great depth of field, stereo, and x-ray analysis capability affored by TEM and SEM, enable us to examine the individual clay particles by the use of ultra-thin sections (TEM), to observe the particle surface and its three dimensional structure (SEM), and to determine the clays' chemical composition.

Clay fabric from various environments, such as shallow-marine deltas, deep ocean trenches, and laboratory consolidated samples have been investigated. Clay fabric study of these sediment reveals a good correlation with their physical properties as well as depositional history. Thus, combined information of clay fabric analyses, geotechnical properties, and mineralogic data will not only be useful in reflecting different conditions of sedimentation, but will also be beneficial in depicting postdepositional history. It is the time to develop the new science of clay fabric analysis, and hope that our understanding of argillaceous sediments can be further improved by these new analytical approaches.

CLARK, DAVID L., Univ. Wisconsin, Madison, WI

Icebergs and Glacial-Marine Sediment of Central Arctic Ocean

Mechanism of one variety of glacial-marine sediment transportation and deposition is inferred from observation of the activity of ice island T-3. This iceberg carries a significant sediment load. As T-3 moves with the Arctic pack ice, several meters of ice melt annually, releasing sediment to the ocean floor. The sediment accumulates at rates measured in a few mm per 1,000 years but in remarkably homogeneous layers. This uniform sedimentation in a seemingly heterogeneous environment is unexpected. The uniformity results from clockwise rotation of the pack ice that transports T-3–sized icebergs at rates up to several km/day in constant patterns. T-3 currently is in at least its third traverse of the Amerasian Basin during the past 30 years. The consistent Arctic surface currents have brought T-3 over the same areas during the different cycles.

There has been little change in central Arctic sedimentation since at least the late Miocene. Late Cenozoic layers of glacial-marine sediment on the Alpha Cordillera have been organized into thirteen lithostratigraphic units. Even thin units can be correlated over several hundred thousand square kilometers. A textural classification of Arctic glacial-marine sediment recognized four classes, all forming since the late Miocene in the Alpha Cordillera region.

Quantities of glacial ice, bearing sediment derived from similar source areas and transported in similar patterns by constant ocean basin currents, account for the uniform glacial-marine sediment in the Arctic Ocean.

CLUFF, ROBERT M., Illinois State Geol. Survey, Champaign, IL

Depositional Environments and Diagenesis of Salem Limestone (Middle Mississippian) Reservoirs in Southern Illinois

The 1972 discovery of oil in the Salem Limestone (Valmeyeran Series) in Wayne County, Illinois, stimulated a resurgence of Salem and deeper exploration that continues to dominate Illinois basin activity.

Lower parts of the porous pay intervals in the Salem reservoirs are cross-bedded, oolitic grainstones and packstones, grading upward into highly bioturbated, mixed oolitic-skeletal grainstones. Hardground surfaces and fenestral vugs filled by anhydrite and sparry calcite are common in the uppermost parts of the pay zones. The reservoirs are capped by fine-grained, dolomitic, and argillaceous peloidal packstones and wackestones. Although most Salem reservoirs discovered occur at or near the crests of plunging anticlines, there commonly is no apparent structural closure over the pool, and the updip entrapment is entirely stratigraphic owing to thinning of the porous oolitic facies and thickening of the overlying packstone-wackestone facies. These variations in thickness probably reflect relict topography across oolite shoals.

Porosity and permeability in the Salem are closely related to depositional facies. Most Salem porosity is primary—depositional interparticle and intraparticle spaces, subsequently reduced in volume by pressure solution and cementation. Cementation of Salem grainstones was strongly influenced by the availability of suitable particle surfaces for nucleation of cement crystals. Sparry calcite cement is common on clean crystalline substrates (fossil fragments, especially monocrystalline echinoderms) and is rare on microcrystalline substrates (micritized fossils, peloids, oolites). Highest porosity and permeability occur in rocks with high percentages of oolitic coatings and micritized grains—most notably the oolitic grainstone facies.

COBB, ROBERT C., Sohio Petroleum Co., Dallas, TX, and STEPHEN POTH, Marathon Oil Co., Anchorage, AK

Superposed Laramide and Basin-and-Range Deformation in Santiago and Northern Del Carmen Mountains, Trans-Pecos Texas

Persimmon Gap, the northeast entrance to Big Bend National Park, lies astride a reverse-faulted monocline of a northwest-trending segment of the Santiago Mountains. Preserved Cretaceous rocks, about 762 m of Comanchean, and an incomplete section of Gulfian, consist of limestone, marl, and sandstone. Slip reversal, between Laramide and basin-and-range deformation using part of the Santiago thrust, is well-displayed in this range.

Laramide deformation produced the southwest-facing, N58°W-trending, reverse-faulted monocline of the Santiago Mountains. Structural relief across this faulted monocline is about 914 m. On the upthrown side, northeast of the Santiagos, are en echelon folds that suggest a left-lateral component of movement along the fault. The northwest end of this segment turns north where it becomes an unfaulted monocline with about 762 m of structural relief. To the southeast, structures in the Santiagos turn south and the monocline is unfaulted, with structural relief being about 762 m. The transition southward from the narrow northwest-trending Santiagos to the relatively broad, asymmetric anticlines with faulted limbs of the northern Sierra del Carmen involves both Laramide and basin-and-range episodes of deformation.

Basin-and-range deformation has reactivated the steeply-dipping Laramide fault planes and displacement is reversed. Throw along these faults ranges from 30 to 945 m. This area lies along the southeastern extension of the Texas lineament and suggests a left-lateral component of movement during Laramide time and a right-lateral component during basin-and-range time.

COLEMAN, CRAIG J., and JAMES L. COLEMAN, JR., Amoco Production Co., New Orleans, LA

Rapid Evaluation of Mature Hydrocarbon Producing Provinces in Sedimentary Basins

In mature exploration areas the ability to rapidly evaluate acreage for further exploration and development has previously been restricted by the vast amounts of data that must be analyzed. To efficiently evaluate selected areas it becomes necessary to subdivide such areas into workable tracts based on the amount of data and time available. Regional attempts at exploration in many places become too manpower-intensive for many energy companies.

Through utilization of computer data bases it is possible for a small group of individuals to effectively evaluate significant amounts of acreage. In mature provinces, this capability lets individuals rapidly develop exploration recommendations which previously could be made only by geologists who were already knowledgeable about that part of the province.

Two approaches which have been successfully applied to recent exploration efforts are (1) mapping of exploration potential/development potential values and (2) statistical mapping of structural trends. The exploration potential/development potential concept assigns arbitrary values to pertinent tests of specific geologic horizons. By using automatic contour mapping programs it becomes possible to define areas of exploration potential as well as areas of development potential.

The second application involves residual and trend surface analysis mapping of selected geologic horizons to define regional paleostructures. In the example to be presented, both seismic and well control indicated that sedimentary onlapping occurred during Lower Cretaceous time on the flanks of basins; these onlaps were located by computer-drawn contours. Significant potential hydrocarbon plays lie within these onlap zones.

COLEMAN, J. M., and D. B. PRIOR*, Louisiana State Univ., Baton Rouge, LA

Deltaic Influence on Shelf-Edge Instability Processes

Large river systems deliver significant quantities of fine-grained sediment to continental shelf regions. In specific areas off deltas, deposition rates are rapid and the sediment may be involved in a variety of mass movement processes on the subaqueous slopes (slumps and slides, debris flows, and mudflows) causing rapid sediment accumulation at shelf-edge depths and resulting in active progradation of the shelf edge. Seismically, the deposits appear as large-scale foresets and are commonly composed of in-situ deep-water deposits alternating with shallow-water sediments transported by mass movement. On electric logs, sands within these units are sporadic and display sharp basal planes and blocky shapes. Progradation of the shelf-edge deposits is generally accompanied by oversteepening and large-scale instability of the upper shelf-edge slopes. Deep-seated and shallow rotational slides move large volumes of sediments and deposit them on the adjacent slopes and upper rise. Extensive contemporaneous faults commonly form at the shelf-edge. Continuous addition of sediment to the fault scarps, particularly by mass movement from nearby delta-front instability, causes large volumes of shallow-water sediment to accumulate on the downthrown sides of the faults, mostly forming large-scale rollover structures. Continued movement along the concave-upward shear planes commonly results in compressional folds and diapiric structures. Contemporaneous accmulation of shallow-water mass movement deposits may occur in association with these structures.

Massive retrogressive, arcuate-shaped landslide scars and canyons or trenches can also form at the shelf edge owing to slumping and other mass-movement processes. Such canyons and trenches can attain widths of 10 to 20 km, depths of 800 m, and lengths of 80 to 100 km. The creation of such features by shelf-edge instability results in exceptionally large volumes of shallow-water sediment yielded to the deep basins in the form of massive submarine fans. The infilling of depressions by deltaic progradation is rapid, forming large foresets near the canyon heads. The low strength of the rapidly infilled, underconsolidated sediments causes downslope creep or reactivation of failure mechanisms, resulting in multiple episodes of filling and evacuation.

COMER, J. B., Univ. Tulsa, Tulsa, OK, and H. H. HINCH, Amoco Production Co., Tulsa, OK

Petrologic Factors Controlling Internal Migration and Expulsion of Petroleum from Source Rocks: Woodford-Chattanooga of Oklahoma and Arkansas

Upper Devonian-Lower Mississippian Woodford-Chattanooga black shales are oil source beds throughout Oklahoma and much of western Arkansas. Diagenesis in the Woodford-Chattanooga source section proceeded through the following relative time sequence: (a) silicification, chiefly by recrystallization of radiolarians, which probably followed the reaction conversion of amorphous opal-A to opal-CT to chert; (b) dolomitization of deep-basin opal or chert and shallow-platform carbonate laminae; (c) tectonic faulting, folding, and associated fracturing and stylolitization predominantly associated with the late Paleozoic Arbuckle and Ouachita orogenesis; (d) late silicification and mineralization along fractures contemporaneous with (e) generation and expulsion of petroleum.

The principal expulsion mechanism for these Upper Devonian-Lower Mississippian oil source rocks is whole-oil migration through coarser grained matrix pores, stylolites, and fractures, rather than diffusion on a molecular scale. Diffusion migration does occur but appears only to affect internal migration over a few millimeters within the source rock, and thus cannot account for expulsion of large volumes of oil. Preliminary calculations based on source rock extract data indicate that approximately 147 billion bbl of oil have been generated within Woodford shales in the 23,000 sq mi (60,000 sq km) geographic area of southern and western Oklahoma underlain by the Woodford Formation. Minimum relative oil-expulsion efficiency appears to have been approximately 18 to 19% of the oil generated. Thus, at least 27 billion bbl of oil have been expelled from the Woodford into adjacent formations in southern and western Oklahoma while 120 billion bbl of oil remain unexpelled in the source rock.

COOK, E. E., L. J. MCCLURE, and N. S. NEIDELL*, Zenith Exploration Co., Inc., Houston, TX

Now You See It, Now You Don't—Seismic Expressions of the Subtle Trap

Exploration geologists and geophysicists have much in common in terms of tools and vocabulary when it comes to searching for hydrocarbons, but there are clear differences in approach. Certain occurrences of hydrocarbons are subtle in terms of their geologic setting. Others may be obvious in terms of geology, but subtle in their seismic expression. Little has been written about such traps other than what has appeared in works on stratigraphic applications for seismic data. It is also important to distinguish between subtle seismic expressions of traps and complicated seismic expressions. The complicated seismic expression, while difficult to interpret, is not often overlooked. Noting subtle seismic signature in the first in-