mineralization is also hosted by euxinic sedimentary-tuffaceous facies adjacent to the volcanic complexes. The volcanics are generally, though not exclusively, acid in composition, have alkaline affinities, and are typical of the variety developed in continental rift systems. The mineralization within the volcanic and volcaniclastic rocks is generally conformable showing a preference for more clastic permeable units. Structurally controlled mineralization may occur and is sometimes of economic importance. In both places the controlling features have acted as channelways for migrating hydrothermal and ground-water solutions. Alkali, CO_2, and H metasomatism commonly accompany the ore-forming process.

The uranium is considered to be of magmatic origin, transported by F- and CO_2-rich hydrothermal fluids which have percolated through the volcanic pile. Under favorable conditions additional uranium may have been scavenged during transport of the ore fluids, during metasomatism or by ground waters circulating on the flanks of the caldera(s). Subaqueous venting of hydrothermal fluids distal to the volcanic centers may give rise to uranium concentrations within reducing (sulfide-rich) sedimentary facies. Precipitation of uranium in the subaerial or subaqueous environ may have been influenced by H_2S exhalation in the vicinity of fumaroles or by dissolved H_2S provided by a plumbing system. For these deposits in which F is a significant component it is probable that U-F complexes transported by acid solutions have been destabilized by changes in pH (and Eh) due to mixing with mildly acid to alkaline ground waters or due to precipitation of the fluoride ion. Precipitation of any free or clay-absorbed uranyl ion would also be promoted by the presence of H_2S.

Although some later supergene processes may have upgraded the primary uranium concentrations, I interpret the mineralizing episode(s) to be synvolcanic. This does not deny the importance of the intermixing of ground waters and the uranium-rich hydrothermal fluids as a means of inducing uranium precipitation, or the scavenging of uranium by these fluids as they percolate through the volcanic pile.

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Peralkaline Ash-Flow Tuffs in Santa Clara Canyon, North of Chihuahua City, Mexico, Possible Source Rocks for Uranium

A thick sequence of upper Oligocene peralkaline ash-flow tuffs and an associated vent complex are located in Santa Clara Canyon, 91 km north of Chihuahua City, Mexico. The principal unit, the Cryptic Tuff, is a comendite and contains about 1% phenocrysts that include sanidine (Or_{45-55}) quartz, hedenbergite, and magnetite. A complete cooling unit consists of: (1) a basal vitrophyre with associated spherulitic pods; (2) greenish, densely welded tuff that contains stretched pumice lapilli; (3) a banded red and light pink zone that contains flowage features and shear folds; (4) a highly porous zone with abundant quartz and sanidine in cavities; and (5) a thick zone of micropoikilitic sanidine and quartz interspersed with riebeckite and aegirine. Flow breccias that contain fragments of the different Cryptic tuff varieties usually separate micropoikilitic riebeckite tuff units. A north-south-trending vent zone (at least 3 km long) is present in lower Santa Clara Canyon where over 400 m of Cryptic tuff is exposed. Flow foliation is vertical in the vent area. Overlying the Cryptic sequence is the bluish, comenditic Campana tuff. It is densely welded and contains about 10% sanidine and quartz phenocrysts set in a groundmass that includes riebeckite and matted aegirine needles.

A minimum loss of 8 mg U_3O_8 per gram of Cryptic tuff has been calculated using data for glassy and massive riebeckitic phases. These paralkaline tuffs could have been source rocks from which large amounts of uranium were mobilized.

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Icelandite and Aenigmatite-Bearing Pantellerite from McDermitt Caldera Complex, Nevada-Oregon, and Their Petrogenetic Significance

Icelandite, apparently the first to be recognized in the western United States, is a petrographically important component of the volcanic suite of the middle Miocene McDermitt caldera complex. Median major-element composition of seven rocks that both pre-date and post-date the major ash-flow sheets exposed on the northern margin of the Long Ridge caldera have been determined. Very high Fe contents (9.1 to 10.2 wt % FeO) are associated with low to very low MgO (0.4 to 2.0 wt %); FeO/Mg ratios of from 5.4 to 25 are strongly "tholeiitic." Both alumina and total alkali contents are relatively low. With the exception of their significantly higher K_2O contents (3.1 to 4.7 wt %), the rocks are chemically similar to icelandites from hot-spot-related oceanic islands such as Iceland and the Galapagos that are situated near spreading centers. A very thin unit of crystal-rich pentellerite welded tuff containing 1.5 vol % aenigmatite phenocrysts underlies the lower major ash-flow sheet exposed at the northern margin of the Long Ridge caldera. Analyses of progressively Fe-rich intermediate and silicic rocks given by Greene provide evidence for a coherent and continuous rock series from icelandite to peralkaline rhyolite. The high FeO/MgO ratios of the icelandites and the presence of aenigmatite in the tuff support a petrogenetic model for the intermediate and silicic rocks of the McDermitt complex involving extensive high-level differentiation of mantle (diapir?)-derived subalkaline mafic magma under conditions of low f_{O_2} and f_{H_2O}. The K_2O and U (4 to 5 ppm) contents of the icelandites suggest that the parent magmas were moderately rich in these and other lithophile elements.

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Geochemistry of Hydrocarbon Source Rocks, Palo Duro Basin, Texas

The sparsely drilled Palo Duro basin of the Texas Panhandle remains an exploration frontier. An understanding of source rock geochemistry can aid in evaluation of its hydrocarbon potential. To determine whether sediments in the basin contained sufficient organic matter to generate hydrocarbons, samples collected from 20 geographically widespread wells were analyzed for total organic carbon content (TOC). Highest values of TOC, up to 6.9%, occur in Upper Permian San Andres dolomite in the southern part of the basin. Pennsylvanian and Wolfcampian basinal shales contain up to 2.4% of TOC and are fair to very good source rocks.

Source beds in the Palo Duro basin had to reach sufficiently high temperatures to generate hydrocarbons from disseminated organic matter. Kerogen color and vitrinite reflectance, which indicate maximum paleotemperatures, were studied in all samples containing greater than 0.5% TOC.

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.

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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.

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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).

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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.

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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