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Transtensional deformation in the Lake Tahoe region, California and Nevada, USA

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Abstract

Dextral transtensional deformation is occurring along the Sierra Nevadaâ€“Great Basin boundary zone (SNGBBZ) at the eastern edge of the Sierra Nevada microplate. In the Lake Tahoe region of the SNGBBZ, transtension is partitioned spatially and temporally into domains of northâ€“south striking normal faults and transitional domains with conjugate strike-slip faults. The normal fault domains, which have had large Holocene earthquakes but account only for background seismicity in the historic period, primarily accommodate eastâ€“west extension, while the transitional domains, which have had moderate Holocene and historic earthquakes and are currently seismically active, primarily record northâ€“south shortening. Through partitioned slip, the upper crust in this region undergoes overall constrictional strain.

Major fault zones within the Lake Tahoe basin include two normal fault zones: the northwest-trending Tahoeâ€“Sierra frontal fault zone (TSFFZ) and the north-trending

northwest-trending Tahoeâ€“Sierra frontal fault zone (TSFFZ) and the north-trending West Tahoeâ€“Dollar Point fault zone. Most faults in these zones show eastside down displacements. Both of these fault zones show evidence of Holocene earthquakes but are relatively quiet seismically through the historic record. The northeast-trending North Tahoeâ€“Incline Village fault zone is a major normal to sinistral-oblique fault zone. This fault zone shows evidence for large Holocene earthquakes and based on the historic record is seismically active at the microearthquake level. The zone forms the boundary between the Lake Tahoe normal fault domain to the south and the Truckee transition zone to the north.

Several lines of evidence, including both geology and historic seismicity, indicate that the seismically active Truckee and Gardnerville transition zones, north and southeast of Lake Tahoe basin, respectively, are undergoing northâ€“south shortening. In addition, the central Carson Range, a major north-trending range block between two large normal fault zones, shows internal fault patterns that suggest the range is undergoing northâ€“south shortening in addition to eastâ€“west extension.

A model capable of explaining the spatial and temporal partitioning of slip suggests that seismic behavior in the region alternates between two modes, one mode characterized by an eastâ€“west minimum principal stress and a northâ€“south maximum principal stress as at present. In this mode, seismicity and small-scale faulting reflecting northâ€“south shortening concentrate in mechanically weak transition zones with primarily strike-slip faulting in relatively small-magnitude events, and domains with major normal faults are relatively quiet. A second mode occurs after sufficient northâ€“south shortening reduces the northâ€“south S_{hmax} in magnitude until it is less than S_{v}, at which point S_{v} becomes the maximum principal stress. This second mode is then characterized by large earthquakes on major normal faults in the large normal fault domains, which dominate the overall moment release in the region, producing significant eastâ€“west extension.

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Keywords

Transtension; Seismotectonics; Lake Tahoe region; Western USA

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