depth of exploration and resolution of non-radiometric geophysical methods. The first approach is to use EM methods that have not been commonly used such as the controlled-source or natural-field audiomagnetotelluric method which can have a depth of exploration of several kilometers. The second approach is to use advanced geophysical interpretation methods to define responses from the alteration halos around the uranium mineralization. Advanced Induced Polarization surveys may detect such halos as evidenced by applications in Tertiary sedimentary basins.

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Carbonate-Sulfate Mineral Replacements in Diagenesis of Peritidal Limestone

Petrographic study of crystal textures and fabrics, both original and replacement, has revealed the postdepositional history of carbonate and sulfate minerals in the Silurian Tonolway Limestone. Crystal forms, assumed to have been gypsum originally, are locally common in supratidal facies; they occur as coarse euhedral needles, randomly oriented to bedding, and commonly in clusters. When this gypsum precipitated interstitially in the lime sediment, micrite was often incorporated into the crystals; organic matter, concentrated on side faces, may have blocked nucleation, causing the fibrous crystallization texture. As a consequence of the changing chemistry of pore fluids, a series of mineral replacements began within these crystal forms. Gypsum was first replaced by celestite, as evidenced by its pseudomorphism. The enclosing aragonite sediment inverted to calcite, and strontium was thus freed for the making of celestite. Afterwards, calcitization of the sulfates took place, i.e., each crystal was replaced by a mosaic of very finely crystalline calcite. Calcitization began around inclusions of micrite within the crystal forms. Presumably, decomposition of algal material produced carbon dioxide that was used for the calcitization reaction. Sulfate ions released by this last replacement inhibited the growth of calcite, resulting in its very fine crystallization fabric. Lastly, these calcite "pseudomorphs" were themselves partly replaced by limpid dolomite.

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Coastal Swamp Origin of San Miguel Lignite Deposit, Jackson Group, South Texas

The environments of deposition of the San Miguel lignite, a commercial quality deposit in a 4.5 by 0.3-km area in Atascosa and McMullen counties, Texas, was determined through analysis of nearly 122 m of continuous core and over 600 electric and radiation logs. The lignite is in the Jackson Group and is part of the south Texas Eocene lagoonal-coastal plain system.

The lignite is overlain and underlain by a unit of gray-green bioturbated siltstone and claystone 33.9 m thick. The lack of body fossils and abundance of root structures indicates this unit was deposited in a coastal grass-flats environment.

Below the bioturbated unit is a unit of massive green claystone 3.4 m thick, which contains abundant macroinvertebrate fossils. The fossils indicate this unit was formed in an open bay or lagoon.

Below the green claystone is a coarse, carbonaceous sandstone 3.6 m thick. Sedimentary structures and petrographic trends of this unit are analogous to those of modern back-barrier flats deposits.

The lignite interval is composed of lignite and carbonaceous clay partings of 4.2 m average thickness. The lignite interval has an overall strike-trend with local dip-trending segments. The lignite represents the accumulation of plant matter in a coastal swamp behind a lagoon. The clay partings formed during occasional flooding of the swamp by coastal streams.

Analysis of sedimentary structures, petrography, and paleontology from continuous cores is considered essential to oil and gas exploration. This study demonstrates these techniques are also important in lignite exploration.

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Anomalous Thermoluminescence Around Uranium Deposits

Radiation damage to crystal structures may be detected using thermoluminescence (TL). Quartz and feldspar grains separated from rocks that were once mineralized with uranium display an anomalous TL characterized by an increase in high-temperature TL relative to low-temperature TL. This anomalous TL may be detected by either examining the ratio of low-temperature TL to high-temperature TL or a graph of TL intensity versus temperature. One of these methods of comparison must be used to normalize the variation in the susceptibility of the samples to TL. Without this normalization, the variation in the susceptibility could mask the anomalous TL caused by mineralization. After a uranium-mineralized rock has been leached of uranium, this type of anomalous TL persists for geologically significant lengths of time. Consequently, TL may be used to identify formerly mineralized rocks. Studies of TL around uranium deposits indicate that this type of anomalous TL is present in rocks updip from migrating roll-type deposits (one in Texas and one in Wyoming), around the margins of a partly leached tabular deposit in Utah, and in leached outcrops above a vein-type deposit in Colorado.

TL may be a very practical prospecting guide; it is inexpensive, fast, and easy, requires little sample, and is a direct indicator of uranium mineralization rather than of a concomitant process. Further, Tl samples are less susceptible to contamination than other types of geochemical samples.

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Depositional Models for Fine-Grained Sediment in Western Hellenic Trench, Eastern Mediterranean

Sediments in tectonically active, topographically re-

stricted settings of the western Hellenic arc, eastern Mediterranean, consist primarily of seven clayey silt and silty clay facies. These sediment types are closely related to specific environment, time, or both.

We propose two depositional models for Hellenic arc fine-grained sediments. The first emphasizes downslope transformations from slump and debris flow, to turbidity current, to low density turbidity current or turbid layer mechanisms. The distal end-member deposits settling from low concentration flows are thick, rapidly emplaced, fine-grained uniform muds closely associated with faintly laminated muds, and were ponded in flat trench basin plains. Planktonic and terrigenous fractions in the turbiditic, finely laminated and uniform muds record mixing of materials of gravitative and suspension origin. This sequence prevails under conditions of minimal stratification of water masses, as characterized by the present Mediterranean.

A second depositional model is developed for conditions of well-developed water mass stratification, which temporarily occurred over large parts of the basin. In this example, well-laminated rather than uniform mud prevails as the end-product of low concentration flows. These more slowly deposited, very finely laminated and graded units record particle-by-particle settling from detached turbid layers concentrated along density interfaces. Well-laminated layers thus include material from turbid layers complemented by the normal "rain" of pelagic material settling through the water column. Stratification barriers resulted in region-wide distribution of such deposits, in both slope and trench environments. The applicability of both depositional schemes to other regions of the Mediterranean and to other small ocean basins can be tested.

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Forms and Associations of Pyrite in Upper Freeport Coal Bed, Homer City, Pennsylvania

Five genetically different forms of microscopic pyrite occur in samples of the upper Freeport coal obtained near Homer City, Pennsylvania. At least two facies of pyrite forms and associations can be observed throughout the study area.

The five forms of pyrite are: (1) maceral encapsulated crystals which formed in cell cavities of plants shortly after death of the plants; (2) framboids, which form early in peat accumulation; (3) maceral cell fillings, which form before compaction of the plant material and in association with calcite and kaolinite; (4) replacement of pre-macerals before compaction; and (5) cleat and fracture filling during or after compaction and the formation of cleat.

Facies of pyrite forms and associations may include the five pyrite forms in differing concentrations. Facies 1 is dominantly composed of framboids associated with vitrinite and clay; facies 2 is dominantly composed of massive pyrite that replaced vitrinite pre-macerals. Facies 1 is in the lowermost coal type, which was believed to have been deposited on previously (subaerially) exposed freshwater lime muds and argillaceous sediments.

Microscopic analyses of the pyrite forms, associations, and grain size of the iron disulfide minerals may be used as tools for estimating the washability of a coal bed before mining.

STARK, PHILIP H., and TOM DOUGHERTY, Petroleum Information Corp., Denver, CO

What's New in U.S. Industry Activity

U.S. drilling and production highlights in the first half of 1980 are reviewed, featuring recent drilling activity, important exploration plays, and significant production trends. Industry results in the 1970s are summarized to provide a basis to forecast industry trends in regard to political and economic restraints that are anticipated in the 1980s.

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Cementation of Lime-Mud and Pellet Mud Beneath Tidal Flats of Southwest Andros Island, Bahamas

Scanning electron microscopy delineates several diagenetic products currently forming beneath the prograding Holocene wedge of carbonate sediments along southwest Andros Island. Various diagenetic reactions are associated with distinct chemical pore-water environments in the affected sediments.

Pore fluids of near normal marine concentrations occur in sediments over widespread areas of the tidal flats and, in these, small amounts of non-lithifying aragonite have been precipitated at isolated locations. Meteoric water infiltrates and is stored beneath topographic high areas (hammocks), while a halo of brackish groundwater surrounds the hammocks. Non-lithifying protodolomite cement occurs in sediments saturated with brackish water beneath the hammocks and adjacent areas. An unusual Mg-calcite (7 to 8 mole % $MgCO_3$) occurs as a beachrock cement where brackish hammock-water mixes with more normal-marine (bank) water. Sediments saturated with fresh water beneath hammocks are being calcitized. Groundwater near the surface of low positive topographic areas with a high exposure index, such as flanks of hammocks, modern beach ridges, and tidal-creek levees, become hypersaline due to evaporation of capillary waters. The well-known protodolomitic crusts form in these environments. Most carbonate precipitation beneath the tidal flats is nonlithifying; some nodule formation, nodular beachrock, and, of course, the crusts of varying mineralogy are exceptions.

STONE, WILLIAM P., JR., Chevron U.S.A., Inc., New Orleans, LA

Profile of Unusual Oolite Deposit—Drum Limestone, Pennsylvanian (Missourian), Montgomery County, Kansas

The Upper Pennsylvanian (Missourian) Drum Limestone, cropping out in Montgomery County, Kansas, is characterized by a thick body of cross-bedded oolite formed by filling a paleobathymetric depression. This oolite contains abundant, well-preserved, seemingly delicate fossils, which were protected from breakage and