A lateritic paleosol underlies the nonmarine Goler Formation of early Paleogene age on the north flank of the El Paso Mountains north of the Garlock fault. The dark reddish-brown, indurated paleosol formed by weathering of underlying pre-Tertiary metasedimentary rocks. It is as much as 8 m thick and is composed principally of quartz, kaolinite, and hematite. Strata directly overlying the paleosol include debris-flow breccia and pebbly mudstone containing clasts derived from metasedimentary rocks exposed in the El Paso Mountains. The clay-rich matrix of these deposits resembles the paleosol in color, induration, and mineralogy. Other workers have reported middle Paleocene (Torrejonian) fossils from conformably overlying strata. The debris-flow deposits and paleosol therefore are middle Paleocene or older.

The lateritic paleosol suggests prolonged weathering of a subdued landscape under a humid, subtropical to tropical climate. Fossil plants previously reported from the Goler Formation also suggest such a climate. Paleocene laterites have been described from other parts of southern California, indicating that warm, humid conditions extended across the region at that time.

The debris-flow deposits probably developed by mass wasting of lateritic soils that may have once blanketed the area now occupied by the El Paso Mountains. The debris flows may indicate early upwarping of an ancestral El Paso Mountains. If so, such tectonism may reflect activity of a proto-Garlock fault during early or middle Paleocene time.

ORIGIN OF BASIN-RANGE EXTENSION: BACK-ARC SPREADING CONTROLLED BY NORTH AMERICAN PLATE MOTION

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Global plate reconstructions (supported by San Andreas offset history and magmatic arc patterns), when combined with middle Cenozoic palinspastic reconstructions of the U.S. Cordillera, indicate that formation of the Basin Range Province (BRP) by either diffuse shear or spreading of a sublithospheric diapir after cessation of subduction is not viable. Diffuse NNW-SSE Pacific-N. American transform interaction is inconsistent with the prevailing E-W direction of extension in the eastern parts of the BRP. The diapiric model seems untenable because at 20-18 myBP, the age of inception of extension (from cross-cutting relations, areal extent of ash-flow tuffs, and direct dating of denudational faults), Farallon subduction had not yet ceased beneath much of the BRP.

An alternate model is proposed, involving gravitational instability of the subducting plate, resulting in seaward migration of the subduction zone when the upper plate moves slowly towards or even away from the trench--a mechanism supported by correspondence of contemporary back-arc spreading with absolute motion models. If the Snake River Plain-Columbia River Plateau-Oregon Coast Range volcanics represent the trace of the Yellowstone hotspot, and, therefore, record N. American plate motion, W to SW motion is indicated prior to ∿20 myBP and since ∿10 myBP. Between ∿20 and ∿10 myBP, N. America apparently moved northward, parallel to or obliquely away from the trench, resulting in back-arc extension (Basin Range faulting) in the regions of arc magmatism; limited extension occurred in those regions in which magmatism, and beneath which subduction had ceased. Continued faulting since ∿10 myBP represents the combined effects of diffuse Pacific-N. American interaction and the Yellowstone hotspot.

QUATERNARY FAULTING IN CLAYTON AND BIG SMOKEY VALLEYS, NEVADA

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Two trends of fault scarps occur near the margins of the playa surface of Clayton Valley, 45 km southwest of Tonopah, Nevada. At the eastern margin, a set of moderately dissected scarps in alluvial gravels of Quaternary age strikes about N. 20° E. South of the northeastern arm of the playa, a more highly dissected set of scarps in consolidated alluvium strikes about N. 65° E. Representative slope profiles of both scarp trends were measured in the field. Scarps of the N. 20° E. trend have pronounced basal concavities, suggesting accumulation of sediment. Profiles of the N. 65° E. trend show less pronounced concavities, suggesting some removal of debris at the base. However, for a given scarp height, scarps associated with the N. 65° E. trend consistently have shallower slope angles than scarps along the N. 20° E. trend. This relationship is probably not influenced by the effect of basal erosion or accumulation, and suggests that the N. 65° E. scarps are the older of the two sets. The regression line calculated from scarp height versus slope angle for the N. 20° E. set of scarps is similar to regression lines calculated for 10,000- to 15,000-year-old scarps elsewhere in the Great Basin.

Scarps resulting from multiple displacements in alluvium in Big Smokey Valley suggest a chronology of faulting similar to that in Clayton Valley. In Big Smokey Valley, however, the youngest scarps, which offset pluvial lake gravels, appear to be distinctly younger than any scarps found in Clayton Valley.

METHODS OF GROUND-WATER DATING

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The age of ground water is the length of time the water has been isolated from the atmosphere. Theoretically, ages can be estimated by (1) travel time of ground water from a recharge point to a subsurface point as calculated by Darcy's law, (2) decay of atmospheric radionuclides such as ^{3}H, ^{39}Ar, ^{32}Si, ^{14}C, ^{81}Kr, and ^{36}Cl, (3) accumulation of products of radioactive reactions and decay such as ^{3}He, ^{4}He, ^{21}Ne, ^{40}Ar, and ^{136}Xe, (4) disequlibrium between radioactive parent and daughter products such as ^{234}U and ^{238}U, (5) time dependent changes of molecular structures of compounds such as amino acids, (6) concentration of man-made compounds such as CCl_3F and CCl_2F_2, (7) correlation of temperature indicators such as Ar/Ne and $^{18}O/^{16}O$ ratios with known changes in paleotemperatures, and (8) presence or absence of ions such as chloride which originate from past geologic events such as sea-level fluctuations. Darcy's law and analyses of ^{3}H, ^{14}C, and $^{18}O/^{16}O$ are widely used; ^{39}Ar and ^{36}Cl decay, ^{4}He accumulation, $^{234}U/^{238}U$, CCl_3F/CCl_2F_2, and Ar/Ne also appear feasible. For very old water, ^{81}Kr, ^{21}Ne, and ^{136}Xe would be geochemically attractive, but sample preparation problems and volume of water required are formidable. Most hydrogeologic studies require more than one method in order to date water in different age ranges. For example, CCl_3F/CCl_2F_2 (0-30 yr), ^{39}Ar (30-1000 yr), ^{14}C (500-5X10^4 yr), and ^{36}Cl (5X10^4-10^6 yr) might be used as a combination of methods. Combinations are needed to determine the extent of mixing during both transit in aquifers and subsequent flow into wells.

LATE QUATERNARY VERTICAL DEFORMATION ALONG THE NORTH FLANK OF THE SAN EMIGDIO MOUNTAINS, CALIFORNIA

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The north flank of the San Emigdio Mountains lies between two active tectonic systems; the San Andreas Fault and the Pleito Thrust-Wheeler Ridge-White Wolf fault system. Nearby level surveys during this century mark the latter tectonic system as the zone of crustal flexuring along the northwestern boundary of the southern California uplifts (1902/1926 and 1959/76). Geomorphic and structural data supplemented by study of the Quaternary deposits allow a general understanding of the nature, distribution, and evolution of vertical crustal movements in the San Emigdio Mountains during the late Quaternary.

A well preserved flight of late Cenozoic erosional and depositional surfaces descend the mountain front to the San Joaquin Valley. Late Pleistocene (?) deposits associated with the youngest and lowermost surface truncate the western segment of the Pleito thrust system; however, valleyward from the Pleito these deposits are strongly folded (up to 80 degrees overturned) in a monoclinal style along the western projection of the Wheeler Ridge anticline. Immediately north of the flexure, within the valley floor, active fan systems are being deformed by the rapid growth of a series of east-west trending folds.

Clast provenance of the Quaternary deposits along the mountain front, the distribution of stream captures, and geomorphic characteristics of present-day streams indicate that drainage basins associated with outlets to the San Joaquin Valley were and are now rapidly impinging on older and less active south and east flowing drainages.

These observations suggest: 1) rapid crustal flexuring along the north flank of the San Emigdio Mountains during the late Quaternary, 2) northward expansion of this flexure with time, 3) folding as the dominant mode of vertical tectonics, and 4) episodic uplift rates.

STRIP MAP OF THE WESTERN BIG BEND SEGMENT OF THE SAN ANDREAS FAULT ZONE, CALIFORNIA

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Large-scale fault zone mapping by graduate students at UCSB has resulted in a 6 km-wide strip map of the San Andreas fault zone from Interstate 5 to Highways 166 and 33 at a scale of 1:12000; future additions are now in progress to the southeast. The mapped area includes the western portion of the "Big Bend" where the fault trace curves sharply from a northwest to an east-west trend. The map shows the various structural and geomorphic elements of the fault zone such as the 1857 earthquake rupture, other older active and inactive faults, an assortment of tectonic landforms and pertinent Quaternary deposits.

Throughout the mapped segment the fault zone is usually narrow (<300 m), the active zone narrower (<100 m), and the zone of surface rupture attributed to the 1857 earthquake is commonly no wider than 10's of meters. The recent shear pattern is dominated by en echelon left-stepping right shears which commonly bound similarly oriented linear ridges (pressure ridges or squeeze-ups). Deep exposures of the fault zone in the western part of the area reveal that Tertiary marine strata and older crystalline rocks have been squeezed up along the fault zone and thrust over late Pleistocene (?) depositional surfaces. Other salient features of the mapped area include displaced drainages, offset late Pleistocene ponded alluvium, a series of offset Pleistocene drainage networks, and correlative Quaternary surfaces which reside on both sides of the fault. The above field work has found abundant evidence for continual right-slip during the late Quaternary but no compelling evidence for any significant regional component of vertical slip during the same time period.