In Canyonlands National Park, the Ceder Mesa Sandstone consists of 700 ft (213 m) of large-scale trough, cross-bedded, well-sorted sandstone. It conformably overlies 1,100 ft (335 m) of interbedded sandstone, limestone, and shale of the Elephant Canyon Formation. Sandstones of both formations, formerly interpreted as shallow marine, are here interpreted as eolian due to occurrence of: (1) subcritically climbing translatent strata produced by migrating wind ripples; (2) unimodal southeasterly dips; (3) rare vertebrate fossils and trackways; (4) gypsum sand crystal pseudomorphs; and (5) abundant calcified plant roots. In contrast, limestones, conglomeratic sandstones, and shales of the Elephant Canyon contain diverse marine body and trace fossil faunas, and dip directions are widely dispersed.

Roots occur along twelve major bedding planes in the Cedar Mesa, several of which can be traced at least 16 mi (26 km). These planes are not channeled by overlying trough cross-beds. Planes do not climb downwind and are thus unrelated to migrating bedforms. Roots also occur along the planar tops of 15 eolian sandstone bodies in the Elephant Canyon, but are there overlain by fossiliferous marine carbonates. The planes are interpreted as eolian deflation surfaces resulting from decreased sand supply to a coastal dune field. A modern analogy is the Sabkha Matti south of the Persian gulf. Colonization by plants and growth of gypsum sand crystals was followed by transgression (Elephant Canyon) or by renewal of erg conditions (Cedar Mesa). Eustatic control of both sand supply and deflation is a strong possibility.

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Basin Evolution and Present Faulting Patterns Within Isthmus of Panama Volcanic Arc

The present foundation of Panama consists of a raised block of Upper Cretaceous or older oceanic crust within a plate convergence zone. The trend of the Panamanian volcanic arc is east-west. Although broken laterally, the structural pattern from the Pacific to the Caribbean includes a subduction complex crested by a coastal range, a fore-arc basin, followed by a volcanic arc, and a back-arc fold-thrust belt and retro-arc basin along the Caribbean margin. Plate interactions have been a prime mechanism in causing trans-isthmian faulting. The present boundary between Nazca (Panama basin) and Cocos plates is the Panama fracture zone. Faulting within this fracture zone partly cuts the fore-arc basin. Due north, in the Gulf of Mosquitos, there is morphologic evidence of faulting along the continental margin. The southeastward trend of eastern Panama is contrary to the convexity, relative to the underthrusting plates, of volcanic island arcs; thus, eastern Panama should trend toward the northeast and all of eastern Panama may have rotated up to 90°, from northeast to southeast. The Darien-Atrato basin is a fore-arc basin. East-west compression in eastern Panama is suggested by fault patterns lying perpendicular to the trend of the San Blas-Darien cordillera. There, inferred faults change trend from roughly north-south in the west to northeast-southwest in the east. Extension of these faults into adjacent basins is not known. Thus, one consideration in hydrocarbon exploration in Panama is the locating of faults.

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Seismic Stratigraphic Identification of Submarine Fans—Espirito Santo Basin, Offshore Brazil

Seismic stratigraphic analysis of the Upper Cretaceous/middle Eocene sedimentary section of the Espirito Santo basin reveals two distinctive, seismic supersequences which were deposited in open-marine conditions. Several submarine fan-forming episodes are identified. The lower supersequence of Late Cretaceous to Paleocene is a sedimentary wedge onlapping a tilted Albian/Cenomanian carbonate shelf. The upper supersequence, deposited from early to middle Eocene, displays a progradational pattern. Within this thick and well-defined Tertiary section, several depositional sequences are recognized, some closely related to global relative sea level changes.

The integration of data from 16 wells with seismic lines led to the identification and mapping of several seismic features which are interpreted as turbidite fans.

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Geologic and Geophysical Study of Cerro Prieto Geothermal Field, Mexico

The Cerro Prieto geothermal field is near the southwestern margin of the Colorado River delta, Baja California. The subsurface stratigraphy at Cerro Prieto is characterized by complex vertical and lateral variations in lithofacies, which is typical of deltaic deposits. The geothermal production zone is not a uniform reservoir layer overlain by a laterally continuous top seal of low-permeability strata.

The top of the geothermal-related hydrothermal alteration zone has a dome-like configuration which cuts across the sedimentary strata. Shales in the altered zone exhibit high densities and high resistivities on the well logs relative to those outside the zone. The geothermal producing intervals generally straddle or underlie the top of the altered shale zone.

Sandstones in the hydrothermal alteration zone commonly have fair to good porosities (15 to 35% or higher), which have resulted from the removal of unstable grains and carbonate cement by solution. Open fractures are unusual in the altered zone, based on core description. While fractures may be an important contributor to local reservoir permeability, secondary matrix porosity and permeability are considered to be more important volumetrically in the Cerro Prieto reservoirs.

Detection of geothermal anomalies in the Cerro Prieto region may be difficult from resistivity, magnetic, or gravity data. However, the occurrence of a reflection-poor zone coincident with the hydrothermal alteration zone suggests that the seismic reflection method may be a good approach to detecting these anomalies. Other types of geophysical data are necessary to eliminate alternate causes of reflection-poor zones on seismic profiles.

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Subtle Traps in East China Oil-Bearing Basins

Some oil-producing basins in eastern China, such as Songliao basin, Bohai Gulf basin, and Nanyang basin are extensively explored regions. In these basins, reserves in structural traps account for 34% of the total proved plus prospective, and 21% of the total estimated; in subtle traps, 7.6% of the proved plus prospective and 38.4% of the estimated.

The eastern China oil-bearing basins belong to the intracratonic basins of Mesozoic-Cenozoic age and can be separated into two basic types based on genetic and developing characteristics: depression (Songliao basin) and faulted depression (Bohai Gulf basin).

As a symmetrical, gentle syncline, the depressional basin occurred mainly in the Early Cretaceous, forming a unified vast deep-water lake and oil-generating center. Giant deltaic sandstone bodies wedged into the source rocks, constituting a sequence of oil and gas reservoirs. The faulted depressional basin occurred mainly in the Paleogene. The basin is composed of a series of uplifts and wedge-shaped faulted depressions with certain trends. The latter is an independent oil-bearing unit, in which very thick source rocks were deposited. The occurrence and distribution of oil and gas pools are controlled by structural framework and lithofacies zones in the faulted depression.

Geologic conditions were excellent for forming various types of subtle oil and gas pools. With the high potential of oil and gas reserves in eastern China, exploration for them will become increasingly important.

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Interactive Stratigraphic Well Log and Seismic Modeling

For many years, interpreters have attempted to further analyze seismic traces by studying their character and by trying to relate waveform variations to stratigraphic changes apparent on well logs, using synthetic seismograms to simulate possible responses. Because this method relies on the comparison of shapes on complex signals, it lacks accuracy and does not go beyond an empirical evaluation. However, direct modeling through interactive well log editing becomes a matter of simple modifications to the sonic and density logs to yield a better correlation between seismic data and acoustic impedance derived from edited logs.

Geologic boundaries can be more precisely interpreted from the resulting logs, and the final model can better match the seismic line with the possibility of varying porosity, inserting new logs, or modifying the depth model and/or variation of lithology to simulate onlap, erosional surfaces, or mixed type of sedimentation. In addition, the interactive package includes such features as wavelet processing and stratigraphic deconvolution to optimize the modeling result. This method of interactive interpretation is illustrated by an example with sandy reservoirs deposited in a deltaic environment.

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Geology and Uranium Deposits of Tallahassee Creek District, Fremont County, Colorado

Following discoveries of commercial uranium deposits near Tallahassee Creek in 1955 and 1956, field studies were undertaken to investigate the general geology of the area and its relation to uranium occurrences. The Tallahassee Creek district may serve as a type locality upon which to further evaluate uranium potential in adjacent areas with similar geology.

Rocks of the Tallahassee Creek district are Precambrian, Tertiary, and Quaternary in age. The Precambrian is composed of the Pikes Peak granite and metamorphic rocks of the Idaho Springs Formation which have complicated structural relations and form the basement to the study area. Approximately 100 to 300 ft (30 to 91 m) of relief existed on the Precambrian surface before deposition of the Tertiary sediments. The basal unit of the Eocene consists of residual arkoses which are restricted to the lows of the buried Precambrian topography. Sanidine rhyolites and augite andesites overlie the arkoses and also overstep the Precambrian relief. After an erosional period, Oligocene and Miocene volcanic conglomerates with interbedded lavas and tuffs were deposited unconformably over the Eocene augite andesites and the Precambrian basement. Overlying the conglomerates, thick deposits of volcanic rock, chiefly brecciated andesite flows, pyroclastics, and rhyolites, are considered to be Oligocene-Miocene in age by superposition only. A series of parallel, northwest-trending faults, apparently reflects pre-existing zones of weakness in the Precambrian basement. Movement occurred during early Oligocene-Miocene time and again in the late Miocene or Pliocene.

Two uranium deposits occur in the volcanic conglomerates, and a third in the arkosic sediments at the base of the Tertiary. Generally, the ore deposits are lenticular bodies in paleostream channels or basins. Physical and chemical characteristics of the enclosing sediments are believed to have influenced the localization of uranium. All ore bodies are related to faults, or linear features which reflect probable faults at depth. It is believed that the uranium originated in hypogene solutions which ascended along the fault zones.

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Capping Rock and Its Formation

Calcareous shales, called capping rocks, are found in the zone immediately above the deep undercompacted and geopressured intervals in the Gulf Coast district. The capping rocks are believed to have been formed by precipitation of minerals carried in aqueous solution by compaction water moving vertically upward and/or horizontally from the geopressured intervals.

Deep sandstones, in which significant secondary porosity has been developed by leached grains and cement, could have been the prime source of such precipitating minerals. Differences of physical and chemical environments (especially pressure, temperature, water salinity, and pH) between the geopressured and normally pressured zones may have been the principal cause of mineral leaching and precipitation.

It has been suggested that the generation of CO_2 gas associated with thermal maturation of organic matter and its solution in water, causing an acidic environment (low pH), are the prime causes for leached calcite and feldspar. Woody and herbaceous organic matter, which are commonly associated with deltaic sandstone deposition, seem to have produced more CO_2 gas than algal organic matter, facilitating dissolution of calcite and feldspar grains and cement. The acidic solution, which contains these mineral ions, would have moved to shallower intervals and mixed with more normal brines, thus increasing pH. The minerals would be precipitated there.

Differences of pressure, temperature, and concentration of other ions in water between the deep and hot geopressured interval and the shallow and cool hydropressured interval may also be an additional cause for mineral precipitation at the shallow interval.