glass or (2) minor enrichment in uranium resulting from diagenesis. Whole-rock Th/U ratios average about 2 whereas ratios in glass alone are about 3 to 4, implying that a significant fraction of uranium is contained in relatively Th-poor detrital components such as zircon. Th/U ratios in sediments do not show any correlation with either stratigraphic position or mineralogic zone, implying that no measureable uranium depletion has occurred.

Fission-track maps of glassy sediment show that uranium occurs in glass and in high concentrations in zircons and amorphous iron hydroxides. In altered rocks uranium is enriched in amorphous iron hydroxides and is unevenly distributed in moderate concentrations through the groundmass associated with no distinct mineral. Opal, calcite, clinoptilolite, and analcime contain little uranium. This shows that solution of glass, including minor etching during hydration, releases uranium but most is immediately absorbed by hydroxides. Later recrystallization of diagenetic minerals does not mobilize uranium. Diagenesis which affected amorphous iron hydroxide could mobilize uranium.

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Tectonics of Western Permian Basin

The Permian basin of west Texas and southeastern New Mexico probably originated in late Precambrian time as a shallow geosynclinal trough on the southern edge of the North American craton. The extreme southern part of the region formed part of a subduction trough.

By Late Cambrian time the seas in the southern part of the trough had advanced over part of the craton, and Paleozoic sedimentation began. Perhaps in late Precambrian a north-facing salient of the trough developed into an aulacogen with lateral dextral movement along steep faults in what later became the eastern part of the Delaware basin.

During early and middle Paleozoic time the region was tectonically quiet. However by Middle Mississippian the Precambrian zones of weakness were reactivated and the Delaware and Midland subbasins began to form. At the same time the Marathon-Ouachita trough began to deepen.

In early Middle Pennsylvanian time active tectonism with stresses from the northeast formed a small mountain chain between the two subbasins, on the site of the Central Basin platform. In later Pennsylvanian and Early Permian time renewed tectonism resulted in low-angle thrusting of early Paleozoic rocks northward from the Marathon trough. At the same time there was renewed vertical movement on the ancient lateral faults which formed the eastern edge of the Delaware basin.

Middle and Late Permian was a quiet time tectonically with the only movement being slight subsidence, probably due to differential compaction in the basins. This regime continued through the early Mesozoic. By Early Cretaceous, however, a major change in paleogeography resulted in an advance of the sea over the region which was by then securely welded to the craton.

The area was protected from severe deformation during the Laramide orogeny by the beam effect of the Matador and Amarillo uplifts on the north and the east-west folds of the Marathon belt on the south. Tectonic activity since the early Tertiary has been minimal.

Tectonic style in the Delaware basin is characterized by eastward tilt in the Permian and younger rocks. The older rocks are folded and cut by steeply dipping faults. The Central Basin platform style comprises supertenuous draped structures in the younger rocks. These overlie closed folds with steeply dipping faults in the older rocks which trend north-northwest. The Midland basin contains en echelon faults and extension fracturing, reflecting moderate movement. The extreme southern part of the Permian basin consists of deep folded troughs bounded by thrust faults. The trend of these structures forms a large angle with the trends of the Central Basin platform.

The long interval of tectonic stability in the region since the early Permian has undoubtedly contributed to the maturation and accumulation of the oil and gas resources of the basin.

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Geothermal Anomalies in Western Trans-Pecos Texas

Several major geothermal anomalies are present in Trans-Pecos Texas because of warm to hot water springs and wells, silica geochemical indicators, and shallow thermal gradient measurements.

Forty-four thermal water (30°C or above) occurrences have been located in the area. The largest concentration of thermal waters is in southern Hudspeth and western Presidio Counties adjacent to the Rio Grande. The thermal waters range from slightly fresh to salty; total dissolved solids range from 275 to 11,500 ppm. Major ions in the high dissolved solid waters include sodium and chloride.

As indicated by the silica geothermometer temperatures, subsurface waters above 125°C exist at seven locations in northeast El Paso, western and southeastern Jeff Davis, western and northern Presidio, and southern Brewster Counties. The areas having highest silica temperatures are (1) west of the Hueco Mountains in northeastern El Paso County and extending northward into southwestern Otero County, New Mexico; here maximum silica temperatures are 151°C and maximum measured water temperatures reach 71°C; and (2) north of Candelaria in western Presidio County where maximum silica temperatures reach 177°C and maximum measured water temperatures are 72°C.

Geothermal gradients have been measured in over 70 wells and boreholes, most of these in Presidio County. Average gradient is 77°C/km in the Rio Grande Valley, with 30°C/km in the highlands east of the valley; this would seem to reflect the possible boundary of the Basin and Range and Great Plains tectonic provinces. In addition, a drilling program has been underway in northeastern El Paso County to investigate the geochemical anomaly west of the Hueco Mountains. Twelve to 14 holes drilled yielded gradients of over 100°C/km, and two of these penetrated the limestone bedrock, where the elevated gradients continued to increase with depth. Heat-flow values of 9 and 11 HFU were calculated for these latter two holes. On the basis of these gradients a geothermal resource may exist close to El Paso.

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Deposition and Diagenesis of Horquilla Carbonates, Big Hatchet Peak Section, Pedregosa Basin

In the Big Hatchet Peak section the Pennsylvanian-Permian (Morrowan to Wolfcampian) Horquilla Formation is 3,230 ft (985 m) thick and consists of shallow shelf carbonates which accumulated along the outer shelf margin of the Alamo Hueco basin.

The lower Horquilla (Morrowan to Desmoinesian) is 1,363