tonic style of sedimentation occurred in the middle Berriasian from arc-derived to basement-derived sediment. These changes are ascribed to a decrease in the angle of subduction, which caused a cessation of volcanism and widespread uplift of basement rocks. Sedimentation and subsidence continued only along the frontal-arc and rear-arc due to thermally induced subsidence. Away from the arc, sedimentation was initiated diachronously after regional unconformity, and subsidence was mainly controlled by the rate of sedimentation.

Two subparallel metamorphic belts were the main source terranes for the Morro Solar Group, which was deposited in a tectonically quiescent basin. The Brazilian shield furnished sediment only to the foreland basin. A complex distribution of source terranes gave rise to nonsystematic distribution of environments along and across the Andes. Fluviodeltaic and shallow-marine peritidal sedimentation characterizes most of the lowermost Cretaceous strata in the Peruvian Andes.

In the Lima basin, the Morro Solar Group consists of quartz-rich sandstone, shale, and minor micritic limestone beds. Sandstones are highly mature and exhibit cross-bedding that suggests paleosediment transport to the southeast. Shale units are thinly laminated and contain minor interbedded siltstone. Vertical facies variation suggests progradation of a braided system toward a broad intertidal zone prior to encroachment of the late Valanginian sea.

Lower Neocomian siliciclastic sedimentation in the Peruvian Andes is consistent with earlier facies developed in the initial stages of fore-arc evolution prior to the emplacement and localization of the volcanic arc. Continuous Mesozoic continental erosion not only accounts for the lack of an accretionary wedge, but also for the landward migration of the trench and uplifting of metamorphic cores. These processes resulted in a shortening of the fore-arc basin.

ALLEN, G. P., D. LAURIER, and J. P. THOUVENIN, Total–Compagnie Francaise des Petroles, Talence, France

Modern Mahakam Delta, Indonesia: Sand Distribution and Geometry in Mixed Tide and Fluvial Delta

A core study was made of a mixed, tide and fluvial, low-wave delta formed in the humid tropics. Little subsurface data were previously available for this type of delta, in which morphology and sediment distribution reflect both fluvial and tidal characteristics.

The delta plain is a tidal marsh, with bioturbated organic clays, incised by separate networks of distributary and tidal channels. In contrast to the mud-filled meandering tidal channels, distributaries are linear and filled with sand accumulating as lateral accretion bars. Distributaries form narrow ribbons of channel-fill sands of variable thickness (5 to 11 m), eroded or superimposed onto underlying delta front clays and sands. Facies and vertical sequences are fluvial, erosive based and fining-up in the upper delta plain, and tidal and coarsening-up in the lower delta plain. The lack of fluvial levees and splays reflects the tidal influence in the distributaries.

On the delta front, sand occurs as numerous bars, forming a spectrum of distinct types which reflect the local river-tide ratio. Major distributaries form thick (7 m) localized arcuate mouth bars, while off smaller distributaries, triangular middle ground bars occur, forming more sheet-like, thinner sand bodies. In areas of low river input, tidal ridges predominate. The bars are separated by organic clay, but lateral coalescence and stacking can locally increase sand continuity. Sequences are coarsening-up, and facies show tidal and marine characteristics. A general seaward bar thickening exists owing to the more distal position of the thicker arcuate bars; this results in a vertical bar thinning-up progradational sequence.

Seaward of the delta front bars, prodelta sediments composed of massive clays form the base of a 50-m thick regressive sequence composed of multiple bar deposits, followed and incised by sandy distributary fills. Sedimentation rates range between 0.2 and 1.3 cm per year^{-1}.

ALLMENDINGER, R. W., J. A. BREWER, L. D. BROWN, et al, Cornell Univ., Ithaca, NY

Structural Control of Rocky Mountain Front: COCORP Profiles Across Laramie Mountains

The Rocky Mountain Front forms the eastern edge of the North American Cordillera and represents significant Laramide deformation of the continental basement 1,500 km from the nearest coeval plate margin. COCORP deep seismic profiles were recorded across the northern part of the front to investigate its structure and the influence of the Archean-Proterozoic crustal boundary, expressed in the nearby Medicine Bow Mountains as the Nash Fork–Mullen Creek (NFMC) shear zone.

Four COCORP profiles totaling 180 km transect the Denver basin, Laramie Mountains, and Laramie basin. West-dipping (20°) reflections beneath the mountains truncate basement events and project to key frontal faults, suggesting that the northern front has a structure of shallow, en echelon basement thrusts. A steep northwest dip for the NFMC shear zone is indicated by equivocal truncations and diffractions in basement beneath the east edge of the Laramie basin. Alternatively, a band of events with apparent southward dip under the mountains may be sideswiped from the shear zone, which, together with a predominant southeast-dipping seismic basement fabric, suggests a moderately steep southeast-dipping shear zone. The second interpretation is favored. Continuous reflections at 15.5 to 17.0 sec east of the mountains may indicate a Moho depth of 48 km, while the deepest events on other lines are shallower (11 to 13 sec).

Thus, COCORP profiling and nearby refraction surveys suggest crustal thinning to the northwest across the Archean-Proterozoic boundary which also controlled the segmentation of the northern Rocky Mountain front. On a regional scale, crustal thinning may be partly responsible for the greater diversity of the Laramide in Wyoming.

AL-SHAIEB, ZUHAIR, Oklahoma State Univ., Stillwater, OK, WILLIAM C. WARD, Univ. New Orleans, New Orleans, LA, and JOHN W. SHELTON, ERICO, Tulsa, OK

Diagenesis and Secondary Porosity Evolution of Sarir Sandstone, Southeastern Sirte Basin, Libya

Virtually all porosity is of secondary origin in the productive Lower Cretaceous Sarir Sandstones of the Calanscio area in the southeastern Sirte basin, Libya, where production is obtained from depths of about 8,000 to 13,000 ft (2,438 to 3,962 m). Principal reservoirs are fluvial sandstones now composed predominantly of quartz, but originally composed of up to 25% mud intraclasts, rock fragments, feldspars, and mica. Even though most of the original porosity was destroyed by compaction and cementation, deep-burial leaching of the non-quartz constituents created considerable porosity. Average porosity is 13%; the maximum is 31%. Most secondary pores are oversized molds of dissolved non-quartz grains. Skeletal feldspars and ragged metamorphic rock fragments are preserved in some layers. Commonly, feldspar and rock fragments are 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.

ANDERSON, DONNA S., Univ. California, Los Angeles, CA

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.

ANDERSON, JOHN B., EUGENE DOMACK, ROBYN WRIGHT, et al, Rice Univ., Houston, TX

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.

ANDERSON, ROBERT C., RICHARD A. WISE, and WILLIAM P. DILLON*, U.S. Geol. Survey, Denver, CO

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.

ANSTEY, N. A., Boston, MA

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-