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HYDRAULIC FRACTURING—NEW DEVELOPMENTS

Several factors should be considered in determining if a stimulation treatment should be conducted. These are existing wellbore damage, formation-flow capacity, required stimulation, remaining reserves, and economics.

The objectives in hydraulic fracturing are twofold: (1) the stimulation of the formation by increasing the effective wellbore radius, and (2) the bypass of formation damage.

Once it is decided to use hydraulic fracturing, there are many factors to consider in designing the treatment. These are related to the formation characteristics, fluid type to be used in the treatment, proppant type, treatment size, and economics.

New developments in the last few years have proved successful in stimulating zones that previously were considered uneconomical or marginal. These new developments are in the area of fluids, methods of attaining greater conductivity in fractures with greater fracture lengths, and in shutting off nonproductive zones.

DAVIS, D. K., and F. ETHRIDGE

RECOGNITION OF DELTAIC ENVIRONMENTS FROM SMALL SAMPLES

No abstract available.

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PALEONTOLOGIC EVIDENCE FOR MID-MIOCENE REFRIGERATION FROM SUBSURFACE MARINE SHALE, LOUISIANA GULF COAST

The Harang facies, a regional diachronic middle Miocene shale in Louisiana, has characteristics which can be interpreted as indications of deep-water or cold-water deposition. It occurs in a seaward-thickening subsurface wedge or dark-gray to brown or black marine shales and clays with interbedded sandstones, and with a distinctive foraminiferal biofacies. The biofacies is characterized by an abundant and diversified benthonic foraminiferal fauna including huge arenaceous forms, and a small percentage of planktonic Foraminifera. *Globorotalia fohsi*, *G. mayeri*, *G. menardii*, and other planktonic species are sinistrally coiled. The change from random to predominantly sinistral coiling coincides approximately with the inception of Harang deposition (\pm 12–14 m. y. ago). The faunal assemblages indicate a muddy-water outer neritic to bathyal environment, and suggest a cool water mass. The apparent anomaly of a cold-water fauna in this stratigraphic position in this area might be explained by upwelling, paleogeographic changes, and/or significant Miocene refrigeration.

During the time span that includes Harang deposition, continental glaciation in Antarctica, cold-water invertebrate faunas, cool-climate floras, and other evidences of cool climate in many parts of the world indicate mid-Miocene refrigeration. Although some conflicting evidence also exists, we conclude that the distinctive characteristics of the Harang biofacies are related to a cool water mass which was part of a world-wide cooling phenomenon.

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WHAT HAS DEEP-SEA DRILLING PROJECT FOUND OUT ABOUT DEEP OCEANS?

The drilling vessel *Glomar Challenger* is completing 6 years of drilling at more than 300 sites in the Atlan-

tic, Pacific, and Indian Oceans, as well as the Gulf of Mexico, Caribbean Sea, Labrador Sea, Mediterranean Sea, Bering Sea, Red Sea, and Antarctic waters. Significant achievements from drilling in the deep-marine environment have been accomplished in the fields of global tectonics, micropaleontology, paleo-oceanography, chemistry of interstitial water, diagenesis, mineralogy, and sedimentology.

The oldest sediment recovered from any ocean basin is only Late Jurassic. This fact coupled with the systematic geographic distribution of the ages, constitutes powerful support for the concept of sea-floor spreading and continental drift. In addition to horizontal tectonics, the drilling has revealed areas of uplift and subsidence.

Increased core recovery allowed the study of paleoenvironments on an ocean-wide basis. A major period of stagnation occurred in the Early and Late Cretaceous in the North Atlantic and Caribbean resulting in the deposition of carbonaceous sediments. Circulation was renewed in the Late Cretaceous and aerobic conditions prevailed to the present. Bottom water circulation became increasingly vigorous causing hiatuses in sedimentation of up to 70 million years in the Cretaceous-Paleogene section. Recently completed voyages into Antarctic waters traced glaciation on Antarctica to early Miocene.

Another important application of drilling is the identification of seismic reflectors in the deep ocean sediments. The nature of these reflectors is varied but commonly includes chert, limestone layers, ash layers, basalts, unconformities, and rarely, what is believed to be a clathrate or gas hydrates.

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MAPPING HYDROCARBON CONCENTRATION AND PERMEABILITY IMPROVES EXPLOITATION OF OIL AND GAS

Commercial oil and gas production requires the presence of hydrocarbons and the ability of the reservoir to give them up.

Property value is related to the magnitude of hydrocarbon concentration and reservoir permeability. Of course, other factors, such as the relative position of a possible critical water-saturation level, well depth, and the efficiency of exploration and reservoir development, also are important.

To look for hydrocarbons, it is logical to map hydrocarbon concentration and project trends. To predict production rates from proposed wells, it is logical to map permeability from existing well data and project permeability trends. These mapping parameters are derived easily from well-log data. Such maps may bear little resemblance to isopach and structure maps of the same reservoir.

Hydrocarbon concentration and permeability mapping are vastly superior to those obtained by conventional structural and isopach mapping techniques in some places.

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ENVIRONMENTAL MANAGEMENT IN MISSISSIPPI DELTA SYSTEM

The deltaic lowlands of the Louisiana coastal zone are exceptionally high in biologic productivity. Natural beauty and a rich cultural heritage further identify the coastal lowlands as a nationally important resource. As

the origin and ecology of the region are products of deltaic processes, it can be described appropriately as a self-maintaining natural system.

Human activity has altered seriously the natural balance of the delta system. Massive environmental degradation has occurred during the past 30 years, and the entire system may soon collapse. Primary causes of deterioration include (1) flood-control and navigation improvement; (2) accelerated subsidence; (3) urban encroachment into wetlands; and (4) water pollution.

A pilot study in south-central Louisiana has reviewed the problem of restoring the system's balance and allowing for projected growth and development. A multi-use management plan based on analysis of natural and human processes operating in the area and land-use suitability has been proposed. Highways and other public-works projects provide the mechanism for directing growth and development to environmentally suitable areas. Renewable resource areas are identified, and management priorities and guidelines outlined. A water-resource management program calls for conservation of local runoff as well as directing Mississippi River water and sediment for environmental maintenance and enhancement. Controlled delta building and introduction of supplementary water into estuarine basins will partly restore the delta-system balance. Other features of the plan include identification of transportation and utilities corridors, man-made barrier islands as protection against erosion and storm surge, geometries for dredge cuts and spoil designed to create habitat diversity and optimize hydrology.

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CALCAREOUS NANNOFOSSIL STUDIES—STATE OF ART

Nannofossils commonly occur in astronomically large numbers in fine-grained marine deposits. This fact, coupled with the rapid evolution that characterizes the group and the succession of distinctive assemblages, makes them extremely useful for dating Mesozoic and Cenozoic marine strata.

Cenozoic nannofossils are best known; consequently zonation of this interval is the most satisfactory. Two recent compilations of Cenozoic nannofossil zones list 46 and 49 zones, respectively, for a time period of 65 million years. Most zones can be recognized in marine sediments of the different continents and ocean basins. Local and regional zonations are possible on a finer scale in many areas, because of the many "provincial" species present in hemipelagic sediments. However, the same "provincial" species are found in hemipelagic sediments on several continents.

Mesozoic nannofossils are less well known, although considerable work has been done on the diverse assemblages from Upper Cretaceous chalks and marls from which several hundred species have been described. Lower Cretaceous and Jurassic deposits contain appreciably less-diverse nannofossil assemblages. Several partial zonations have been proposed for the Jurassic and Cretaceous, but these are considered only preliminary and are not entirely satisfactory.

The immediate need in further nannofossil studies is for systematic studies in the Mesozoic for biostratigraphic purposes. In the Cenozoic the most profitable areas of research probably are to determine the environmental significance of the many "provincial" and hemipelagic species. In addition, much useful information can be derived from intensive studies on individual lineages such as have been undertaken with the genera *Chiasmolithus*, *Helicopontosphaera*, and *Sphenolithus*.

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RESULTS OF STUDY OF NATURAL HYDROCARBON SEEPAGE IN GULF OF MEXICO

The Department of Oceanography has been studying natural hydrocarbon seeps in the Gulf of Mexico for several years in cooperation with 11 oil companies and the Sea Grant program of the National Oceanic and Atmospheric Administration. Archaeological reports indicate that the Karankawa Indians used tar in their pottery making in pre-Columbian times; and survivors of DeSoto's group used tar found along the Texas-Louisiana coast to calk their boats. From 1902 to 1909 heavy oil slicks were noted in an area about 100 mi south of the Louisiana coast and the locations plotted on charts issued by the United States Coast and Geodetic Survey. Oil spouting into the air was reported in the same area in 1909, and oil ponds off the Sabine area were reported in a United States Geological Survey publication in 1903.

Reports of seeps in the Gulf of Mexico are numerous, and the Department's study has located several general areas of seepage within and around the Gulf. Tar samples from these areas, as well as samples found floating in the Gulf, have been collected and analyzed chemically.

The seep sites have been studied geologically and geophysically, and pertinent chemical, biological, and physical oceanographic characteristics were determined.

GLASER, PETER E.

POTENTIAL FOR SOLAR ENERGY APPLICATIONS

Future energy needs can determine the potential of solar energy applications. There are large-scale applications for energy production from wind, ocean thermal temperature differences, solar thermal power plants, and photovoltaic energy conversion. Near-term approaches, including house heating and cooling, have great potential for conserving energy. Solar heating and cooling costs will vary in different regions of the United States. Specific programs have been designed to introduce solar house heating and cooling on a substantial scale. New architectural approaches to incorporating solar heating and cooling systems have been determined.

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SCANNING ELECTRON MICROSCOPE APPLICATION TO FORMATION EVALUATION

The scanning electron microscope (SEM) can be utilized to relate rock type to pore geometry, log response, and fluid distribution in reservoir rocks. SEM photos have aided in properly evaluating other engineering and geologic data to establish production which normally might be overlooked. The alteration of sands by cementation can be documented, and original environments of deposition can be reconstructed by using the scanning electron microscope.

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PROBABILISTIC ANALYSIS OF DISTRIBUTION OF LATE PALEOCENE-EARLY EOCENE CALCAREOUS NANNOPLANKTON

Probabilistic analysis of a suite of internally consistent data on the distribution of calcareous nannofossils