d28 Basin and Range province < graben & horsts >

> Basin. Fault. Range. Basin. Fault. Range. A mile of relief between basin and range. Stillwater Range. Pleasant Valley. Tobin Range. Jersey Valley. Sonoma Range. Pumpernickle Valley. Shoshone Range. Reese River Valley. Pequop Mountains. Steptoe Valley. Ondographic rhythms of the Basin and Range.
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> —John McPhee, *Basin and Range*, 1981.[1]

Basin and Range province is characterized, as in Nevada, by numerous mountainous blocks of rock bounded by north-trending faults. Movements on these faults continue. Down-dropped blocks (termed *graben*), are here the basins that with internal drainage accumulate sediments. Up-lifted blocks (termed *horsts*), are here the ranges, often thinly covered in snow in the winter, and wooded at their crests. Subject to erosion, the ranges have pediments at their feet. Intermittent streams flow from the ranges and feed lakes as freshwater Lake Tahoe, CA, Great Salt Lake, UT, and smaller salty lakes, called *playas*. Death Valley is a well known basin. Its parched floor at Bad Water at 86 m (282 ft) below sealevel is the lowest continental elevation in the western hemisphere (***Footnote d28.1***). But this is exceptional in the Basin and Range province where northward (concomitant with stretch-thinning of the lithosphere and inflow-thickening of the asthenosphere beneath to maintain isostasy) basin-floor altitudes are 1,000 to 1,500 m above sealevel. The western margin of the province is marked by the dramatic fault escarpment of the Sierra Nevada. A recent analysis by Jack A. Wolfe of fossil leaves from basin sediments indicate that the elevations of the basins he sampled have changed little since 13 million years ago.[2] But the same basin-floors were 3,000 m above sealevel 16 million years ago and at even higher elevations before. The fossil-leaf altitude data depend on how well leaf-size and shape, number of notches on leaf margins, and other measurable characteristics, proxy for moisture and temperature. The raising of the Sierra Nevada during the Pliocene also caused the rain-shadow climate to the east to become increasingly arid. The climate had been subtropical at the beginning of the Pliocene. At that time, the entire region was a plain at low elevation.

Widening, beginning 17 million years ago, of the Basin and Range by normal (tensional) faulting has doubled its east-west width. During this time, counterclockwise rotations of the North American and Pacific plates amount to a right-lateral shear difference of 737 km at their contact. Of that, 315 km can be accounted for by right-lateral slip on the San Andreas Fault. William R. Dickinson in 2002 proposed that the other half is best accounted for by movements spread through the width of the Basin and Range province.[3] Shear deformation of the province is locally evident in the Santa Monica and Santa Ynez mountains' east-west trend that paleomagnetic studies, first by M. J. Kamerling in 1979,[4] show has been cogwheel-rotated clockwise from a north-south trend.

The present graben and horst scenery is due to normal fault throws that have thinned the crust by half on listric reverse faults that formerly thickened the crust.[5]

Early Neogene volcanism had covered most of the province with lava flows. In these, basaltic lava flows of Late Miocene age succeed Early Miocene rhyolitic lava flows and pyroclastics. Of these latter, Gerardo J. Aguirre-Diaz and Guillermo Labarthe-Hernandez in 2002 describe, in the Sierra Madre Occidental, domes and dikes of devolatized rhyolitic magmas aligned to Basin and Range extensional faults in which are also co-ignimbrite lithic lag breccias.[6] Evidently normal faults cut the roofs of batholith-sized magma chambers at shallow crustal levels. Resulting fast decompressions, produced the world's largest body of continuous ignimbrite (1,000 m in average thickness, 1,200 km long, and 200-500 km wide). Congress has instructed DOE to investigate the rhyolitic ash-flow tuffs of Yucca Mountain within southern Great Basin, Nevada, for a nuclear waste repository that, located some 300 m above the regions' water table, would permit monitoring and retrieval if needed.[7]

During the Paleogene, the region was an upland of moderate elevation undergoing erosion. ❑