thick paleochannel sandstones of the Bartlett Barren Member of the Crevasse Canyon Formation. The coal-bearing Gibson Coal Member of the Crevasse Canyon Formation, which cannot be differentiated from the Cleary Coal Member of the overlying Menefee Formation, contains finer grained sediments and coals deposited in a broad interfluvial depression bounded on the west by Bartlett alluvial channel facies. Coal accumulation in this depression was terminated by southeasterly oriented, crevasse-like deposits associated with thick fluvial sandstones (Menefee Formation).

Stratigraphic variations of coal beds are directly related to their proximity to contemporaneous channel facies. Uniformly thick coals trend subparallel to channel facies; near the channel facies, coals become erratic and pass into rooted, carbonaceous overbank detritus. Coals are offset locally by faults caused by differential compaction beneath overlying channel sandstones.

CECIL, C. B., R. W. STANTON, F. T. DULONG, et al, U.S. Geol. Survey, Reston, VA

Geologic Controls on Mineral-Matter Content of Coal in Central Appalachian Basin

Mineral-matter content of coal in the central Appalachian basin was primarily controlled by chemical conditions in a peat-forming paleoenvironment. Coal that is low in mineral matter was derived from peat that accumulated under highly acidic conditions ($pH<4.5$), whereas coal having high mineral-matter content was derived from peat that accumulated under pH conditions ranging from 4.5 to 7.5. Highly acid conditions during the peat-forming stage of coal formation favored leaching of mineral matter and inhibited bacterial degradation. Increasing pH resulting from buffering by dissolved calcium carbonate species could have (1) reduced the degree of leaching of mineral matter and (2) concentrated mineral matter, including sulfur compounds, because of increased bacterial degradation of peat and concomitant sulfate reduction.

Coal that has a low mineral-matter content (1) is associated with noncalcareous sedimentary sequences; (2) has a high kaolinite to illite ratio; and (3) has a relatively low calcium carbonate content. The converse is true for coal having high mineral-matter content. Mineral matter other than calcium, iron, and sulfur in Appalachian basin coal is dominated by inherent ash derived from plants. Calcium, iron, and sulfur contents are thought to have been fixed primarily by chemical reactions indirectly resulting from bacterial degradation during the early stages of coal formation.

CECIL, C. B., R. W. STANTON, F. T. DULONG, U. S. Geol. Survey, Reston, VA, et al

Geologic Controls on Sulfur Content in Coal

One of the principal factors controlling sulfur content of coal is the pH of the ancestral peat-forming environment. Coals derived from peats that are believed to have formed under highly acidic conditions ($pH <4.5$) are low in sulfur ($<1\%$), whereas sulfur content in coals derived from peats that formed under elevated pH conditions (pH 4.5 to 7.5) tends to increase where pH was higher.

Maximum bacterial activity occurs where conditions are neutral, or nearly so; such conditions favor sulfate reduction and peat degradation. This pH model is consistent with Schopf's suggestion "that the sulfur content of a coal may give an indirect indication of the extent of anaerobic decay." Also, the common occurrence of pyrite in fusain bands may be related to pH conditions (neutral to slightly alkaline) in the pre-fusain layer caused by hydrolysis of alkali and alkaline earth metal ions, which were concentrated by burning.

Regional and stratigraphic differences in sulfur contents of Appalachian basin coals are related to differences in pH conditions of the peat-forming paleoenvironments. High-sulfur coals (1) are associated with calcareous sedimentary sequences (marine, nonmarine, or both), (2) have elevated calcium carbonate content, and (3) have a low kaolinite to illite ratio. The converse is true for low-sulfur coals.

Exploration for low-sulfur coal should focus on coal-bearing sequences that contain a paucity of calcareous sediments.

CHAKRABARTI, A., Indian Inst. Technoloy, Kharagpur, West Bengal, India

Burrow Patterns of Ghost Crab *Ocypode ceratophthalma* (Pallas) as Possible Indicators of Foreshore Slopes

Burrow patterns of the ghost crab, *Ocypode ceratophthalma* (Pallas), collected in India from different types of beaches in different geomorphic settings, display a limited zonation whose seaward limit is the backshore-foreshore transition zone. Burrow forms whose initial direction of burrowing is shoreward include simple unbranched or multibranched types of J, U, and Y shapes.

Although the different subenvironments of a particular beach can be subdivided tentatively by the dominance of a particular form, similar subenvironments of beaches having different slopes and permeability of the beach surface register different types of burrows. In high sloped beaches, whether composed of quartz sand or carbonate skeletal sands, the upper part of the foreshore slope is mostly dominated by J, U, and Y forms, sometimes multibranched, and with relatively small burrow diameters. In flat beaches the region near the high water line is marked by large diameter, unbranched step-like burrows, and the U and Y shapes found in high sloped beaches are absent.

A uniformity in the asymptotic nature of the juncture of the secondary arm with the primary arm of Y burrows found in the upper part of the foreshore slope of high sloped beaches has been noted. A mathematical analogy between the shape of the secondary arm of these Y burrows with the streak line of water seepage caused by wave uprush and its successive movement of the saturated-unsaturated boundary under a pressure head due to the capillary action of the water table has been attempted.

CHAMBERLAIN, C. KENT, Cities Service Co., Denver, CO

Synonymy, Ethology, and Environmental Implications of *Nereites* Group of Trace Fossils

Members of the *Nereites* family consist of a median backfilled structure and lateral-worked-areas. The current, senior synonyms (Häntzschel, 1975) are *Nereites* MacLeay 1839, *Helminthoida* Schafhäutl 1851, *Phyllodocites* Geinitz 1867, *Scalarituba* Weller 1899, *Neonereites* Seilacher 1960, and *Palaeohelminthoida* Ruchholz 1967.

The main, fundamental difference between different family members appears to be that in some the backfilled area consists of a continuous fecal string (e.g., *Helminthoida*) and in others it is a meniscate alternation of coarse and fine (fecal) sediment (e.g., *Scalarituba*). The second fundamental difference appears to be behavioral (≈environmental); some forms are tight, grazing patterns (most *Helminthoida*, *Palaeohelminthoida*, *Nereites*) and others are loosely-looping grazing patterns (*Scalarituba*, some *Helminthoida* and *Nereites*). The least important difference appears to be preservational; it depends on a top view (*Phyllodocites*, *Nereites*), interlaminar views (*Scalarituba*, *Palaeohelminthoida*, *Neonereites*?), or bottom (or low-in-the-structure) view (*Neonereites*).

Based on the difference in the median structure, *Nereites* and *Scalarituba* are probably the only two valid senior synonyms.

Nereites (≈*Helminthoida*) occurs in shallow shelf through abyssal environments. *Scalarituba* occurs in shallow shelf to probably no deeper than bathyal.

Nereites (≈*Helminthoida*) can be confused with simple backfilled tubes (usually fecal ribbons) because even in *Nereites*, the lateral-worked-areas are not always obvious. The use of *Cosmorhaphe* for simple fecal ribbons further confuses the nomenclature and is inappropriate because *Cosmorhaphe* is a hyporelief sand cast of a simple, open tube originally made in a mud substrate. *Nereites* can be confused with *Phycosiphon* where lateral-worked-area of the former and the spreite of the latter are not visible.

CHANG, YI-MAW, and JAMES HELWIG, ARCO Oil and Gas Co., Dallas, TX

Decompaction Technique Helps Correlation

As a result of differential compaction, the geometry of strata in a sedimentary basin changes continually during progressive burial. Shales and coals, in particular, undergo strong compaction relative to other lithologic units. A stratigraphic cross section constructed from present bed thicknesses may differ substantially from the cross section at the time of deposition. Therefore, decompaction study of cross sections helps stratigraphic correlation, especially in laterally intertonguing sequences of compressible and incompressible facies, and also helps define compaction-related structures.

The decompaction technique uses the porosity-depth curve of each lithology to calculate the thickness of each bed at a given burial depth; calculations and plotting are done by computer. The simplest way to visualize the technique is to consider that the stratigraphic section is moved up along the porosity-depth curve to any previous burial depth. When a bed reaches the surface, it is completely decompacted and recovers its maximum (initial) thickness. The decompaction technique may be difficult to apply where beds have undergone geopressuring or complex diagenesis.

Use of decompacted cross sections in Gulf Coast clastic sequences and in coal-bearing strata in Colorado results in more accurate and refined stratigraphic correlations. Precise correlation of sand, shale, and coal beds is economically significant, because the physical continuity of beds from one exploratory well to another is of the utmost importance in mining and petroleum geology.