Key and Missouri Key. The top of the crust has been dated at approximately 400 years B.P., indicating very recent cementation in the littoral zone of these areas.

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Morphology, Sedimentology, and Genesis of Three Large Submarine Canyons Adjacent to Navarin Basin, Bering Sea

Three large submarine canyons cut deeply into the Bering Sea margin adjacent to the Navarin basin, a prospective petroleum province scheduled for leasing in 1984. These canyons, Navarinsky, Pervenets, and Zhemchug, head in water shallower than 150 m, extend seaward as far as 230 km, and debouch onto extensive deep-sea fans at depths of 3,200 m. The three canyons are incised as deeply as 2,400 m into Neogene and older more lithified Paleogene rocks that make up much of Navarin basin. These canyons are apparently controlled by structures dating back to the Paleogene. Major cutting of the canyons probably occurred when lowered sea levels exposed the Bering shelf and allowed such large rivers as the Yukon to carry large amounts of sediment to the outer shelf. Slumping and the resulting turbidity currents are the most likely canyon-cutting processes. Seismic-reflection profiles across and down the canyons indicate that numerous slumps and well-developed cut-and-fill structures are present throughout the canyon systems. The large width of the modern Bering Sea shelf may have resulted in low rates of sediment accumulation on the outer shelf during present highstands of sea level. However, the presence of a few graded sand layers in 2 to 5-m cores recovered from the canyons and their fans suggest at least some occasional ongoing turbidity-current activity in these canyons. Extensive fields of sand waves have recently been discovered at the heads of all three canyons. Preliminary interpretations of geophysical data indicate that these sand waves are relict features that formed at times of lower sea level during glacial episodes.

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Sidescan Sonar Depiction of Slump Features Associated with Diapirism on Continental Slope Off Southeastern United States

A newly developed mid-range sidescan sonar system having a range of 2.5 km/side was used in conjunction with long-range, GLORIA II, sonographs (maximum range 22 km/side) and high-resolution seismic profiles to map parts of the continental slope and upper continental rise between Cape Hatteras and the Blake Spur, off southeastern United States. A 60-m-high scarp that traverses the slope to encircle a near-surface diapir complex was identified from seismic-reflection records and traced laterally for approximately 30 km by using GLORIA II data. More detailed mid-range sidescan sonographs of the area show detached-block slide paths cut into the sea floor, which have scarps 15 to 20 m high and areal extents of at least 3 to 5 sq km. These slide blocks appear to originate at the scarp face and extend downslope to lobate deposits of apparent sediment debris, or to areas beyond our data coverage. Such features as overlapping slide paths and minor sediment failures on the scarp face revealed in the images indicate the relative chronology of events. The position of the scarp relative to the near-surface diapir complex, and its presence on an otherwise featureless and gently sloping segment of the continental slope, suggests that the scarp was created during the formation of the diapir complex, when withdrawal of salt at depth led to local oversteepening of the slope surface and consequent failure by slumping and surficial slides.

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Ubarana Oil Field, Offshore Brazil: Case History

Ubarana is the first commercial oil field on the northern continental shelf of Brazil. Discovery well 1-RNS-3, drilled in 1973, was located on a seismic structural high in the offshore extension of the Potiguar basin, about 13 km from the coast and 160 km northwest of Natal. The well penetrated oil-bearing, fluvio-deltaic sandstones of the Cretaceous Acu Formtion. Five outpost wells, also located on the mapping of seismic horizons adjacent to the producing interval, helped to extend the limits of the accumulation. A total of 1.4 million cu m of oil has been produced between 1976 and October 1980.

The surface area of Ubarana field is about 35 sq km with oil-bearing reservoirs at an average depth of about 2,400 m. Permeability and porosity of the sandstones are generally poor. Pressure is normal and the main production mechanism is solution gas-drive. The volume of oil in place is about 37 million cu m; estimated recovery factor is 29%. There are presently four platforms in the Ubarana field active in drilling and production with 32 producing wells, and 14 locations to be drilled. Ubarana is not yet fully delimited because a recently drilled well, 3-UB-25, has shown that the field extends southward. This has resulted in selection of four additional production platforms which will allow drilling another 48 wells for production.

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Petrofacies and Depositional Environments of Upper Jurassic Naknek Formation, Lower Cook Inlet, Alaska

More than 3,000 m of conglomerate, sandstone, and siltstone were deposited in fluvial, shelf, slope, and basin-floor environments in an Upper Jurassic fore-arc basin on the Alaska Peninsula. Distance from uplands to basin floor was short and sediment supply locally concentrated, resulting in narrow facies belts and abrupt facies changes. Three successively younger depositional packages are exposed from north to south: (1) deep-water proximal turbidites from the Iniskin-Tuxedni area to Contact Point; (2) nonmarine sandstones northwest of Akumwarvik Bay; and (3) shallow-shelf sandstones east of Akumwarvik Bay.

Three distinctive and successively younger sandstone petrofacies are recognized from north to south, but these petrofacies do not correlate exactly with the three depositional packages. (1) Naknek sandstones in the Iniskin-Tuxedni area contain abundant plagioclase (typically replaced by zeolites), volcanic rock fragments, reddish hornblende, with a notable lack of quartz and K-feldspar. (2) Naknek sandstones south of Iniskin Peninsula and north of Akumwarvik Bay contain quartz, K-feldspar, and metamorphic rock fragments, with a decrease in volcanic rock fragments. (3) Naknek sandstones east of Akumwarvik Bay have more quartz, K-feldspar, and metamorphic rock fragments than older Naknek sandstones and are better sorted and rounded due to abrasion on a shallow shelf.

Depositional environments did not control sandstone composition. Distinctive Naknek petrofacies are due to (1) erosion of Lower Jurassic volcanics followed by unroofing of Lower to Middle Jurassic diorite and granodiorite plutons; and (2) variations of provenance in separate drainage basins through time.

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Reservoir Quality of Sandstones Influenced by Mineralogy and Texture: Example of Brazilian Offshore Basins

Lower Cretaceous sandstones in four basins off Brazil illustrate that reservoir quality is controlled by diagenetic events that were pre-programmed by (1) detrital mineralogy, (2) grain size, and (3) sorting.

The northeasternmost basin (Cassipore) received volcanic-rock detritus. At depths less than 3,000 m all pores in these lacustrine turbidite sands were cemented by pervasive corrensite and local laumontite. Secondary porosity is trivial.

Five hundred km to the southeast, the Ilha de Santana basin received granitic and reworked red-bed detritus. Samples from fluvial and lacustrine turbidite sandstones between 1,500 and 2,800 m show that sands lost porosity by cementation by patchy calcite, minor quartz, and pervasive mixed-layer clays. Modest secondary porosity developed by dissolution of calcite and clay cements, and detrital plagioclase.

Five hundred km farther to the southeast, the Ceara and Potiguar basins received granitic detritus and minor metamorphic-rock debris. Lacustrine deltaic deposits of the Ceara were sampled between 1,500 and 2,700 m and fluvial deposits of the Potiguar between 1,600 and 2,500 m. Except for the presence of kaolinite beneath an unconformity in the Ceara basin, the basins had a similar history. Porosity was lost successively by precipitation of clay coatings, quartz and calcite cement, and by compaction. Good secondary porosity developed by dissolution of calcite and plagioclase, but much porosity was lost subsequently by precipitation of mixed-layer clays derived from reaction of pore fluids with feldspars.

The best secondary porosity developed in the coarser and better sorted sandstones. Coarser sandstones (1) had more calcite cement that yielded clean secondary-pores and (2) have larger pore throats that were affected less by clay cement. Fine sandstones (1) have more ductile micas and rock fragments that compacted and plugged pores and (2) have smaller pore throats that were strongly affected by clay cement.

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Vibroseis System: a High-Frequency Tool

Exploration methods are extended to their limits as the search for energy resources continues. Successful application of high-frequency seismic methods requires evaluating each element in the seismic data acquisition system and assuring that each part of the system contributes to the success of the method. This extends from seismic signal generation through data processing where good equipment performance and correct parameter selection are required.

The Vibroseis system depends upon the ability of vibrators to generate synchronous, repeatable sweeps over the frequency range of interest. Many considerations are used in building a vibrator. Typical baseplate responses show excellent drive levels at the design goal of 200 Hz. With an excellent source available, correct application is essential to assure retention of high-frequency data. Recording offsets, array lengths, and array sampling must be selected for the sweep frequencies used. Also, approximate matching of the data acquisition system response to the spectral response of the earth reduces the dynamic range requirements for recording systems and subsequent data processing. Data are included to show the successful application of high-frequency techniques to stratigraphic exploration problems.

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Geometry and Facies of Latest Cretaceous Deltaic and Submarine Fan Systems, Southern Sacramento and Northern San Joaquin Basins, California

Regional cross sections and net-sand isopach maps depict the geometry and genetic relations of Maestrichtian deltaic and submarine fan depositional systems in the southern Sacramento and northern San Joaquin basins. The six Starkey sands are multilobed cuspate to lobate deltas with east-west or northeast-southwest axes and apices near Sacramento and Stockton. The overlying sand ("Bunker," "3rd Massive," etc) in the Sacramento Valley is an elongate delta with north-south axes and multiple apices. Submarine fans (lower and upper Winters, Tracy, Blewett, and Azevedo sands) are elongate northwest-southeast, parallel to the basin axis. Most fan shapes are distorted owing to onlap on basin slopes or the cross-valley sill termed the Stockton Arch, but less confined fans show the expected fan shape.

Initially the slope was fault controlled, but the deltas prograded the slope, constricting the basin. Five deltas overtook the prograding slope and fed sand over the shelf edge or through shallow slope channels to the fans. Deltas were abandoned during cyclic sea level rises; during the succeeding progradations, mud was swept out of the deltas and draped over the slope and previous fan. Thus, five cycles of delta progradation, fan growth, delta retreat, and fan abandonment are preserved. As the basin filled and water depth decreased, deltas became larger and fans grew smaller.

Local cross sections show facies relations and lithologies. Cuspate deltas consist mainly of coarsening-upward prodelta mud-delta front/shoreface sand. Elongate deltas are largely delta-plain marsh and channel facies. Fans are mainly thick-bedded (amalgamated) massive to fining-upward sand; bed thickness and grain size decrease in a narrow periphery where fans onlap basin slopes or grade to basin-plain shale. Gas is produced from both suprafans and fan margins.

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Clay Fabric—New Aspect of Clay Petrology

Geologists have long been interested in the fabric of clastic sediments and their use in the reconstruction of current direction. However, study of the fabric of argillaceous sediments has not been extensive due to their extremely fine texture and complex composition.

With advanced technology and instrumentation, particularly transmission electron microscopy (TEM) and scanning electron microscopy (SEM), a new era of clay petrology has arrived. The superior resolution, wide range of magnification, very