## **Earthquake Hazards in Carson City**

Presentation by Jonathan G. Price Nevada Bureau of Mines and Geology





Earthquake faults occur throughout Nevada, and potential losses from earthquakes are high for many communities, including Carson City.





# Earthquake faults occur throughout Nevada, and potential losses from earthquakes are high for many communities.

NBMG Map 167, *Quaternary Faults in Nevada*, is now available not only as a poster but also as an interactive map (Open-File Report 09-9) on line at <u>www.nbmg.unr.edu.</u> You can use it to locate your home or business.







www.nbmg.unr.edu





## Easy to pinpoint an address



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#### Quaternary Faults in Nevada - Online Interactive Map

www.nbmg.unr.edu

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## Multiple ways to zoom in to a location



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Display faults, colored by age of most recent movement, on topographic or aerial photographic base maps.



Display faults, colored by age of most recent movement, Look for a fault | Find Address on topographic or aerial photographic base maps. Results I402 West King Street, 1402 W King St, Carsol ÷ Irginia City **New Washoe City** ne Village Tahoe Vista Kings/E Map Contents Quaternary\_Faults te Bav Legend Historic - within the Historic - within the Dolla latest Pliestocene & Lyon Count Zlatest Pliestocene & Tahoe City late Quaternary - wi Washoe County late Quaternary - wi middle Quaternary Middle Quaternary -Quaternary - within Quaternary - within Base Data 9i10glj\_TOPO\_data Base Data USGS\_aerial\_photographs Glenbrook Carson City 🗄 🔽 Base Data Douglas County Dorado County Lake Tahoe Zephyr Cove

Look for a fault | Find Address Information is available on individual faults. Results ■ ▼ 1402 West King Street, 1402 W King St, Carson + rginia City s **New Washoe City** > ine Village Tahoe Vista Kings/B Map Contents Quaternary\_Faults Bas Legend Historic - within the Historic - within the Doifa latest Pliestocene & von Count Zlatest Pliestocene & Tahoe City Genoa fault (Legend)  $\triangle (X)$ late Quaternary - wi Washoe County late Quaternary - wi Genoa fault Name middle Quaternary Zmiddle Quaternary -Zone Quaternary - within <15,000 years Age Quaternary - within Туре Base Data Symbol 9i10glj\_TOPO\_data USGS Q Fault & Fold Base Data Source Database USGS\_aerial\_photographs Glenbrook Remarks 🗄 🔽 Base Data Slip rate of SlipRate 1-5 mm/yr County Dorado Co QFLT ID 1 to 5 mm/yr = QFTL\_NUM 1285 up to 5 meters Symbol Mapped (16 feet) every Quaternary Faults > Legend Lake T Add to Results 1,000 years.

#### Look for a fault | Find Address



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Faults are shown as 1,000-meter (3,281-feet) swaths, inside which geological studies should be conducted to precisely locate the faults relative to building sites.



#### Look for a fault | Find Address

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Individual faults are sometimes visible as breaks in the slope (scarps), which appear as shadows or lines of vegetation on aerial photographs.

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Faults are shown as 1,000-meter (3,281-feet) swaths, inside which geological studies should be conducted to precisely locate the faults relative to building sites.

Carson

Individual faults are sometimes visible as breaks in the slope (scarps), as along US-395 north of Williams Street.

Miller Way

Pineview Way

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W Adams St

W Park S

E Adams St

E Park St

CorbettSt

E John St

E William St.

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#### Faults in Nevada - Online Interactive Map

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automatically picks a more detailed USGS topographic base map.

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Faults are shown as 1,000-meter-wide swaths, here on an aerial photograph base.

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Faults are shown as 1,000-meter-wide swaths, here on a topographic map base.

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Genoa fault (500 Meter Fault \* Buffer) Genoa fault Name Zone <15,000 Age :Ol N Туре USGS Q Fault & Fold Source Database Remarks SlipRate 1-5 QFLT\_ID QFTL\_NUM 1285 Symbol Mapped

Use the information icon to find the age of latest rupture (in years), the slip rate (in millimeters per year), and other information.

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The USGS integrates (1) fault, (2) earthquake, and (3) geodetic data into its probabilistic seismic hazard analysis.

(1) Active faults occur nearly everywhere in Nevada, including Carson City.

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(2) Earthquakes have occurred throughout Nevada.



(3) Geodetic data indicate that the **Basin and Range** province is gaining about 1.3 acres of area per year through crustal extension, and that western Nevada is accommodating ~20% of the North American-**Pacific plate** interaction.

Kreemer and Hammond (2007)



In Nevada, much of the right-lateral shear between the North American and Pacific plates occurs along northwest-striking strike-slip faults of the Walker Lane.

Extension largely is accommodated along N- to NE-striking, basin-bounding normal faults.

Walker Lane

40 60 kilometers

# The hazard: expressed in terms of probability of an earthquake of a given magnitude occurring within 50 years and within 50 km of the community.

	% Proba	bility of mag	gnitude greate	er than or ec	qual to magnitude
Community	5.0	5.5	6.0	6.5	7.0
Dayton	>90	~80	70-75	50-55	12-15
Carson City	>90	~80	70	50-55	12-15
Reno	>90	~80	67	50	12-15
Incline Village	>90	~80	60-70	40-50	10-12
Stateline	>90	~80	60-70	40-50	10
Fallon	80-90	~60	35	20-25	6-8
Las Vegas	40-50	~30	12	4-5	<0.5
Elko	30-40	~25	10-15	6-8	0.5-1
Wells	30-40	~20	9	6	0.5-1
Laughlin	10-20	~5	2-3	0.5-1	<0.5

Data are from the USGS at http://eqint.cr.usgs.gov/eqprob/2002/index.php. Values for magnitude 5.5 are extrapolated between 5.0 and 6.0. Earthquake faults occur throughout Nevada, and potential losses from earthquakes are high for many communities.

NBMG Open-File Report 09-8, *Estimated Losses from Earthquakes near Nevada Communities*, demonstrates that the consequences of earthquakes can be huge in Nevada, particularly if individuals are not prepared.





Earthquake risks in Nevada are assessed by the Nevada Bureau of Mines and Geology using the Federal Emergency Management Agency's lossestimation model, HAZUS-MH, and the U.S. Geological Survey's probabilistic seismic hazard analysis. These loss estimates are useful in hazard-mitigation planning, in building scenarios for emergency response and recovery exercises, and in helping emergency managers and the Governor make decisions on official disaster declarations after an actual earthquake.



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NBMG Open-File Report 09-8, *Estimated Losses from Earthquakes near Nevada Communities*, contains HAZUS scenarios for magnitude 5.0, 5.5, 6.0, 6.5, and 7.0 earthquakes near 38 communities in Nevada.

Uncertainties in the location of epicenters, depths, and magnitude, when combined with changing population and uncertainties in local effects (soil and rock types, assumptions about attenuation, basin geometry, liquefaction potential, and directivity), make loss estimates generally consistent within one order of magnitude (a factor of 10), although experience with urban earthquakes in the US has generally yielded numbers within a factor of 2 or 3 of the actual damages.

HAZUS estimates for total economic loss from a magnitude 6.0 earthquake and probability of an earthquake of this magnitude or greater occurring within 50 years and within 50 km of the community.

Community	<b>Total Economic Loss</b>	Probability in 50 years within 50 km
Las Vegas	\$7.2 billion	12%
Reno	\$1.9 billion	67%
<b>Carson City</b>	\$650 million	<b>70%</b>
Elko	\$160 million	10 to 15%
Fallon	\$110 million	35%
Wells	\$30 million	9%

Total economic loss is from HAZUS. Probabilities are from the USGS at http://eqint.cr.usgs.gov/eqprob/2002/index.php .

The probability of a magnitude 6.0 earthquake occurring within 50 km of Wells, Nevada within the next 50 years is approximately 9%. It happened on 21 February 2008.



The probability of a magnitude 6.0 earthquake occurring within 50 km of Carson City within the next 50 years is approximately 70%, 7.8 times higher than for Wells.

> 0.80 0.75 0.70

> 0.65 0.60 0.50

0.40 0.30

0.20

0.10

0.05 0.00



Earthquake faults occur throughout Nevada, and potential losses from earthquakes are high for many communities.

The consequences of earthquakes can be huge in Nevada, particularly if individuals are not prepared.

A. Be prepared to respond.

B. Mitigate structural risks, largely through building codes and avoiding faults and areas of liquefaction.

C. Mitigate nonstructural risks.

Unreinforced masonry building (URM) that collapsed during the Wells earthquake on 21 February 2008

View from back, 20 May 2009

View from front, 20 May 2009



Nonstructural damage often can be easily prevented.







# Thank you!

And thanks to Craig dePolo, Gary Johnson, Christine Ballard, Heather Armeno, Irene Seeley, Linda D. Goar, and Jordan T. Hastings for their work on the open-file reports (OF 09-8 and 09-9), which are available as online documents at www.nbmg.unr.edu.

From there, go to online documents at http://www.nbmg.unr.edu/dox/dox.htm, then scroll down to OF 09-8 or 09-9. Link to the fault map from OF 09-9.



