freshwater deposition.

The purpose of this study is to evaluate what influence paleoenvironments have on the nature of variation of pyrite in coal. To further the scope of this evaluation, the lower Kittanning samples were also compared to previously studied coals from the predominantly marine environments of western Kentucky.

Comparison of coals has been done using the percentages of pyrite in the microlithotypes vitrite and clarite. In the lower Kittanning coal, framboidal pyrite is generally less abundant and dendritic pyrite was not observed at all. Euhedral pyrite exhibited no clear variation between the two environments. Massive pyrite was more abundant in the set of samples from the mine with the highest average pyritic sulfur but otherwise exhibited no variation. In contrast, a larger percentage of pyrite in the western Kentucky coals examined is framboidal and dendritic. Mines examined in the Moorman syncline of western Kentucky do have a framboidal pyrite percentage comparable to the lower Kittanning samples, but the percentage of dendritic pyrite (particularly in the Western Kentucky No. 9 coal) is significantly higher for the western Kentucky coals.

Bulk petrography of the coals is similar with all having greater than 80% total vitrinite. The association of the pyritic sulfur does, however, change significantly between the various coals studied and particularly between the coals of western Kentucky and among the "marine" lower Kittanning samples and the "fresh water" lower Kittanning samples. Among the pyrite in the "fresh water" coals, massive (perhaps epigenetic) pyrite dominates the associations. In summary, the study of form and association of iron sulfides has the potential to give more information about variations in coal depositional environments than simply the study of bulk petrologic or bulk sulfur variations.

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Future Trends in Sandstone Diagenesis

Discovery of highly porous and permeable sandstones at great depths and temperatures has clearly demonstrated that porosity reduction with depth is not monotonic. Recognition that porosity can be created in sandstones at depth has spurred tremendous interest in developing predictive models of porosity evolution and distribution in sedimentary basins. Instead of predicting economic basement, emphasis has shifted to prediction of porosity "windows" in the subsurface.

Historically, diagenesis has been considered a function of sandstone composition and temperature. However, it has become increasingly clear that this view is too simplistic. Factors such as pore fluid composition, flow rate, organic maturation, and time may significantly alter the course of diagenesis. Development of predictive models that provide for these parameters will, when coupled with structural-stratigraphic and hydrocarbon generation models, permit the relative timing of porosity evolution, hydrocarbon generation, and trap formation to be determined.

In order to simulate the diagenetic evolution of basins and predict porosity distribution, the processes that lead to creation and destruction of porosity must be understood. Many of the important porosity-producing processes have been identified through petrologic studies: dissolution of carbonates, feldspars, and rock fragments. Formation of deep porosity in a variety of basins is commonly associated with precipitation of kaolinite and iron-rich carbonate, suggesting that, although the paths of diagenesis may be diverse, common trends exist. Development of predictive diagenetic models will require continued accumulation of petrologic data and case studies more fully using presently available technology (e.g., electron and ion microprobe, stable isotope geochemistry, age-dating techniques). This will better document the time, temperature, and chemical environment of formation of diagenetic materials.

Areas of research requiring attention are the following. (1) Fluid flow and heat transfer in sedimentary basins. What are the volumes of fluid, rates of flow and flow paths? How do these change as a basin evolves? (2) Geochemistry of subsurface fluids. Reliable analyses are required to identify compositional trends of subsurface fluids. What controls the pH of subsurface fluids? These questions will require further research on shale diagenesis, fluid diagenesis, fluid expulsion, and clay membrane filtration. (3) Diagenesis of organic matter in sediments. Recent studies have shown that by-products of petroleum generation (e.g., CO_2, H_2S, organic acids) may be an important factor in sandstone diagenesis. (4) Computer models simulating the chemical consequences of rock-fluid interaction are restricted by the lack of reliable thermodynamic data for many common diagenetic minerals (e.g., clays, zeolites). We need additional information concerning *rates* of dissolution and precipitation of common minerals under various conditions. (5) Physical compaction of sandstones. (6) Relationship between depositional environment and subsequent diagenetic events.

Because porosity prediction requires an understanding of many related disciplines, an integrated approach is required. By combining the talents and expertise of petrologists, organic and inorganic geochemists, fluid mechanicists, and structural geologists, not only will we be able to develop powerful models for porosity prediction, but we will also be better able to place porosity development in its proper context as one aspect of basin evolution and hydrocarbon accumulation.

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Organic Facies of Some Mesozoic Source Rocks on Alaskan North Slope

Geochemical screening (TOC and Rock-Eval pyrolysis) of picked cuttings of Mesozoic age from seven wells located between Prudhoe Bay and the Colville delta distinguished three types of organic facies and one subtype. Identification of the organic facies was based on the organic content of the sediments and their position in a modified van Krevelen diagram. This paper demonstrates relationships between organic facies of the sediments and their inferred depositional environment.

The organic matter type and quantity serve to separate the Mesozoic stratigraphy into five intervals: (a) Shublik Formation; (b) basal Kingak Shale; (c) upper Kingak Shale; (d) Pebble Shale/Hot Zone; and (e) Torok/Seabee Formations. The hydrocarbon-generating potential and predicted hydrocarbon products differ considerably and are controlled by the sedimentary environment of each interval.

The Shublik Formation in the study area was deposited on a carbonate platform with a deep basin lying to the south. High organic-carbon content and relatively high hydrogen content of the Shublik can be explained by preservation of marine organic matter in anoxic lagoons or local depressions.

Deposition of the basal Kingak Shale and of the Pebble Shale/Hot Zone is the result of major transgressions during the Jurassic and the Neocomian, respectively. Both intervals were deposited as bottomsets of prograding sequences (prodelta) and contain high quantities of relatively hydrogen-rich organic matter. Their organic facies are the result of distal sedimentation coupled with high organic productivity and moderate to good preservation. The Fishbone Shale, deposited elsewhere in an environment similar to that of the basal Kingak and the Hot Zone, is not developed in the study area.

The upper Kingak Shale and the Torok/Seabee Formations are of a similar organic facies that is characterized by relatively low quantities of hydrogen-poor organic matter. Both intervals were deposited as foresets in a progradational sequence. The former extended toward the south during the Jurassic and the latter toward the north during the Cretaceous. The organic facies of these intervals are the result of clastic dilution, increased input of terrigenous organic matter, and increased bioturbation during early burial.

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Coexisting Reefs and Terrigenous Muds in Java Sea

A rugged tectonic backbone, deeply weathered and stream-incised, composes the island of Java, Indonesia. Streams laden with fine-grained terrigenous sediment spill out into the marine setting of the Java Sea. Longshore drift moves the fine-grained suspended sediment load from points of discharge parallel to the coastline. Hence, although the Java Sea lies beneath the equator, carbonate sedimentation is essentially inactive along the coast. Reefs and skeletal facies, however, develop and become abundant about 25 km (16 mi) offshore, away from the influence of terrigenous sediments and freshwater plumes from rivers. The reefs, known as the Pulau Seribu Group, occur on the shelf at a depth of 30 to 40 m (100 to 130 ft) and are elongated in an approximately east-west direction. Storms pile up skeletal debris on the reef flats, thus building up islands that develop beaches and locally become vegetated. The skeletal debris is mostly composed of particles of corals, mollusks, echinoid spines, foraminifera, and red and green algae.

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Problem of Cements in Classifying Carbonate Rocks, Especially Reefs

Classifications of limestone are based on the relative concentrations of micrite and sparite. These classifications are based on the idea that, in calm waters, tiny particles of lime mud are (1) available and (2) able to settle on the bottom and remain there, whereas in agitated waters, particles of microsize remain in suspension and are not deposited. Two problems limit this reasoning: (1) lime mud from low-energy deposits commonly filters into underlying high-energy deposits, or waters flowing through pores may effect such a transfer of lime mud, and (2) an even more complicated problem is the biochemical precipitation of cryptocrystalline cement in reefs. Cryptocrystalline cement that precipitates within millimeters to centimeters of the surfaces of reef rock looks just like micrite. As bioerosion converts the solid colonies of reef organisms into skeletal particles that are cemented rapidly beneath the surfaces of the reef by cryptocrystalline cement, the unwary geologist is tempted to term reef rock a biomicrite or wackestone or complain the "the reef core is represented by lithified lime mud." Hence, case histories abound where unwary geologists confused reef rock for low-energy lime-mud facies.

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Sedimentary Sequence from 1980 and 1982 Mount St. Helens Sediment Flows: A Model for Older Volcaniclastic Deposits

Sediment flows resulting from May 18, 1980, and March 19, 1982, eruptions of Mount St. Helens produced a three-unit sequence that provides a model for interpreting similar deposits in the rock record. After the 1982 eruption, rivers rapidly reestablished pre-eruption channel levels and downcut through the new flows, allowing examination of the internal structures before extensive modification by reconstruction projects.

The depositional sequence consists of a basal graded to massive layer (Unit 1) of large clasts in grain-to-grain contact overlain by a distinctly finer-grained stratified unit (Unit 2) of similar thickness. The top unit (Unit 3) contains very large matrix-supported clasts and transported log debris. Grain size and total thickness of the sequence varies from 3.5 m (11 ft) thick, 40 cm (16 in.) boulders, and coarse sand in proximal flows above Camp Baker to 0.5 m (1.5 ft) thick, coarse sand, and silt in distal flows on the lower Cowlitz River. This sequence resembles some fluvial deposits, but clearly formed during extremely rapid deposition related to mudflows. We have noted similar Tertiary volcaniclastic sediments and believe Mount St. Helens sediment flows provide a model for interpreting volcaniclastic deposits often considered dominated by fluvial processes.

Three Unit Sequence from 1982 Sediment Flow North Fork Toutle River Sec. 2, T. 3 E., R. 10 N.