Pennsylvanian and Wolfcampian kerogen is yellow-orange to orange, suggesting that temperatures were high enough to begin to generate hydrocarbons from lipid-rich amorphous organic material. Palo Duro basin samples have a broad range of vitrinite reflectance values, but populations with the lowest reflectance probably indicate the true temperatures that were reached in the basin. The average reflectance in representative Pennsylvanian vitrinite is 0.52%; in Wolfcampian samples the average reflectance is 0.48%. These values are consistent with the kerogen color and suggest that basinal source rocks may have begun to generate hydrocarbons.

ELAM, JACK G., Consulting Geologist, Midland, TX

Plate Tectonics of Permian Basin

The recorded plate history in the Permian basin began in Early Cambrian time. The area was uplifted and eroded over one of a line of mantle plumes that extended across the southern North American plate. Rift-rift-rift triple junctions formed over these hot spots and sea-floor spreading led to plate separation.

As the new ocean opened up to the south, the craton cooled and the sedimentation in the lower and middle Paleozoic was controlled by cooling.

In Pennsylvanian time, the North American plate probably came temporarily to rest over a hot spot located under the Tabosa basin. Thermal doming occurred and the Delaware-Val Verde-Marfa triple junction was formed. By the close of the Pennsylvanian, a large part of the dome was elevated above sea level. Thermal activity waned, or the plate resumed its movement again before new oceanic crust formed and all three basins became failed arms or aulacogens.

Intracrustal melting and intrusion accompanied the period of high heat flow; individual oil-producing anticlinoria are upwarps over intrusives. Optimum conditions for generation and migration of hydrocarbons accompanied this time of high heat flow.

On the south, ocean closing occurred along a subduction zone with the suturing reflected by the Marathon-Ouachita overthrust belt. There is little reflection of this collision in the tectonic history of the Delaware and Val Verde basins, but much of the basin fill was from this southerly source.

Cooling and contraction controlled the sedimentary and structural history throughout the remainder of the Permian.

ELSTON, WOLFGANG E., Duval Corp., Tucson, AZ, and EDWARD E. ERB, Chevron Resources Co., Denver, CO

Tertiary Volcanic Centers as Constraints on Oil and Gas Potential of Basin and Range Province: New Mexico Segment of Pedregosa Basin

Stratigraphic similarities with the Permian basin and structural similarities with the Overthrust belt make the New Mexico segment of the Pedregosa basin an attractive target for petroleum exploration. Middle Tertiary volcanic cover and postvolcanic faults introduce constraints, as elsewhere in the Basin and Range province.

Geologic mapping in southwesternmost New Mexico (Hidalgo County) has traced Oligocene ash-flow tuff sheets to at least nine major cauldrons, including Valles-type resurgent cauldrons 10 to 40 km wide (Apache Hills: Apache cauldron; southern Pyramid Mountains: Muir cauldron; southern Animas Mountains: Tullous, Juniper, Animas Peak, Cowboy Rim, San Luis cauldrons; southern Peloncillo Mountains: Rodeo and Geronimo Trail cauldrons). Faulted-off cauldron segments continue beneath the Playas, Animas-San Luis, and San Simon-San Bernadino Valleys.

Composite batholiths probably underlie cauldron clusters, as in the San Juan and Mogollon-Datil volcanic fields. Exposed monzonitic plutons (Apache Hills, Pyramid Mountains, Animas Mountains) are apophyses, emplaced during resurgence. Other plutons, apparently unrelated to cauldrons, are present in the northern Pyramid and Little Hatchet Mountains. Distribution of cauldrons and plutons suggests that much of the Pyramid, Peloncillo, Little Hatchet, and Animas Mountains, Apache Hills, and adjacent valleys are unfavorable for petroleum accumulations. However, destructive thermal effects may be confined to aureoles extending only about 1,000 m from intrusive contacts, as in the KCM 1 Forest Federal wildcat. Cauldrons and thermal effects deleterious to petroleum potential are unknown in southeastern Hidalgo County (Dog, Alamo Hueco, Big Hatchet Mountains, southern Sierra Rica).

FALLON, JAMES H., Sul Ross State Univ., Alpine, TX

Depositional Environments, History, and Biostratigraphy of Upper Albian Rocks, Trans-Pecos Texas

Upper Albian rocks in Brewster, Presidio, Jeff Davis, Reeves, and Pecos Counties, Texas, between the *Adkinsites brazoensis* and *Pleisioturrilites brazoensis* zones are divided into 10 lithofacies and associated depositional environments. These lithofacies represent deposition in environments ranging from nearshore high-energy carbonate and quartz sands, to offshore high-energy carbonate shoals and rudistid banks, to medium- to low-energy offshore shales and biomicrites, to deeper water low-energy micrites. All or parts of the Benevides, Loma Plata, Sue Peaks, Santa Elena, Boracho, Fort Terrett and Fort Lancaster Formations are included in this study.

The wide variety of lithofacies present reflects variations in local source areas, depositional slope, source area and basin stability, and paleogeography. Distribution and thickness of lithofacies during the late Albian indicate that the Glass Mountains area and Diablo platform were structural highs separated by a shelf basin which occupied the position of the Paleozoic Hovey channel. The northern part of the area was a gently sloping shallow-water shelf; the southern part was the northern edge of the Chihuahua trough. The use of ammonite zones to trace lithofacies and depositional environments through space and time shows an initial transgressive followed by a lesser regressive sequence. The overall effect of late Albian deposition was transgressive.

FINLEY, ROBERT J., and WILLIAM E. GALLOWAY, Bur. Economic Geology, Univ. Texas, Austin, TX

Genetic Stratigraphy of Uranium Host Facies, Tordilla Sandstone Member, Upper Jackson Group, Panna Maria, Texas

Uranium mineralization in the Panna Maria, Texas, area occurs in the Tordilla Sandstone Member of the Eocene upper Jackson Whitsett Formation on the reduced side of a linear alteration front that extends more than 3 mi (5 km) along strike. Two open-pit mines at Panna Maria expose parts of a strike-oriented sand belt associated with a barrier island-tidal inlet system.

The east pit exposes (1) a tidal inlet-embayment entrance, overlain by (2) tidal-channel, and (3) tidal-flat facies. The inlet facies, the uranium host, is dominantly fine to very fine sand with multidirectional trough and planar cross-bedding, *Ophiomorpha* sp., rounded mud clasts, and mud blocks. The tidal channel cuts through tidal-flat deposits, is approximately 40 m wide and 11 m thick, and contains gently dipping accretion beds of fine to very fine sand, including small-scale cross-stratification, and upwardly decreasing sand bed thickness. The lithology and sedimentary structures of facies 3 strongly resemble classic tidal-flat deposits of the Wadden Sea.

The west pit exposes a regressive sequence of (1) tidal-inlet fill, (2) a poorly represented upper shoreface-beach-barrier flat facies, overlain by (3) bay-lagoon deposits. The inlet facies of fine to very fine sand includes large-scale, low-angle planar cross-beds, *Ophiomorpha* sp., bipolar, planar cross-beds, and has a scoured base. Some zones are highly burrowed. Facies 2 consists of trough and planar cross-bedded fine to very fine sand, with low-angle parallel bedding, root traces, and woody fragments near a hummocky upper surface. Facies 3 includes an ashy, burrowed lignite overlain by a massive, burrowed clayey siltstone containing plant debris. Facies 1 and 2, as well as the base of the lignite bed, are uranium bearing.

GABELMAN, JOHN W., Utah International, San Francisco, CA

Uranium in Volcanic Rocks: Progress

Calc-alkaline rocks of crustal(?) derivation analyzed 0 to 5 ppm uranium in magmatic phases, but hundreds of ppm in epigenetic end-products. Alkaline rocks of mantle(?) derivation analyzed 0 to 22 ppm in magmatic phases, 30 to 45 ppm in deuterically modified phases and hundreds of ppm in final epigenetic modifications. Incompatibility with rock-forming silicates relegates large ions including uranium to residual gas or fluid. Mantle volatiles released during magma generation or crystallization mineralize rocks according to relative chemical reactivity.

In rocks with <5 ppm U, U-Th were not detected by autoradiography or fluorescence. Uniform weak glow at 10 to 20 ppm U suggests uniform distribution at the eutectic. Selective distribution in more uraniferous rocks favors deuteric or pegmatitic biotite, zircon, complex silicates, and multiple oxides. U-Th uniformly distributed within grains are considered contemporaneous lattice substitutions. Some magmatic minerals in rocks with >60 ppm U show inclusions variably containing Th, REE, U, Ti, V, Ni, Cr, Cu, Pb, Zn, Ba, and Mn. Halogens, S, and P underscore the volatile role. Inclusion-laden asphaltite is common. Lattice inclusions may represent vapor trapped during crystallization. Those in cleavages, amygdules, or fractures appear epigenetic. Those lacking Th probably are of relatively low temperature.

Surface tension would inhibit liquid entry into tight textures and lattices, so volatile transport and ionic lattice diffusion are inferred. Inclusions account for most Th-U distribution patterns suggesting dominant epigenetic enrichment of volcanics by residual volatiles.

GIBSON, G. G., and D. R. RECK, Sul Ross State Univ., Alpine, TX

Oncolites in Cretaceous Yucca Formation, Presidio County, Texas

Detailed stratigraphic work in the Yucca Formation, Presidio County, Texas, has revealed about 70 ft (21 m) of oncolite-bearing strata. The zone of oncolite occurrence is 180 ft (55 m) above the unconformity separating the Permian and Cretaceous rocks and 665 ft (203 m) below the initial occurrence of abundant *Orbitolina*. The zone varies both vertically and laterally from oncolite-supported conglomerate with micrite matrix to micrite with less than 10% oncolite content, to algal-encrusted, matrix-supported pebble conglomerate. Oncolites range from less than 0.5 in. (1.25 cm) to approximately 3 in. (7.5 cm) in diameter, and are commonly size sorted within the zone.

The oncolites are most commonly nucleated about a fragmental piece of oncolite material and are classified as type-SS. In the pebble conglomerate facies, algal encrustations occur on very well-rounded, spheroidal clasts of siltstone, micrite, and chert. Very rare encrustations are present on clasts appreciably larger or smaller than the pebble size. Rarely is the algal material nucleated about organic remains such as pelecypod, gastropod, or brachiopod shells.

The presence of this oncolite zone within an otherwise unfossiliferous section provides some control for interpreting depositional environments within the Yucca Formation. However, oncolites have been reported from several aquatic depositional environments both in the geologic record and as forming today. These environments include: lacustrine, fluvial; shallow, nearshore marine; and marginal marine brackish water systems. Local sedimentary features and broader stratigraphic relations effectively eliminate lacustrine and fluvial interpretation.

GOODELL, PHILIP, and KENNETH CARRAWAY, Univ. Texas, El Paso, TX

Geology of Sierra Pena Blanca Region, Chihuahua, Mexico

The Sierra Pena Blanca is a fault-block mountain range, extending 100 km in a north-south direction, and being up to 15 km wide. Paleozoic eugeosynclinal sediments constitute the southernmost part, and rocks are progressively younger to the north. Cretaceous basinal and reef carbonate facies are present, and are succeeded northward by lower Tertiary conglomerates, ash-flow tuffs, and volcaniclastics, ranging in age from 44 to 35 m.y. The area is at the boundary of the Chihuahua trough on the east and the Aldama platform on the west. Internally, the range has a repetition of significant northwest-trending, down-to-the-northeast faults. The Tertiary units show some variation in thickness and facies throughout the area. They illustrate an outflow environment, and some units suggest a caldera source on the west or southwest.

Significant uranium deposits occur near the base of the ignimbrite pile. The largest volume of ore is stratigraphically controlled at the base of a welded ash-flow tuff, the Nopal Formation. The Margarita deposit and northern El Curvo zone are examples of this type. Additional mineralization occurs in fractures and faults, as at Nopal 1 and 3. Some mineralization is also present in the underlying Cretaceous carbonate rocks, as at Domatilla, and Sierra Gomez.

Data were collected from drill holes in the Margarita deposits. To define the geochemical indicators a principal factor analysis was performed on the data, which consists of 30 samples with 28 chemical elements. Factor analysis reduced this data set to 8 latent variables or factors. The factors can be interpreted from the association of variables which have the highest factor loadings.

An eight-factor solution to the analysis indicated that certain trace elements, as well as some important major elements, could be used as possible geochemical indicators for this type of deposit. The positive trace elements defined are: MnO, Hg, B, Y As, Mo, F, and Cu. The multiple correlation coefficient