preferentially preserved in finer grained and muddy layers. However, even in some muddy sandstones, rock fragments, feldspars, and matrix were dissolved, creating secondary porosity.

The probable paragenetic sequence of major diagenetic events was: (1) hematite-clay coatings (red-bed units only); (2) quartz-overgrowth; (3) local clay, carbonate, and sulfate cementation; (4) compaction (ductile grains deformed); (5) leaching of non-quartz grains, cement, and matrix; (6) crystallization of authigenic kaolinite and minor illite and halloysite in some secondary pores; (8) minor dolomite cementation and replacement. Hydrocarbons migrated after kaolinite had partly occluded some pores. The products of diagenesis vary according to original composition, porosity, and permeability.

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Provenance of Middle Tertiary Nonmarine Deposits, Santa Maria Basin and Vicinity, California

Rocks of the middle Tertiary (mostly Oligocene) Sespe and Lospe Formations crop out in the Santa Maria basin and vicinity. Lithofacies are typical of alluvial fan/plain deposits: clast- and matrix-supported conglomerates interbedded with planar to crossbedded sandstones are commonly overlain by sandstone-shale sequences.

Although Lospe deposits near San Simeon, in northwestern San Luis Obispo County, and at Point Sal, near Santa Maria in Santa Barbara County, are presently more than 90 km apart on opposite sides of the San Simeon-Hosgri fault zone, they were derived from the same western source consisting partly of silica-carbonate rock and ophiolite terranes. Proximal fan lithofacies near San Simeon and medial to distal facies at Point Sal indicate an easterly draining system in which San Simeon was closer to the source. Point Sal sandstone clasts containing more than 5% detrital potassium-feldspar were probably derived from an Upper Cretaceous-Paleogene sedimentary terrane to the southwest.

The middle Tertiary paleogeology of the Santa Maria basin was dominated by an easterly draining, aggrading alluvial fan complex near Point Sal. Displacement along a proto-Hosgri fault probably initially uplifted the highlands west of the fan complex. Lospe alluvial deposition at Point Sal was separate from Sespe-Lospe deposition to the south, southeast and north, with the possible exception of an area 3 km northeast of Santa Maria.

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Sedimentation on Antarctic Sea Floor

The most common sediment type cored on the continental shelf is relict diamicton. Sediments were deposited by grounded ice (basal tills) through lodgement processes or from floating ice. The seaward limit of basal tills is the shelf edge. Glacial marine sediments derived from floating ice are probably deposited near the grounding line of ice shelves. Several criteria distinguish basal tills from glacial marine sediments.

Sedimentation on exposed Antarctic continental shelf is predominantly marine rather than glacial. Antarctica generally lacks a wave dominated coastal zone and the continental shelf is unusually deep (average 500 m). Therefore, waves and wind-generated currents have little influence on bottom sediments. Tidal and thermohaline currents are apparently too weak to erode the cohesive basal tills and glacial marine sediments. Mass-flow processes are the important factors in shelf sedimentation today. Turbidites, consisting of well sorted quartz sands, are widespread on the continental margin and abyssal floor. These sands are commonly interbedded with poorly sorted glacial marine sediments. Calcareous turbidites have also been cored in the Ross Sea. Laminated siliceous oozes, which are almost devoid of ice-rafted debris, fill many shelf depressions.

At the shelf edge and upper slope, geostrophic currents erode the bottom and transport sands by traction, while silts and clays are suspended and transported parallel to the slope. These currents are disrupted only in areas where shelf waters are sufficiently dense to displace and mix with circumpolar waters (thermohaline mixing). This mixed bottom water flows downslope at velocities of only a few centimeters per second, depositing laminated silts along the flow path. Ice-rafting diminishes sharply seaward of the present ice front, and ice-rafted debris comprises a minor component of slope and rise deposits.

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Seismic Investigation of Gas Hydrate Reflectors, Blake Outer Ridge Area Off Southeastern United States

Gas hydrates are known to exist at several deep ocean-floor locations across the continental margin of the eastern United States. Hydrates are stable in sediments having sufficient gas saturations at suitable pressures and temperatures. These conditions usually confine the hydrate to the uppermost few hundred meters of sediment below the sea floor. At greater depths and increased temperatures, free gas occurs and is probably trapped by the overlying hydrate zone. The transition boundary between the hydrate zone and free-gas zone is a relatively large impedance contrast to seismic sound waves and, hence, produced a high-amplitude reflection on multichannel seismic data.

Regional multichannel seismic reflection profiles have been collected by the U.S. Geological Survey along the continental shelf from Cape Hatteras to the Blake Outer Ridge area. These profiles reveal several major and several minor seismic-amplitude anomalies that parallel the sea floor. Depth maps of the high-amplitude reflections were constructed to determine whether free gas is trapped by an impermeable gas hydrate layer, or by local structural or stratigraphic traps. In some places, derivation of interval velocities has produced abnormally low velocities for the free gas layer. Investigation of the high-amplitude reflectors shows that they are not distinct, but consist of several interfering phases which complicate the selection of correct velocities.

Two-dimensional seismic modeling was used as an aid for determining the proper velocity estimating technique. Depth maps of the high amplitude reflections demonstrate the distribution of these anomalous features and strongly suggest the formation of gas hydrates.

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Resolution, Bandwidth, and Money

Our preoccupation with big structure is over. Today the geophysicist and geologist, together, must establish small-scale stratigraphy and faulting, delineate the limits of reservoirs, and compute rock properties. Critical to these efforts is resolu-