solubility at higher hydrostatic pressures owing to the weight of the overlying water column; the gas subsequently exsolved because of uplift and erosion during the Tertiary.

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Ferruginization and Phosphatization of Foraminifera in Pleistocene/Holocene Sands on Mid-Atlantic Continental Shelf

Pleistocene/Holocene sands up to several meters thick, which contain 5% to 40% phosphate grains, occur on the continental shelf of Onslow Bay, North Carolina. Altered foraminiferal specimens, 98% of which belong to the genus *Quinqueloculina,* exhibit gradational surface discoloration (white to dark yellow-brown) that progresses from late to early-formed chambers. The percentage of extensively altered specimens varies directly with phosphate concentration in the sand fraction. Microprobe analyses of polished sections from completely discolored specimens indicate that alteration involves a decrease in %CaO and concomitant enrichment in %FeO and $\%P_2O_5$. Degree of alteration diminishes from the outside to the inside of exterior-facing chamber walls (mean values are: 70 to 78 to 82% CaO; 18 to 11 to 7% FeO; 0.8 to 0.5 to 0.4% P_2O_5). Interior chamber walls are less altered (mean values are: 84% CaO, 6% FeO, 0.3% P_2O_5). On a CaO-FeO-P_2O_5 diagram the compositional changes through successive chambers of a single specimen parallel those from unaltered through altered specimens. The chemical compositions of completely discolored specimens fall on a proposed alteration trend between unaltered calcareous specimens and chamber fillings. Chamber fillings contain 0.9% CaO, 49% FeO, 12% MgO, and 1.6% P_2O_5; they are generally black. Relative concentrations of CaO-FeO-MgO plot within the compositional range of siderite and magnesite. Constant MgO values (7.5%) in altered foraminiferal tests demonstrate that initial diagenesis involves conversion to high-magnesium calcite. Subsequent alteration is largely ferruginization and minor phophatization of the test and the diagenetic materials forming within the chambers.

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Coal Beds—Source Rock and Reservoir

Coal beds are known to exist in parts of almost all major sedimentary basins in the conterminous United States from outcrop to depths in excess of 15,000 ft (4,570 m). Coal-bearing strata often exist interbedded with tight gas reservoirs, making it very difficult to differentiate the tight gas resource from the methane-from-coal beds resource. Studies of the methane-from-coal beds resource have determined that it may exceed 400 tcf. Measurements of methane in coal beds have shown that much gas generated during coalification is not currently present in the coal beds and may have escaped into stratigraphically contiguous formation which are now tight gas reservoirs.

Bituminous coals have been analyzed that contain more than 600 ft^3 of methane per ton of coal, or approximately 1 mmcf of gas per acre-foot of coal. More than 5,000 ft^3 is generated during the thermochemical alteration of peat to the low volatile bituminous-semi-anthracite boundary. Only a fifth to a third of that gas appears to be retained in the coal. The excess gas may be a source for other reservoirs.

Analysis of coal samples collected throughout the United States shows gas contents ranging from less than 25 ft^3/ton for subbituminous coals in the Powder River and San Juan basins to more than 500 ft^3/ton for coals in parts of the Green River, Raton, San Juan, and Appalachian basins. In the Powder River basin, where the coal resource is very large, even the low gas content coals have potential as producing gas reservoirs.

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Provenance and Depositional Environments of Middle Eocene Canoe Formation, Big Bend National Park, Brewster County, Texas

The middle Eocene Canoe Formation contains the first sedimentologic evidence of local volcanism in the Big Bend region. Sediments comprising the formation's lower member, the Big Yellow Sandstone, were deposited by sandy braided streams which were scoured by ancient carbonate highlands and volcanic terranes to the west. The unit represents a continuation of the depositional styles and compositional trends recorded in the Paleocene and early Eocene strata of the region. In contrast, sediments comprising the upper, unnamed member of the Canoe Formation were deposited as a volcanic sediment apron on the fringes of the newly forming Chisos Mountains volcanic center. The sandstones (feldspathic litharenites and lithic arkoses) are dominated by volcanic rock fragments and, as such, document an abrupt change in depositional style and sediment composition brought about by the onset of local volcanism.

A comparison of Canoe Formation and earlier Tertiary sediment compositions results in the delineation of distinct petrologic trends which record the tectonic evolution of the early Tertiary sediment source area. The Paleocene sediments of the area were derived primarily from ancient magmatic arcs in northeastern Mexico. With the onset of the Laramide orogeny in late Paleocene-early Eocene, a new source of sediment—newly uplifted carbonate highlands—was added. Local volcanism in the middle Eocene produced yet another source of sediment, lava flows, ash flow tuffs, and sand-size pyroclastic materials from the Chisos Mountain volcanic center. Rapid erosion of these materials produced volcanic sediment aprons such as the one described here. As regional volcanic activity increased, typical Paleocene and early Eocene depositional styles may have been completely abandoned, especially in areas proximal to the volcanic centers.

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Size Distributions of World's Largest Known Oil and Tar Accumulations

Gross volumes of oil, which must be kept in mind by resource estimators to address the volume/size framework, may be thought of in order from largest to probably smallest volumes as follows: (1) generated; (2) dissipated; (3) degraded, partially preserved; and (4) trapped and conventionally producible. Basic knowledge of these volumes may be from greatest to least in essentially reverse order.

The 332 largest known accumulations (less than 1% of the total number) account for more than three quarters of the known 8.2 trillion bbl of oil and heavy oil or tar in more than 35,000 accumulations in the world. About 2.6 trillion bbl of estimated undiscovered conventional oil added to the known volume of 8.2 trillion bbl yields a total of 10.8 trillion bbl known or reasonably estimated. Worldwide cumulative production of about 461 billion bbl of oil accounts for only 4% of the gross.

Oil in place must be estimated for conventional oil fields before comparison with heavy oil and tar accumulations. The size range of accumulations considered in the size distribution of the 332 largest known accumulations is from 0.8 to 1,850 billion bbl of oil. The smallest conventional fields in the distribution are about 1 billion bbl because the size cutoff is 0.5 billion bbl of oil recoverable. The size distribution of the 332 largest known accumulations approaches log normal and is overwhelmed by the largest 3 supergiant tar deposits which hold nearly half of the total 6,267 billion bbl.

Globally, the largest 3 accumulations, all heavy oil or tar, are in South and North America; the 2 largest conventional oil fields are in the Middle East. Prudhoe Bay and east Texas fields rank 25th and 35th respectively in descending size order.

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Sedimentology of Mudflow Deposits in Mississippi River Delta-Front Environment

Shelf deposits of the active Balize Lobe of the Mississippi River delta, are constantly displaced from their original depositional environments by a variety of deformational and mass-movement processes. Consequently, hydraulically controlled sedimentation patterns are altered in favor of sediment displacement to deeper water settings. High-resolution seismic and side-scan sonar surveys have shown that complex mudflow systems are the most important means of sediment transport from the upper and intermediate delta front to deeper shelf and upper-slope environments. With expanding exploration and production of hydrocarbons from shelf depths and deeper, it has become important to identify and understand both the surficial and subsurface characteristics of sediments associated with sea floor instabilities.

The sedimentology of mudflow deposits has been determined from