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Chapter 1o

The seismicity of Nevada and some adjacent parts of the Great Basin

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INTRODUCTION

The seismicity of Nevada is distributed in several broad zones that connect with significant seismic zones in surrounding states and appear to concentrate the largest earthquakes in the Great Basin province. During the historic record, which extends over the last 140 years, a number of large, damaging earthquakes occurred in some of these zones, and those larger than magnitude 6 typically produced surface rupture. Based on geologic evidence, most of these earthquakes are believed to have occurred on steeply dipping range-front normal faults that penetrate the crust to midcrustal depths. For numerous cases, however, seismic and geodetic data suggest that strike slip and oblique slip occurred at focal depths. Microearthquake data also indicate a preference for dextral strike slip and oblique slip on northerly trending, steeply dipping faults at depths ranging from near-surface to about 15 km. In addition, some discrepancy exists between the orientation of faults inferred from seismic and geologic data. Faults show a tendency to be rotated clockwise relative to preferred nodal plane orientation. Little seismic evidence has been found for slip on low-angle detachment or listric faults in spite of abundant geologic evidence for this deformation style in the last 15 m.y.

The existence of seismic evidence for transcurrent slip on northerly trending faults is at variance with popular tectonic models for the large, young structures in the region—the basins and ranges. The seismic data are also not in accord with the abundant northwest and northeast conjugate strike-slip faults that exist in the Walker Lane belt and the margins of the southern Great Basin. The tectonic framework of the seismicity of the region is, thus, incompletely understood. Discerning between various tectonic driving mechanisms could help resolve these problems. For instance, previous discussions have raised questions regarding whether Great Basin deformation is causally related to tectonics along the continental plate margin (i.e., Slemmons, 1967; Atwater, 1970), or to processes internal to the Great Basin such as an over-thickened crust (Coney and Harms, 1984), gravitational spreading (Wernicke, 1981), or other processes related to back-arc extension (Matthews and Anderson, 1973; Coney, 1987). This summary of historical and current seismicity data of the region provides a basis for evaluating contemporary deformation in terms of generalized tectonic models of the Great Basin.

SEISMICITY OVERVIEW

The seismic patterns in Nevada (Fig. 1, 2, and 3) can be discussed in terms of several significant trends. The most prominent seismic trend is the zone of moderate-to-large earthquakes extending northward from southern California into west-central Nevada. This zone was referred to as the 118°W Meridian Zone by Slemmons and others (1965) and as the Ventura-Winnemucca zone by Ryall and others (1966). The part of the zone within Nevada has been referred to as the central Nevada seismic belt (CNSB) by Wallace (1984a). We use the latter term in this chapter. This zone includes the largest Nevada earthquakes in historic time. Since 1900, three earthquakes greater than magnitude 7.0 occurred, and seven earthquakes produced surface rupture (Tables 1 and 2; magnitudes in this chapter are M_L or M_S, unless otherwise noted).

The second zone of prominent seismicity is the Sierra Nevada–Great Basin boundary zone (SNGBZ), described by Van Wormer and Ryall (1980). The zone extends northwest near the California-Nevada border from Bishop to Reno and continues for hundreds of kilometers into northern California. Earthquakes in the zone tend to concentrate along the east flank of the Sierra Nevada. In addition to frequent moderate earthquakes, large events have also occurred in 1852, 1860, and 1872. The Mammoth earthquake series is also in this zone. Five earthquakes in the SNGBZ have produced surface rupture.

The third trend that is apparent in Figure 2 is the arcuate earthquake zone extending from the south end of the Wasatch front in Utah into and across southern Nevada to eastern California near Bishop. This earthquake trend has been referred to as the

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