Abstracts

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Stratigraphic and Lithofacies Computer Modeling in Three Dimensions

A new computer method has been developed to create a three-dimensional lithostratigraphic model from well and seismic data. The model is constructed by interpolating and extrapolating lithofacies data in three dimensions, within a time-stratigraphic framework. Volumes as large as a sedimentary basin or as small as an oil or gas field can be accommodated. The modeling method involves rescaling of original data from a depth to a geologic time scale prior to interpolation, and inverse rescaling thereafter. Displays of the three-dimensional interpretation are in the form of structure contour maps and lithofacies maps representing any geologic time. Also serial cross sections are obtained, which show lithofacies arrangements such as layers, lenses, channels, pinch-outs, reefs, and facies variations. Volumes of all types of sediments are computed. This stratigraphic modeling technique is of interest to exploration and production geologists and geophysicists, because it provides a more complete interpretation than conventional mapping techniques.

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Bottom Boundary Layer Flow Profiling System

An autonomous profiling system is being developed to measure physical and optical properties in ocean-bottom boundary layers. System sensors will include electromagnetic current meters, temperature sensors, transmissometers, and water sample bottles affixed in a vertical array to a bottom-supported instrument frame at heights ranging from 0.25-5.00 m (1-16 ft) above its base. The instrumentation will measure high-frequency property fluctuations (5 Hz) as well as mean values. High-capacity tape recorders will permit unattended deployments for up to 3 months. Field tests will be conducted in the Gulf of Mexico.

The stress exerted by currents on the sea bottom is an important parameter in sedimentologic studies. The level of bottom stress governs the occurrence and the mode (suspension or bed load) of sediment transport. Of particular importance to the determination of bottom stress is the accurate quantification of stress components containing a vertical turbulent velocity term. Direct measurements of this and other high-frequency quantities that control the rates of erosion, deposition, and scour will provide a better understanding of sediment transport dynamics in modern environments and permit the development of rigorous criteria for interpreting ancient marine deposits.

Ocean-bottom boundary layers are characterized by high turbulence levels. An understanding of the flow dynamics thus requires a knowledge of the turbulence field. A large body of evidence indicates that suspended sediment modifies flow dynamics by changing the characteristics of both the mean and turbulence fields. An important change is the reduction in the magnitude and change in direction of the bottom stress. The profiling system will measure turbulence and suspended-sediment quantities contemporaneously. This sampling scheme will allow the determination of flow-sediment interactions and, for the first time, will provide data necessary for the validation of theoretical models of particle-laden flow.

The profiling system is a third-generation device that has an improved capability over any other existing profilers. It is the only one with the capability of evaluating the effects on currents and bottom stress of suspended sediments or temperature gradients very near the sea bed.

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Geochemical Characterization of Rocky Mountain, Northern Great Plains, and Interior Province Coals

Statistical summaries of proximate and ultimate analyses, heat of combustion, and content of 36 major, minor, and trace elements were calculated for 37 Eocene, 470 Paleocene, and 419 Cretaceous coal samples from 31 coal fields or areas in the Rocky Mountain and Northern Great Plains coal provinces and for 503 Pennsylvanian coal samples from 14 areas in the Interior coal province. These analyses show that coals within an age group have similar ranges in composition, and that each group has its own distinctive compositional characteristics. Most variability in element content can be related to changes in rank and differences in ash and total sulfur contents. Mean contents of Ca, Mg, Na, Ba, and Sr are related to rank and decrease as apparent coal rank increases from lignite A to high-volatile B bituminous coal. Mean contents of Si, Al, K, Ti, Ga, Li, Sc, Th, V, Y, and Yb increase as the mean ash content increases (correlation coefficients 0.6), suggesting that these elements are present as aluminosilicates, stable oxides, or phosphate mineral phases. Mean contents of Fe, As, Cd, Co, Cu, Mo, Ni, Pb, Sb, and Zn show high correlation with total sulfur. Contents of these elements are low in Paleocene (0.6% sulfur) and Cretaceous (0.7% sulfur) coals, higher in Eocene (1.8% sulfur) coals, and generally highest in Pennsylvanian (3.9% sulfur) coals. The mean contents of B, Be, Cr, F, Hg, Mn, Nb, Se, U and Zr show no direct relationships to changes in rank or ash and total sulfur contents. Decrease in element content with increased rank probably is related to loss of functional groups that act as cation-exchange sites on organic matter. Ash and sulfur contents are dependent on pH-controlled levels of bacterial activity in ancestral peat swamps.

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Porosity Evolution of Pennsylvanian Morrow Formation in Anadarko Basin, Oklahoma

The Anadarko basin is one of the most outstanding hydrocarbon producers in the North American continent. Examination of more than 50 cores from the Pennsylvanian Morrow sandstones reveals a complex diagenetic history. Although quartzarenite is the major lithology, shell fragments, glauconites, and clayey matrix occur in significant amounts throughout the section. This diagenetic complexity is a function of depositional environment, burial, and thermal history of the basin.

Porosity in the Morrowan sandstones throughout the Anadarko basin is chiefly secondary. Such porosity results from the dissolution of clayey matrix, carbonate fragments and cement, glauconite, and quartz grains and their overgrowth.

Evolution of secondary porosity is related directly to the generation of hydrocarbons. CO_2 gas, with concentrations ranging from 0.3 to 4.7% by volume, was detected in more than 150 natural gas wells examined in the basin. Based on geothermal and geopressure gradients, and on experimental investigations of the solubility potential of CO_2 in formation fluids under elevated temperatures and pressures, a good estimate of solubility of CO_2 in the Morrow Formation water may be attained. Because the concentration of CO_2 appears to increase with depth in the basin, secondary porosity should not be restricted to a particular zone or to particular depths, but definitely would persist with depth. Organic acids at shallow depths and H_2S in deeper zones may be important in enhancement of secondary porosity.

Amounts of porosity and the geometry of pore space are directly related to original lithology. A better understanding of lithofacies is critical in evaluating reservoir quality.

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Importance of People in Resource Assessment

Assessing the world's future undiscovered hydrocarbon resources is important and requires the thoughtful use of extensive data being assembled by large numbers of earth scientists. The soundness of the assessment depends to a significant degree on recognition of the makeup and strengths of the people involved, and how they can most properly reinforce each other in the handling of data available at any given time.