stratigraphic trap in the Tomahawk field. The P-2 zone is approximately 100 ft (30 m) thick, with the main field pay developed in the upper 50 ft (15 m). This interval is a sucrosic, vugular dolomite in which two predolomitization facies can be recognized, an upper oolitic limestone facies and an underlying crinoidal, argillaceous limestone facies. A dolomite bed near the base of the P-2 zone has 4 to 15 ft (1 to 5 m) of porosity over most of the field and is productive in several local areas. Productive porosity in the P-2 zone ranges from 4 to 10% and the thickness of net pay ranges from 10 to 45 ft (3 to 14 m). Good permeability is dependent upon fractures. Several locally successful techniques for fracture detection are used.

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Magnetotelluric Petroleum Exploration—Technology Update and Case Histories

The use of magnetotelluric soundings for the estimation of subsurface electrical conductivity structures and properties has been increasing during the past several years. Greater interpretational capabilities and improved techniques for achieving higher data quality, coupled with the experience gained, have made the method a practical and effective exploration tool. Magnetotelluric exploration has been applied to a large variety of structural and stratigraphic problems and has proven effective and capable of yielding information even in areas which give poor or uninterpretable seismic results.

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Uranium in Challis Volcanic Field, Idaho

Recorded uranium production and known resources in the Challis Volcanics and the Challis-related epizonal silicic plutons of Eocene age are small, but the potential resource is moderately high. Former production was from arkosic conglomerates and sandstones at the base of the Challis Volcanics in Stanley basin and from a scheelite deposit on the contact of the Summit Creek stock. Uranium mineralization also occurs in water-laid rhyodacite pumice-rich tuffs, in the Twin Springs pluton, in the Beaverhead stock, and in shear zones in the Castro granite.

The Challis Volcanics are potash-rich, calc-alkaline rocks and, in general, are not known to be enriched in uranium. However, numerous highly differentiated silicic intrusions that acted, in part, as feeders to the closing phases of Challis volcanism are rich in uranium and thorium. These intrusions range from rhyolite, rhyodacite to granite, and from plugs, domes, dikes, stocks, to batholiths.

Exploration in the Challis field should be concentrated in areas of silicic tuffs and breccias or in arkosic beds that occupy depressions in pre-Challis basement or volcanic-tectonic subsidences. Few such structures are known because detailed mapping of the field is incomplete; one exception is a trap-door graben that contains the uranium-rich arkoses of Stanley basin. Mineralized indicators of uranium are hematite staining, disseminated pyrite, and opaline silica alteration. Radioactive anomalies in present-day valleys can result from the fixation of uranium in organic-rich bogs or from accumulations of coarse detritus from granitic plutons.

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Brachiopod Biostratigraphy of Hueco Group (Wolfcamp), Franklin Mountains, Texas and New Mexico

The Franklin Mountains are located in the extreme western tip of Texas and extend northward into south-central New Mexico, approximately 23 mi (37 km) from El Paso which is built around the southern end of the range.

The outcrops of Permian strata in the Franklin Mountains consist of small outliers on the western edge which are separated from the main range. The Permian is represented by the Hueco Group (Wolfcampian) which is divided into three formations, in ascending order: the Hueco Canyon, Cerro Alto, and Alacran Mountain Formations.

The 1,350-ft (411.5 m) thick Hueco Canyon Formation contains 22 genera and 23 species of brachiopods. These are *Orthotichia* sp., *Accosarina* sp., *Acritosia silicica* Cooper & Grant, *Rhipidomella hessensis* R. E. King, *Derbyia* sp., *Chonetinella* sp., *Kozlowskia capaci* (d'Orbigny), *Reticulatia huecoensis* (R. E. King), *Dasyaria undulata* Cooper & Grant, *Dasyaria wolfcampensis* (R. E. King), *Cancrinella parva* Cooper & Grant, *Linoproductus cora* (d'Orbigny), *Pontisia franklinensis* Cooper & Grant, *Stenocisma* sp., *Hustedia huecoensis* R. E. King, *Rhynchopora* sp., *Crurithyris tumbilis* Cooper & Grant, *Cleiothyridina rectimarginata* Cooper & Grant, *Composita cracens* Cooper & Grant, *Beecheria bovidens* (Morton), *Chondronia obesa* Cooper & Grant, *Dielasma* sp. 1, and Dielasma sp. 2.

The 350 to 425-ft (106.7 to 129.5 m) thick Cerro Alto Formation contains 8 genera and 9 species of brachiopods. These are *Derbyia* sp., *Chonetinella* sp., *Squamaria moorei* Muir-Wood & Cooper, *Cancrinella altissimia* R. H. King, *Linoproductus cora* (d'Orbigny), *Pontisia franklinensis* Cooper & Grant, *Crurithyris quadalupensis* (Girty), *Composita cracens* Copper & Grant, and *Composita mexicana* (Hall).

The 315 to 739-ft (96 to 225.2 m) thick Alacran Mountain Formation contains 24 genera and 27 species of brachiopods. These are *Crania modesta* White & St. John, *Meekela* sp., *Enteletes* sp., *Derbyia* sp., *Pseudoleptodus* sp., *Micraphelia* sp., *Costellarina costellata* (Muir-Wood & Cooper), *Hystriculina convexa* Cooper & Grant, *Kutorginella* sp., *Nudauris* sp., *Kozlowskia capaci* (d'Orbigny), *Dasysaria undulata* Cooper & Grant, *Dasysaria wolfcampensis* (R. E. King), *Linoproductus* sp., *Pontisia franklinensis* Cooper & Grant, *Stenocisma hueconians* (Girty), *Hustedia hessensis* R. E. King, *Hustedia huecoensis* R. E. King, *Crurithyris* sp., *Neophricadothyris* sp., *Composita cracens* Cooper & Grant, *Composita mexicana* (Hall), *Reticulariina heuconiana* Cooper & Grant, *Gypospirifer nelsoni* Cooper & Grant, *Beecheria bovidens* (Morton), *Chondronia obesa* Cooper & Grant, *Dielasma* sp.

Other faunal taxons present in the Hueco Group of the Franklin Mountains include Foraminifera, Fusulinida, Porifera, Coelenterata, Bryozoa, Polyplacophora, Gastropoda, Cephalopoda, Bivalvia, Scaphopoda, Crustacea, Trilobita, Annelida, Crinoidea, Echinoidea, Conodonta, and Vertebrata.

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Petrology and Geochemistry of Peralkaline Volcanics of Sierra Campana, Chihuahua, Mexico

Peralkaline welded tuffs (and flows?) make up the steep walls of the lower Campana Canyon and the east-facing scarp of the Sierra Campana, approximately 100 km north of Ciudad Chihuahua. The sequence includes crystal-poor, highly contorted welded tuffs and the distinctly peralkaline Campana tuff that forms the steep columnar-jointed cliff atop 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.

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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.

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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.

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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.

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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