The hinge line appears to mark the northern limit of a series of growth faults that account for much of the subsidence in the southern basin.

Coal production in 1979 was 113,793,868 short tons (85,697,048 short tons in 1978), according to the West Virginia Department of Mines Annual Report. Estimated remaining recoverable reserves total 57,139,067,471 short tons.

The West Virginia Geological and Economic Survey is involved in a 10-year program to remap coal seams and map mines to obtain more accurate estimates of remaining reserves throughout the state. A great number of coal samples are being collected and analyzed; most analyses are available to the public and will be used to map coal-quality parameters.

Mining has proceeded from outcrops of thick, high-quality coals near early railroads and navigable waterways to areas where the coal is thin, deep, impure, or relatively far from surface transportation facilities. Recently, exploration and development have occurred in the hinge-line area, traditionally regarded as relatively barren.

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Pottsville Alluvial Plain Coals in Northern West Virginia

In upper Pottsville strata (Pennsylvanian) in the central Appalachians, dominant facies are alluvial-plain sandstones. Flood-plain shales and siltstones intercalated with these sandstones contain numerous coal beds. The coals are laterally discontinuous, but locally thick and may be of interest in continuing development of coal resources of the region. Geometry of coal beds is facies-controlled and in many places may be predicted through interpretations of positions, trends, and geometries of associated facies components.

In a study area covering the Philippi and Weston 15-minute quadrangles in north-central West Virginia, Pottsville strata can be subdivided into (1) a lower interval (average thickness in range of 50-60 m) with relatively lower-energy, mixed-load, coal-poor, alluvial-plain deposits, and (2) an upper interval (average thickness in range of 80 to 100 m) with higher-energy, bed-load, alluvial plain deposits with numerous coal beds, commonly at depths less than 300 m. Lower Pottsville strata in the study area contain multistoried sandstone units that occur in belts averaging 6 to 8 km in width. Individual sandstone units are up to 15 m thick and typically include one or more channel-fill sandstone bodies averaging 6 m thick, as interpreted from geophysical logs. In upper Pottsville strata multistoried sandstone units occur in belts averaging 8 to 10 km in width. Individual sandstone units are up to 120 ft (36 m) thick, typically containing one or more channel-fill units averaging 8 m thick. Coal beds up to 2 m thick (as interpreted from geophysical logs) intertongue with or terminate against sandstone units. Coals record deposition in flood-basin environments. Coal thickness may be related partly to variable channel positions, differential compaction, and the interaction of regional subsidence and supply of clastics. Future economic development of such coal units should be carefully keyed to an understanding of facies relations.

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Red-Bed Evaporite, and Carbonate Facies Associations in Interior Basins—A Model for Resource Exploration

Mid-Continent evaporite sequences exhibit a common association with red beds and carbonate rocks. These lithologic elements can be interrelated in a model of coastal evaporite sedimentation, based on modern analogs of evaporites in association with mud-rich tidal flats, coastal sabkhas, and hypersaline brine pans.

As an example of these relations, upper Clear Fork-Glorieta strata (Permian, Leonardian) in the Texas Panhandle contain red beds, evaporites, and carbonate rocks, and are characterized by a gradual basinward (southerly) shift in facies through time. Upper Clear Fork rocks in the study area record dominance of coastal evaporite and carbonate environments early in the development of the study interval. Evaporites and associated carbonates, which were deposited in hypersaline, tide-fed brine pans, landward of open-marine shelf environments, include (1) algal-laminated carbonate rocks, commonly with swallowtail-crystal pseudomorphs after gypsum, (2) laminated anhydrite, and (3) mud-banded salt. Chaotic mudstone-salt is present and was deposited in landward salt-mud flats. Glorieta rocks record late-stage dominance of siliciclastic sedimentation. Laterally-persistent Glorieta siliciclastic units consist of mudstone-siltstone facies, deposited in intertidal mud flats, and grade basinward into sandstone and dolomite deposited in clastic shelf environments. Periods of siliciclastic deposition alternated with periods of evaporite deposition. During sedimentation of each siliciclastic sequence, mud flats prograded seaward into the shelf terrane. Subsequent deposition of evaporites was on the expanded mud flats surface.

This example exhibits many similarities with evaporite sequences in other parts of the Permian basin, parts of the Salina basin, and selected salt occurrences in the Rocky Mountains. Understanding of facies interrelations is important in predicting resource potential of evaporite beds, and the occurrence of hydrocarbons in evaporite-associated strata.

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Upper Devonian Tide-Dominated Deltaic-Intradeltaic Sedimentation in West-Central Pennsylvania: A Sedimentologic Model for Distribution of Petroleum Sandstone Reservoir Types

Upper Devonian Catskill Formation outcrops in west-central Pennsylvania were studied to develop a regional depositional model, and a better understanding of the sedimentologic controls on distribution of the petroleum sandstone reservoir types in the subsurface part of the basin. The Catskill Formation is characterized, from base up, by the Irish Valley, Sherman Creek, and Duncannon Members, whose thicknesses and proportions markedly change by lateral intertonguing along northeast-southwest depositional strike. The Irish Valley Member, in much of the area, consists of alternations of marine and nonmarine sediments which are arranged in several motifs. Each motif consists of a fining-upward facies assemblage, showing a variety of structures attributed to subtidal and intertidal flat sedimentation. The Sherman Creek Member consists of nonmarine mudstone and siltstone and subordinate amounts of sandstone, organized into a succession of fining-up cycles, deposited on a low relief and inactive coastal plain with small and high sinuosity meandering streams and broad flood basins. The Duncannon Member consists of interbeds of nonmarine, thick to massive and complexly cross-bedded sandstone with subordinate amounts of mudstone and siltstone, believed to represent low sinuosity to possibly braided river systems. The Duncannon facies dominates the Catskill Formation in the central parts of the area and intertongues laterally with the Sherman Creek Member and parts of the Irish Valley Member which comprise the main bulk of the Catskill to the south and north. In the same area, the Irish Valley facies, while attaining its tidal origin, is not characterized by repetition of motifs. Paleoenvironmental synthesis suggests that the Catskill shoreline was fed by a tide-dominated delta in central Pennsylvania (Centre County) and was flanked to the south and north by broad tidal flats which graded landward to an inactive coastal plain environment.

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Carbonate Diagenesis in a Quartzarenite: Dolomitic Keefer Sandstone of West Virginia

After deposition as a coastal marine deposit, the Silurian Keefer Sandstone underwent an elaborate diagenetic sequence. In general, the processes were: quartz cementation, calcite cementation, dolomitization, and finally dedolomitization. Diagenesis in this formation, as interpreted from petrographic study, was complex because the composition of pore fluids changed throughout its postdepositional history. Quartz overgrowths precipitated early, most likely from marine connate brines. The second generation of cement, poikilotopic calcite, precipitated when meteoric-derived phreatic water percolated through the sand during a major regression of the sea. Clay minerals in the matrix favored dolomitization of calcite cement, fossils, and calcite mud by serving as sites of nucleation or catalysts and perhaps by providing magnesium. Later, at a moderate burial depth, saline subsurface brines dedolomitized isolated dolomite crystals.

Primary porosity in the Keefer (Big Six) of southwestern West Virginia was virtually occluded by these early cements. Most microscopically visible porosity is secondary and attributed to the volume reduction of carbonate material with dolomitization of local calcite. Several Silurian-Devonian sandstones are petrographically similar to the Keefer, and its postdepositional history, as interpreted here, may serve as an example of diagenesis in other dolomitic and calcareous quartzarenites of the Appalachian basin.

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Illinois Coal—A Major Bituminous Coal Resource

About two-thirds of Illinois is underlain by coal-bearing strata of the Pennsylvanian System. Major coal seams crop out along the margins of the Illinois basin coalfield and are at depths of up to 1,000 ft (300 m) in the deep part of the basin in southeastern Illinois. Identified bituminous coal resources of Illinois are 162 billion tons (147 billion metric tons) which exceeds the bituminous resources of any other state. Over 20 billion tons (18 billion metric tons) of potentially surface-minable coal ($<$150 ft or 45 m deep; $>$18 in. or 45 cm thick) have been mapped, of which 5 billion tons (4.5 billion metric tons) are estimated to be economically recoverable at present. At 50% recovery, about 50 billion tons (45 billion metric tons) of coal with an average thickness of 4 ft (122 cm) or greater are recoverable by deep-mining techniques. Most of these resources occur primarily in two seams—the Springfield and Harrisburg (No. 5) and the Herrin (No. 6) Coal Members. Little exploratory drilling has been done on the Jamestown, Seelyville, De Koven, Davis, and other coals that may represent a substantial additional coal resource. Coal seams of Illinois commonly are overlain by black shale or limestone, which provides a relatively stable roof for modern, high-speed underground mining. Illinois coal is a high-volatile C bituminous coal having high heat values. About 4% of the state's identified coal resources are relatively low in sulfur ($<$2.5%). Studies of stratigraphy and depositional environments have revealed deposits of low-sulfur coal in areas overlain by thick gray shale. As deeper parts of the basin are explored, new discoveries of low-sulfur coal are expected. At present in Illinois, approximately 60 million tons (54 million metric tons) of coal are produced annually from about 60 mines. At least 12 new mines are expected to open during the next several years, and annual production may exceed 75 million tons (68 million metric tons) by 1985.

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Coal Resources in Ohio

Coal is Ohio's single most important mineral resource. With decreasing supplies of oil and natural gas and a lack of alternate energy resources, increasing reliance will be placed on coal as the primary energy resource. To assist in the development and utilization of Ohio's coal resources, the Ohio Division of Geological Survey is continuing to investigate and report on the coal deposits in the state as well as investigating methodologies instrumental to the cleaner burning and more effective utilization of the coal.

Two investigations of deep coal resources in parts of southeastern Ohio have recently been completed, and resources of the Clairon (No. 4a) and Sharon (No. 1) coals in southern Ohio are currently being investigated. Ancillary to coal resource studies is the federally funded Division of Geological Survey project to accurately show the location and extent of abandoned underground coal mines on U.S. Geological Survey 7.5-min-