biologically productive eastern boundary current regimes. The differences between these regions, in terms of topography, climate, surface and subsurface water mass influence, and ecosystem productivity, are expressed in the modern sediment records.

Paleogeographic and paleo-oceanographic evidence indicates that at least some of the factors that influence modern deposition must have found similar expression in the Monterey. Perhaps workers familiar with the laminated sediment facies of the Monterey will recognize a range of stratigraphic features that are contained in the core samples collected from the modern deposits.

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Geology and Reservoir Distribution, Pinda Formation, Offshore Zaire and Southern Offshore Cabinda

The Albian-Cenomanian Pinda Formation of offshore Zaire and Cabinda is composed of mixed carbonates and siliciclastics deposited in a transgressive sequence of supratidal, intertidal, and subtidal facies. The Pinda overlies Aptian salts of the Loeme Formation and is unconformably overlain by calcareous shales of the Iabe Formation.

The supratidal sediments were probably deposited on sabkhas, in coastal playas, and by intermittent streams. Intertidal environments included offshore bars, tidal flats, tidal channels, and restricted lagoons. Shallow-water subtidal sediments accumulated on a broad, gently sloping ramp on which a few isolated shoals developed.

A series of north-northwest-trending growth faults, active during and after Pinda deposition, have affected the thickness and attitude of Pinda rocks, influenced the distribution of secondary dolomite, and created both productive and prospective structures.

Pinda reservoirs are primarily dolomites with intercrystalline, moldic and vug porosity, and sandstones with intergranular porosity. Less important are lime packstones and grainstones with interparticle porosity. Facies, dolomitization, distance from source area, and growth faulting control the occurrence and quality of Pinda reservoirs. Thicker, more prospective reservoirs exist on the eastern part of the shelf, where coarser siliciclastics accumulated closer to their source and secondary dolomitization occurred. Production rates in Pinda fields of offshore Zaire reflect the differences between reservoir characteristics in the eastern and western shelf areas.

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Integrated Stratigraphic and Seismic Approaches to Reservoir Mapping, Mibale Field, Offshore Zaire

Located on a north-northwest-trending growth fault block on the continental shelf of offshore Zaire, the Mibale field produces medium grade oil from the Cretaceous Pinda Formation and is sealed by calcareous shales of the overlying Iabe Formation. An integrated geologic-geophysical study of the field resulted in detailed characterization and mapping of the Pinda reservoir, from which locations for future development and water injection wells have been selected.

The Albian-Cenomanian carbonates and terrigenous clastics of offshore Zaire form a transgressive sequence comprised of landward thickening supratidal and intertidal deposits, and seaward thickening subtidal deposits. In the Mibale field major lithofacies are: (1) supratidal—thick-bedded sandstones and dolomites, with minor shales and anhydrites; (2) intertidal—thin-bedded shales, dolomites, and sandstones with minor anhydrites; and (3) subtidal—(a) thick-bedded dolomites and sandstones; (b) dolomites; and (c) lime wackestones to packstones containing various skeletal and non-skeletal grains.

Cores show that the sandstones and dolomites have better permeabilities than the limestones. The areal distribution of permeable reservoirs is controlled by facies configuration, growth-fault movements, and secondary dolomitization. Within a single facies, thickness variations greater than 300 ft (91 m) occur.

Because of the unpredictable thickness variations, seismic inversions (pseudo-sonic logs) were used to define the subsurface configuration of depositional and diagenetic facies across the field. Inversions were carefully calibrated to sonic logs and used for direct interpretation of lithology in areas lacking well control. Structure and gross pay maps, as well as lithologic and petrophysical characteristics of reservoir facies, enabled engineers to develop a three-dimensional simulation model of the field.

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Mineralogy and Pore Fluid Geochemistry of Great Salt Lake, Utah

Piston cores from the South Arm of Great Salt Lake, Utah, have been analyzed chemically and mineralogically. The major detrital minerals are quartz and clay minerals (illite, smectite, mixed layers, and minor kaolinite) with lesser amounts of feldspars and volcanic ash (both felsic and basaltic). Carbonate minerals include aragonite, calcite (0 to 15% $MgCO_3$), high-Mg calcite (50% $MgCO_3$), and dolomite. The carbonate minerals reflect detrital input as well as authigenic growth in the lake. Saline minerals are halite, mirabilite, and gypsum.

Pore fluids were extracted from 7 piston cores and subjected to wet chemical analyses. The major ion profiles are similar and cut time-stratigraphic units of the cores indicating little influence from primary formation waters. Instead, compositions are controlled primarily by fluctuations in lake water compositions and mineral reactions. Major ion concentrations are determined by mass transport from the lake waters and from the most soluble minerals present in the sediment. Presence or absence of halite influences Cl^- profiles, while SO_4^{2-} is largely controlled by mirabilite dissolution. Because mirabilite and halite solubilities are nearly equal in Great Salt Lake brines, Na^+ is affected by both phases. Gypsum is present; however, because of the much higher solubility of mirabilite, the effect of gypsum on SO_4^{2-} is obscured, while Ca^{2+} responds to gypsum. The effects of carbonate mineral reactions are not apparent in the Ca^{2+} profiles. Because of the relatively small carbonate alkalinity with respect to other weak bases, reactions involving carbonate minerals are difficult to identify.

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Late Pleistocene and Holocene Sedimentary History of Great Salt Lake, Utah

Piston cores to 6 m in length from the South Arm of Great Salt Lake, Utah, have been correlated. Radiocarbon ages indicate a record greater than 30,000 y.b.p. Sediments are divided into 4 units (I to IV, top to bottom). Units I, II, and IV contain laminated mud and pelleted mud with brine shrimp egg capsules; III consists of disrupted (bioturbated) sediment containing two ostracod assemblages.

The position of a volcanic ash (Mt. Mazama, Oregon, ~7,000 y.b.p.) has been traced across eleven cores. Aligned pellets and ooids are deposited at the lake margins as parallel flat laminae or thin beds; basinward flaser laminae are present and toward the center disrupted intervals occur. A similar variation is seen in the surface sediment today. The aligned pellets and ooids are interpreted as shallow ($<\sim 5$ m) nearshore current deposits, the flaser laminae as wave-worked deposits, and the disruption is attributed to intrasediment salt growth. Lateral and vertical variations indicate that Unit I sediments have been deposited under relatively shallow (<25 m) saline conditions. The fine laminae of Unit II sediments are wavy and discontinuous. Toward the basin edge carbonate crusts are present. Reworked clasts of soft sediment are evidence that the sediments were bound, while clasts and scours indicate current activity. Unit III sediments are disrupted (bioturbated) with short intervals of primary layering. The ostracod assemblages have wide salinity and depth tolerances, but indicate a deeper fresher lake. Unit IV contains fine parallel flat, wavy and lenticular laminae and is interpreted as a shallow, saline subfacies.

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Stacked Log Curves: Aid to Multiple Well Exploration Studies

Stacked Log Curves is a graphic display of equivalent log traces from multiple wells, drawn side by side. The Stacked Curve System utilizes digital log data residing in the user's data base. The log traces can be plotted at regular intervals or spaced according to the geographic location of the wells. Interactive graphics technology is the ideal vehicle for this application.

The uses of Stacked Log Curves range from quality control to exploration. Typical data problems easily detected by this display are improper digitizing scales, misidentified curves, and data gaps. Simple statistical and mathematical functions may be applied to the curves, permitting computation of zero shift and sensitivity correction factors. These values are used for curve normalization to compensate for differences in logging tools and borehole environments.

Varying the spacing between wells will produce displays ranging from a geologic cross section to a pseudo seismic section. Markers can be picked, corrected, and displayed for all wells, thus assuring accuracy in tracing horizons across long distances. By plotting computed curves such as porosity and lithology percentages, porosity pinch-outs and facies variations can be recognized. Overlaying Stacked Log Curves of appropriate traces can single out zones of interest. After converting from depth to a time scale, these plots can be directly compared with the seismic section.

The raw log data, the corrected and normalized log data, and the marker picks are stored in the computer for further analysis and mapping.

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Geochemistry of Gaseous Hydrocarbons Adsorbed in Shallow Sediments Offshore Santa Barbara, California

An offshore geochemical surface survey was conducted west of Santa Barbara, California. Two hundred sediment samples were taken in an area of approximately 400 sq km. The samples were degassed and the gases analyzed by gas chromatography and isotope mass spectrometry. GC-MS techniques were applied to the extracts of several samples to look for C_{28} and C_{29} steranes. In addition, grain size determinations and fluorescence analyses were carried out on selected samples. The analytical results, mainly the $^{13}C/^{12}C$ ratios of the methane, allow discrimination between (1) an area of exclusively bacterial methane and (2) an area where thermogenic (petroleum-related) hydrocarbons are present.

The area of biogenic gases is characterized by isotopically light methane in the range of $\delta^{13}C_1 = 90$ ppt. High methane yields occur up to 50,000 ppb.

The area of thermogenic gases is characterized by $\delta^{13}C_1$-values in the range of -44 ppt which correspond to methane originating from predominantly marine source rocks (type II kerogen) within the oil window. The methane yields are approximately 200 ppb. Three oil fields, not yet in production, are situated within the area exhibiting the shallow, thermogenic methane. This observation supports the conclusion that hydrocarbons can migrate to the surface from deeper source rocks or from deep gas and oil reservoirs where they can be identified by isotope geochemistry. The application of this methodology to the field of hydrocarbon exploration is obvious.

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"Mud-Line": Modeling its Position Relative to Shelf Break

The "mud-line," the depth of substantially increased silt and clay content commonly occurs near, but is only rarely coincident with, the shelf-to-slope transition. An evaluation of the mud-line off the United States East Coast and northern Gulf of Mexico highlights discrepancies between depth and position of this horizon and those of the shelf break. (1) Off Cape Hatteras and parts of the West Florida Shelf, off-shelf spillover of sand-size material results in a mud-line position well below the shelf break. Spillover at Cape Hatteras is a response to the powerful northeast flow of the Gulf Stream that tangentially crosses the shallow, narrow shelf. (2) The shallower depth of the mud-line off the Mid-Atlantic states between Norfolk and Wilmington canyons, and off the Panama City, Florida, margin identifies the long-term signature of energy concentrated on the sea floor; erosion results from the interplay of several mechanisms, including fronts, storm waves, tides, and breaking internal waves. The mud-line at these localities thus defines the position where, over time, shear-induced resuspension has largely exceeded the threshold of sediment transport. (3) The near-coincidence of the mud-line with the shelf break at the head of Hudson Canyon is a response to physical oceanographic parameters and to off-shelf spillover; involved are the intersection of density fronts separating shelf and slope waters, and the channelizing effect of the canyon head cut deeply into the outermost shelf. (4) Considerable shallowing of the mud-line and a marked departure between this level and the shelf break occur on margins where large amounts of sediment are supplied. Large asymmetric shoreward swings of the mud-line on the Gulf of Mex-