

shape of the coal body is modified by coexisting and postdepositional environments such as channels.

Iron disulfides are present in coals either as marcasite or pyrite and are the major cause of sulfur variation within the seam. High sulfur contents in the form of disseminated framboidal pyrite are present in coals that were transgressed by marine to brackish-water environments. The only exception is where a sufficient thickness of sediment is introduced early enough to shield the peat from marine to brackish waters. Thus, the environments of deposition that overlie the coal are more important to the distribution of the type and amount of sulfur in the coal than the environments of deposition of the sediment on which the coal developed.

Roof quality in underground mines is dependent on the interrelations of rock types, syndepositional structures, early postdepositional compactional traits, and later tectonic features. Most of the features of roof conditions can be related to depositional or early-stage compactional processes of the environments overlying the coal. Later tectonic events may accentuate these early traits, but the basic characteristics seem to have been established during or shortly after the sediments were deposited.

Superposed on changes in seam character attributed to variations in environments of depositions are contemporaneous tectonic influences. Rapid subsidence during sedimentation generally results in rapid variation in coal seams but favors lower sulfur and trace-element content, whereas slower subsidence favors greater lateral continuity by higher content of chemically precipitated material.

Knowledge of depositional environments and of their tectonic setting is a valid and viable tool in the search for and development of coal resources.

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#### Oil Expulsion—A Consequence of Oil Generation

In source beds, much of the oil-generating organic matter is concentrated along bedding surfaces. During the principal phase of oil generation, when adequate thermal energy is available, 25 to 30 wt. % of the organic matter commonly is converted to liquids, mainly bitumen with some water. Part of the bitumen is then thermally cracked to crude oil. Hydrocarbon gases with some CO<sub>2</sub> and N<sub>2</sub> are generated also; much of the water and CO<sub>2</sub> is generated before oil is formed.

The release of fluids from organic matter causes a reduction in volume of the residual solid organic matter; however, this volume decrease is offset by the considerably greater volume of generated fluids. As a result, pressures increase greatly along sealed bedding surfaces. Internal (intrasource) migration of oil and gas occurs when local, transitory fluid pressures become sufficient to part the bedding laminae and to form or reopen near-vertical microfractures connecting the partings. Permeable migration pathways also may develop along laminae as a result of the reduced volume of the organic matter. Fluids are driven along permeable laminae and partings, into connecting, less pressurized laminae where two or more laminae converge, and along microfractures and faults within the source sequence.

Eventually, high fluid pressures will develop in most parts of an actively generating source-rock section if the section is sealed and confined.

Two properties of argillaceous rocks that permit overpressuring are anisotropy and heterogeneity. Additionally, enough oil must be generated to increase fluid pressure sufficiently for local dilations to occur in oil-source rocks. This requires at least 0.5 wt. % of hydrogen-rich organic matter. In argillaceous source rocks, clay-sized quartz and clay provide brittle pressure and fluid seals, susceptible to microfracturing, on individual laminae. In carbonate-evaporite sequences, evaporites sealing laminae are less likely to fracture.

At a given generation site, dilation and fluid release are followed by a sharp reduction in pressure and closing of partings and fractures to further fluid movement. Pressure will again increase and dilation will recur at a given generation site until the fluid generation rate has diminished enough for the fluid pressure to remain below the dilation point, that is, the fluid pressure required to open or reopen any part of the system sufficiently for local internal fluid migration or expulsion.

A source-rock system functions much like a pressure cooker. It is self-opening and self-sealing. As liquids are expressed from a parting into a fracture, the pressure drops quickly and the fracture will close on the retained liquids, immobilizing them. Silica and/or calcite cement commonly are precipitated along such fractures, both before and after oil migration. Immobilized oil devolatilizes, leaving a solid or semisolid residue. These materials enable resealed parts of the system to repressurize and refracture through the peak gas-generation phase. Thus, the generation of fluids can provide the means by which oil and gas are expelled from source rocks.

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#### Resource Potential and Plate-Margin Geology of Frontier Basins of North Pacific and Bering Sea

Few of Alaska's offshore frontier basins have been explored by drilling. However, regional geologic data and tectonic considerations can be used to assess the likelihood that commercial volumes of oil and gas are present in the basins.

Basins of the northern margin of the Gulf of Alaska, and the contiguous Aleutian Ridge on the west, have formed along the Aleutian subduction zone, a tectonic terrane 3,600 km long that separates the Pacific and North American plates. The eastern gulf shelf is underlain by Cenozoic deposits that are as much as 10 km thick, but adequate reservoir beds are thought to be absent in Neogene and younger beds. However, the discovery that potential reservoir and source beds of early Tertiary age underlie the continental slope enhances the oil and gas prospects of the eastern gulf margin. Basins of the central gulf shelf (Kodiak Island area) contain upper Cenozoic beds that are as much as 5 to 6 km thick. These beds are broadly deformed and unconformably overlie more deformed rocks of Paleogene and Cretaceous age. Grabens (unusual for the gulf margin) filled with 6 to 8 km of Neogene and younger beds are present beneath the western gulf shelf (Sanak Island). Publicly available data imply that reservoir and