the Sierra Campana. The Campana tuff contains a blue crystal-rich basal unit that grades upward into a blue crystal-poor phase containing clumps (lapilli) of sanidine (Or_{40}) plus quartz phenocrysts. Distinctive light-colored clumps (1 cm to 1 m) also occur in the lower part of the tuff. These clumps contain abundant dendritic and coarse vapor phase riebeckite which imparts a speckled blue-white color to the unit. Sanidine phenocrysts are low in CaO (0.1%) but typically contain high FeO (0.6%). The tuff was derived from a magma chamber characterized by a well-developed transient zone of crystallization which was disrupted and mixed with the magma during early eruptive phases. The Campana tuff has been downfaulted at least 300 m along a north-south range-front fault.

Major and trace element analysis of 70 samples defines a distinctly peralkaline suite, with average molecular $Al_2O_3/Na_2O + K_2O + CaO = 0.9$. SiO_2 ranges from 73.7 to 77.6%. The low average Al_2O_3 content (10.9%) and the high Fe_2O_3 content (3.2%) place the suite in the comendite field. The entire suite exhibits a highly fractionated trace element chemistry, with abnormal enrichment of Rb(495 ppm), Zr(970 ppm), Y(144 ppm), and Nb(120 ppm); more significantly, there is very strong depletion of Sr(< 5 ppm), Ba(< 5 ppm), V, Ni, and Cr. The peralkaline volcanics are interpreted as the end product of extreme crystal fractionation under quartz-feldspar ternary minima restrictions.

STEGE, BRUCE R., Exxon, Houston, TX, and N. E. PINGITORE and P. C. GOODELL, Univ. Texas, El Paso, TX

Limestones of Pena Blanca Uranium District, Chihuahua, Mexico

Mexico's largest uranium deposit occurs in the Pena Blanca Range of central Chihuahua. At Pena Blanca, Tertiary silicic pyroclastics overlie middle Cretaceous (Albian and Cenomanian) limestones. The limestones comprise a large rudistid reef, with extensive fore-reef and lagoon facies, at the edge of the Chihuahua trough. Younger, basin limestones overlap the lower edges of the fore-reef slope. The reef itself is of Albian age and shares faunal and lithologic characteristics with both the El Abra Formation of Mexico and the Edwards Formation of Texas. A total thickness of 230 m of reef limestone is exposed in the central and southern part of the range. Important rudistids include caprinids (especially *Mexicaprina),* radiolitids (especially *Eoradiolites* and *Sauvegesia*), and requienids (*Toucasia*). Other faunal elements are gastropods, corals, bivalves, algae, calcisponges, and forams (including *Nummoloculina* sp., useful in correlations). Lagoon, back-reef, requienid rudistid mounds, near back-reef carbonate sand, caprinid and radiolitid rudistid reef core, fore-reef carbonate sand, and fore-reef debris-slope facies are all evident in outcrop. In the reef core, rudistids predominate over all other organisms. None of the reef facies possesses significant porosity. The abundant carbonate mud and diagenetic calcite cement have occluded all available pore space.

The basin limestones include the rhythmically layered Cuesta del Cura, upper Tamaulipas, and Aurora Formations. Approximately 120 m of Tamaulipas Formation interfinger with and lap onto the fore-reef slope facies of the El Abra Formation. The Tamaulipas in this region is a foraminiferal mudstone, locally replaced by rudistid wackestone. It is a deeper water limestone characterized by calcisponges, benthonic, and planktonic Foraminifera, and rudistid debris shed from the reef. The Cuesta del Cura Formation consists of 50 m of interbedded argillaceous limestones and calcareous shales. It covers both the El Abra and Tamaulipas Formations. The calcareous units are mudstones and wackestones containing globigerinid, rotalinid, and rotaliporid Foraminifera and scattered gastropods and bivalves.

THOMPSON, SAM, III, New Mexico Bur. Mines & Minerals Resources, Socorro, NM, JORGE C. TOVAR R., Petroleos Mexicanos, Chihuahua, and J. N. CONLEY, Independent Geologist, Tulsa OK

Oil and Gas Exploration Wells in Pedregosa Basin

In the Pedregosa basin and adjoining areas covering 49,500 sq mi (110,700 sq km) in southeastern Arizona, southwestern New Mexico, northwestern Chihuahua, and northeastern Sonora, 37 petroleum-exploration wells have penetrated Paleozoic and/or Precambrian rocks. Several shows of oil and gas have been reported, but no commercial production has been found. Many of the wells have been drilled on Basin and Range uplifts where reservoirs tend to be flushed with meteoric water. The best remaining prospects lie below the deeper parts of graben valleys where preservation of petroleum is more likely.

The highest ranking objective of the region is in Upper Pennsylvanian-Lower Permian rocks at the margin of the Alamo Hueco basin where shallow-marine dolostone reservoirs are juxtaposed with deep-marine, organically rich limestone and mudstone source rocks. A regional isopach and facies map of the Pennsylvanian shows that the basin axis trends generally southeastward from southern Hidalgo County, New Mexico, across the Ascension-Villa Ahumada area of Chihuahua. Several other petroleum-exploration objectives are indicated in the Paleozoic and Mesozoic rocks.

VELDHUIS, J. H., and G. R. KELLER, Univ. Texas, El Paso, TX

Geophysical and Geologic Analyses of Cenozoic Basins in Trans-Pecos Texas and Southern New Mexico

Geophysical and geologic modeling of Cenozoic basins in Trans-Pecos Texas and southern New Mexico—the Salt Flat, Hueco, Tularosa, Mesilla Valley, Presidio, and Valentine basins—shows north to northwest-trending block faulting. The deep-seated faults could serve as hydrocarbon traps for older Paleozoic and Mesozoic source beds in the area. Interpretations are complicated by the Laramide orogeny and tectonism associated with the formation of the Basin and Range province and Rio Grande rift.

WALLACE, ANDY B., Cordex Exploration Co., Reno, NV, and MICHAEL W. ROPER, Placer-Amex, Inc., McDermitt, NV

Geology and Uranium Deposits Along Northeastern Margin of McDermitt Caldera Complex, Southern Malheur County, Oregon

The adjoining Aurora and Bretz uranium prospects are along the northeastern ring-fracture system of the Miocene McDermitt caldera. A series of block faults, constituting the ring-fracture system, divides the area into two contrasting terranes. The northern terrane, comprising the caldera wall and outflow facies, includes a series of mafic to silicic lavas and rhyolite ash-flow tuffs (Bretz Series). Rocks of the southern terrane (Aurora Series) represent infilling of the caldera after collapse. They include an enormously thickened pile of rhyolite ash-flow tuff, equivalent to the youngest Bretz Series ash-flows, intruded and overlain by rhyolite flow domes and lavas. These rhyolites are overlain by a sequence of intermediate lava flows, flow breccia, and pyroclastic breccia constuting the Aurora Lavas. Tuffaceous lacustrine sediment covers most of the southern terrane and much of the ring-fracture system.

Hydrothermal alteration associated with mercury deposits at the old Bretz mine is clearly controlled by one of the ring faults, but uranium mineralization nearby is stratigraphically controlled and not directly associated with mercury. Uranium concentrations occur along several horizons, including (1) geologic contacts, unconformities, and redox boundaries in the Bretz Series; (2) a widespread horizon in the tuffaceous lake sediments; and (3) potentially commercial deposits along the flow boundaries and interflow breccias in the Aurora Lavas.

The control of uranium by solution channelways along stratigraphic boundaries and lack of crosscutting veins, except in local areas of the Aurora Lavas, suggests that supergene mechanisms were important in ore formation. However, a combination of hydrothermal and supergene processes is favored to explain all the features observed, with the uranium in the lacustrine sediments precipitated from surficial hot springs active during mineralization.

WALTON, ANTHONY W., TIMOTHY L. SALTER, and DALE ZETTERLUND, Univ. Kansas, Lawrence, KS

Postemplacement Uranium Mobility in Oligocene Ash Flow Tuff and Rhyolite Lavas from Hidalgo County, New Mexico

Investigations of the distribution of uranium and other trace and minor elements in a major welded ash flow tuff (the Gillespie Tuff) and in several rhyolite flow units (all Oligocene) included petrographic examination to detect characteristic textures produced during the process of crystallization, and comparison of the chemical composition of rocks of identical original composition, but crystallized by different processes. In all units investigated, unaltered vitrophyres were used to indicate initial content of uranium and elements.

The major process of crystallization in these rocks involved growth of spherulitic and large crystal units in a supercooled magma, beginning at temperatures 200°C below the liquids and continuing at lower degrees of supercooling. This is not strictly devitrification because it probably occurs above the glass-transition temperature. Several distinctly different textures probably result from different crystallization conditions. Vapor-phase crystallization is rare in the Gillespie Tuff. "Granophyric" texture is common in both lavas and the Gillespie Tuff. In other areas, rocks displaying this texture may have lost some uranium, suggesting that volcanic rocks in Hidalgo County may have released considerable amounts during crystallization.

WEISE, JAMES R., and DAVID V. LEMONE, Univ. Texas, El Paso, TX

Carbonate Stratigraphy of U-Bar Formation (Aptian-Albian) of Southeastern Big Hatchet Mountains, Hidalgo County, New Mexico

The U-Bar Formation (Aptian-Albian) consists of five members: they are (in ascending order) brown limestone, oyster limestone, limestone-shale, reef limestone, and suprareef limestone. These members crop out in the area southwest of the Big Hatchet Mountains, Hidalgo County, New Mexico. The U-Bar Formation is overlain by the Mojado Formation (Albian) and underlain by the Hell-to-Finish Formation (pre-Aptian). A composite stratigraphic section (3,115 ft; 950 m) southwest of the Big Hatchet Mountains has been compiled from measured sections at Pierce Tank and Hell-to-Finish Tank.

The brown limestone member contains thin-bedded, fine-grained, ledge-forming, silty, gypsiferous, dolomitic to oolitic limestones, arkosic sandstones and siltstones which weather red-brown to dusky red. The sparse fauna contains fragmented diminutive bivalves, *Ostrea*-type bivalves, and turritelloid-type gastropods.

The yellow-gray to red-brown oyster limestone member primarily contains thin-bedded, fine to medium-grained, clastic, silty limestones and covered shale intervals. Massive limestones, thin-bedded arkosic sandstones, and siltstones occur near the base and middle of the member. This richly fossiliferous member contains some limestones consisting almost entirely of small *Exogyra* and *Ostrea*-type bivalves. Also common are *Pecten,* turritelloid-type gastropods, and serpulid worm tubes which commonly encrust *Ostrea*-type bivalves.

The limestone-shale member contains thin to medium-bedded ledge-forming, fine-grained limestone. These pitted blue-gray to medium-gray weathering limestones contain a sparse fauna of turritelloid-type gastropods, small, thin-shelled bivalves, fragmented echinoid spines, and abundant *Orbitolina,* and large *Lunatia*-type gastropod steinkerns in the upper part of the member.

The reef limestone member is a massive, fine to medium-grained limestone. The light-gray weathering limestone contains fragmented *Ostrea*-type bivalves, rudists, and abundant orbitolinids at the base.

The suprareef limestone member (locally thin) is a medium-grained, clastic limestone, weathering light gray and containing abundant orbitolinids in the base and fragmented *Ostrea*-type bivalves above. The fossils commonly are iron-stained and weather in relief.

WOODWARD, LEE A., Univ. New Mexico, Albuquerque, NM

Structure of Thrust Belt in Southwestern New Mexico: Implications for Hydrocarbon Exploration

The Laramide thrust belt trends west-northwesterly through the southwestern corner of New Mexico and is characterized mainly by flat-lying thrusts and subordinate closely compressed overturned folds. Cenozoic volcanics and sediments cover much of the region and only scattered areas of preorogenic rocks are exposed. Deformed Paleozoic, Mesozoic, and lower Cenozoic strata are exposed in fault-block ranges separated by extensive basins filled with upper Cenozoic clastic debris.

Yielding on the thrust is northward and displacement ranges up to several miles. The regional distribution of thrusts indicates that the entire foldbelt in this region is underlain by thrusts even though considerable parts of the preorogenic sedimentary section may have escaped deformation locally.

Laramide thrusts and Cenozoic volcanism and block faulting make this area extremely difficult for hydrocarbon exploration; techniques used successfully in the Utah-Wyoming thrust belt appear to have little chance for success in New Mexico.