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Damaging Earthquakes in Nevada
1840s to 2008

by

Craig M. dePolo
Nevada Bureau of Mines and Geology

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INTRODUCTION

Many earthquakes have strongly shaken Nevada and caused serious damage throughout its relatively short 150-year recorded history. Some of these earthquakes occurred near Nevada communities and others occurred in more sparsely populated areas of the state, causing variations in damage and information from event to event. Accounts of the earliest of these earthquakes are few, sometimes only as passing references in newspaper archives and museums. More recent earthquakes have been studied in greater detail, but still many of the effects and impacts escaped being recorded. Nevada earthquakes have caused several injuries and damage that has included partially and totally collapsed buildings, broken chimneys and windows, broken merchandise and contents. Major earthquakes have occurred at all times of the year from mid-summer to the cold middle of winter, when broken windows and the loss of chimneys offer serious additional challenges. Damaging earthquakes have struck the state repeatedly, and Nevadans met these challenges head-on with a vigorous pioneering spirit that has led to a successful recovery. The accounts of these earthquakes are the most convincing evidence to motivate people to take earthquake hazards seriously and prepare themselves for future strong earthquakes. They can also motivate communities to seismically strengthen existing vulnerable buildings and build new buildings to current earthquake codes and standards. This poster briefly describes some of Nevada's significant earthquakes to help provide a background of earthquake knowledge.

The earthquake descriptions are culled from many compilations of historical earthquake studies, including Townley and Allen (1939), Slemmons and others (1965), Toppozada and others (2000), Toppozada and others (1981), Stover and Coffman (1993), dePolo and others (2003), and dePolo and Garside (2006). Many sources have been consulted to compile these earthquake accounts, such as newspapers, letters, weather records, and published and unpublished reports. A special abbreviated reference and date was used for the many newspaper accounts in the descriptions. The newspaper abbreviations are listed on the lower left side of the poster. The descriptions are short and tailored to describe different kinds of earthquake effects. For more information, readers are directed to the original references.

Moment magnitudes were used for these events, which were taken from, or slightly modified from, a compilation and analysis by Pancha and others (2006). Over the last ~150 years Nevada has had 3 large earthquakes with magnitude >7, which occurred between 1915 and 1954 in the central Nevada seismic belt. These earthquakes caused damage not only in nearby communities, but also in areas as far as two valleys away and were felt across the entire state. In the same 150-year period, Nevada had 20 earthquakes with magnitudes in the 6–6.9 range and several damaging earthquakes with magnitudes that were less than 6. Most of the damaging events in Nevada have been in the magnitude 6–6.9 range and have occurred every decade or so throughout the historical period. On average in Nevada, magnitude 6 or larger events have occurred every 7 years and magnitude 7 or larger events have occurred about every 50 years, although all three magnitude 7 events occurred within 39 years.

Nevada is earthquake country because it is tectonically active. East–west to NW–SE-directed extension of the Basin and Range Province affects all of Nevada. This extension induces normal faults and the mountain/valley morphology in Nevada. In addition, the western part of Nevada is influenced by the North American and Pacific Plate boundary system (Faulds and Henry, 2008). The Sierra Nevada block is caught up in this system and is moving to the northwest relative to central to eastern Nevada, wrenching western Nevada to the northwest as well. One fifth of the plate boundary motion (~1 cm/yr) occurs to the east of the Sierra Nevada (Kreemer and others, 2012), producing many active right-lateral and left-lateral strike-slip faults in this region. This is why western Nevada has persistently high rates of earthquake activity.

EARTHQUAKE EFFECTS

Nevada earthquakes have caused severe ground-shaking, injuries, pronounced building damage, business disruptions, serious individual lifestyle changes, and remarkable amounts of ground surface displacement. These effects highlight some of the specific hazards that can occur during earthquakes.

Although there are several accounts of severe injuries from earthquakes, such as a skull fracture caused by the 1932 Cedar Mountain earthquake and broken bones from the 1954 Rainbow Mountain and the 2008 Wells events, there have been no recorded deaths in Nevada due to earthquakes. This has been because of the remoteness of some of these events and a certain amount of luck in the case of events near populated areas that occurred at non-peak business hours when people were not occupying or near buildings that collapsed or were damaged.

The ground has been offset, shifted, and wrenched in spectacular ways during the larger Nevada earthquakes. Ground ruptures as long as 75 km (~47 mi) with surface offsets as much as 5.8 m (~19 ft) occurred during earthquakes in 1915, 1932, and twice in 1954. Other natural effects of these earthquakes have included landslides, rock falls, subsided areas of land, earth fissures, and a phenomenon called liquefaction, where water-saturated ground temporarily acts like a liquid because of shaking. During liquefaction, the ground can flow sideways, oscillate very strongly, subside, and/or temporarily spout fountains of water and sand, such as in the 1887, 1933, and 1954 earthquakes.

Damage caused by Nevada earthquakes has ranged from nuisance damage, (such as cans falling to the floor in a pantry) to the total collapse of buildings. The most severe earthquake damage in Nevada has been suffered by older unreinforced masonry buildings. Many of these damaged buildings have been repaired and reused, but several were torn down. Structural damage has been widely variable and has been related to the type and age of the buildings and to the geological nature of the underlying ground on which they are built. Nonstructural damage is defined as damage to the contents and building components that do not threaten the integrity of the structure, but can threaten occupants. In Nevada as elsewhere, nonstructural damage has been common in communities struck by strong earthquakes and has been the leading cause of earthquake injuries.

Damaging earthquakes created significant economic losses and financial hardships for individuals and communities. For example, the 2008 Wells earthquake cost over $10.5 million (dePolo, 2011c). Computer simulations of potential economic cost from future Nevada earthquakes range from millions in our rural communities to billions in Nevada's urban areas (Price and others, 2009). The only way to reduce these costs is through mitigating the shaking and ground offset effects.

EARTHQUAKES AND PEOPLE

Strong earthquakes and their aftershock sequences have been high-anxiety events for people. People who best coped with earthquakes were those who had well-thought-out and rehearsed plans of what to do when they first felt the earthquake and followed those plans. To survive earthquakes well, people need to have a safe place to take cover and should remove or secure any particularly dangerous shaking hazards in their homes and workplaces. A review of historical earthquakes indicates it is far wiser to take cover inside a building and protect oneself from falling objects inside than it is to run outside during an earthquake, where falling debris may injure them and block exitways.

After earthquakes shook communities strongly, everyone was on high alert and people had a strong need to talk to each other, partly to sort through what just happened to them and partly to feel like they were not alone in these feelings. The most common question people first asked each other following an earthquake, almost comically, was "Did you feel that?" This immediate need for social interaction underscores the importance of checking on people who live alone or have mobility issues, because communication systems are usually down or overwhelmed immediately following a strong earthquake. Checking on neighbors following a strong earthquake is an excellent policy. Historically, Nevadans have recovered well from earthquakes, with everyone pitching in to get communities back on their feet.

Nevada's emergency-response professionals and citizens have been effective in responding to and recovering from earthquakes. Emergency response professionals, even those without any formal training in earthquakes, dealt with acute situations quickly and effectively by using general earthquake knowledge and their response training and experience. For example, two officers on duty when the July 6, 1954 earthquake struck Fallon quickly coordinated with one roping off the damaged downtown and the other touring the city looking for fires (Fallon Standard 7/7/54). In the 2008 Wells earthquake, local personnel rapidly secured all emergency situations preventing development of larger incidents.

SUMMARY

These significant earthquakes occurred during the period from the mid-1800s to 2008 and include the largest historical examples, but there were other damaging earthquakes with smaller magnitudes in the state as well. These earthquakes and their descriptions remind us that Nevada is earthquake country and that earthquakes will produce strong shaking within our communities in the future. A wise course of action for Nevadans is to heed the lessons of past events, know how to react to an earthquake, actively prepare for earthquakes, have a disaster plan, have

a disaster kit, and become earthquake resilient. Many ideas for being safe and protecting your property from earthquakes can be found in *Living with Earthquakes in Nevada* on the web at http://www.nbmg.unr.edu (NBMG Special Publication 27).

We know that earthquakes will continue to occur in the future as one type of natural hazard with the potential for disastrous consequences of injury, property damage, and disruption of daily business. The impact that earthquakes have on our lives, however, can be minimized by preparing for earthquakes and by fostering the pioneering spirit, resolve, and know-how that Nevadans have always shown to help restore our communities after disasters.

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