# Earthquake Hazard in the Reno-Tahoe-Carson City Area

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## Introduction

The Reno-Tahoe-Carson City region of Nevada is one of the fastest growing urban areas in the US and lies within the Walker Lane tectonic zone. The Reno-Sparks metro area lies in a triangular valley containing a network of N-striking normal faults, NW-striking right-lateral faults and NE-striking left-lateral faults (Fig. 1).

Potentially damaging earthquakes of M4.5 or greater were frequent in the late 19th and early 20th centuries, with at least 20 events between the 1850s and 1960s (Fig. 2). A period of relative quiescence after the large earthquakes in central Nevada in the 1950s ended with more observed activity from the 1990s to present, including several swarms culminating in felt events and minor damage. Reno-Tahoe-Carson City now has a population exceeding half a million, and is considered to be an area of high hazard and risk given the tectonic setting and record of historical and recent earthquakes.

We present the state of knowledge for the Reno-Tahoe-Carson City area, synthesizing geologic mapping, geophysical investigations, seismicity patterns, available geochronology, and motivate priorities for future earthquake hazard research.

## Motivation

High resolution lidar DEMs have been available for about a decade, allowing for detailed mapping of some Quaternary active faults (e.g. Brailo, 2016). Relocated seismicity catalogs exist for post-2008 sequences, and moment tensor solutions have been compiled for recent M3+ events. Active fault traces with geomorphic expression are well-mapped. Local studies have helped constrain fault dip direction, fault linkages, and in some cases, total displacement, slip rate and recurrence. A few potential earthquake scenarios for use in planning have been developed, along with a community velocity model for scenario-shaking computation.

A comprehensive reassessment of the Reno basin and surrounding region has not been completed. Commonly used fault map sources (e.g. the USGS Quaternary Faults and Folds database, NSHM 2023) are in need of updates and curation using higher resolution datasets.

## Seismicity and Paleoseismic Studies

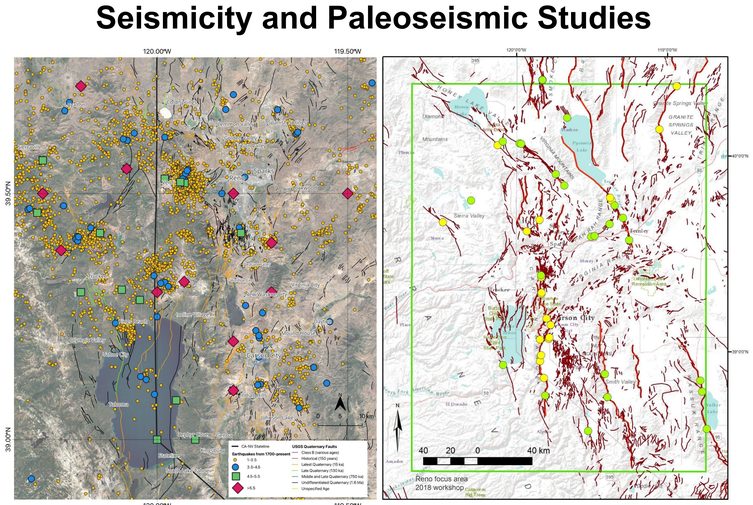


**Figure 1:** Historical seismicity and recent paleoseismic study sites compared to known Quaternary faults (USGS Quaternary Faults & Folds Database, "Q-faults"). **A:** Earthquake epicenters in the Reno-Tahoe-Carson City Study Area 1700-2025, from the USGS Earthquake Catalog. **B:** Sites of paleoseismic studies in the Reno-Carson region of Nevada that are recorded (yellow circles) and not recorded (green circles) in the Quaternary Faults and Folds Database (modified from Anderson & Koehler, 2019). Fault maps shown are Q-faults (thin dark red lines) and the National Seismic Hazard Model fault sources 2014 (heavy bright red lines).

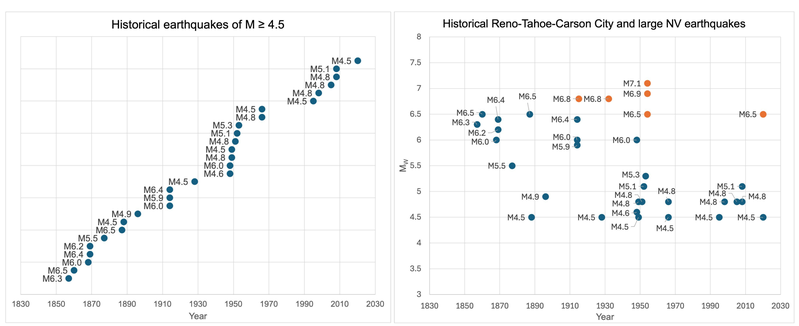


**Figure 2:** Summary of potentially damaging earthquakes of M4.5 or greater from the mid 19th to current day from the USGS earthquake catalog. **A**: Historical earthquakes in the Reno-Tahoe-Carson City area from the mid 19th century to present day. **B**: Comparison of historical earthquakes in the Reno-Tahoe-Carson City area (blue) and large historical earthquakes in Nevada.

## Fault Maps

Geological mapping of faults in this region differs between studies and commonly used fault map sources, notably in terms of fault location, abundance, length, and linkages (Fig. 3). Additionally, most mapped traces from the USGS Quaternary Faults and Folds Database ("QFaults") have not been reviewed since 1999.

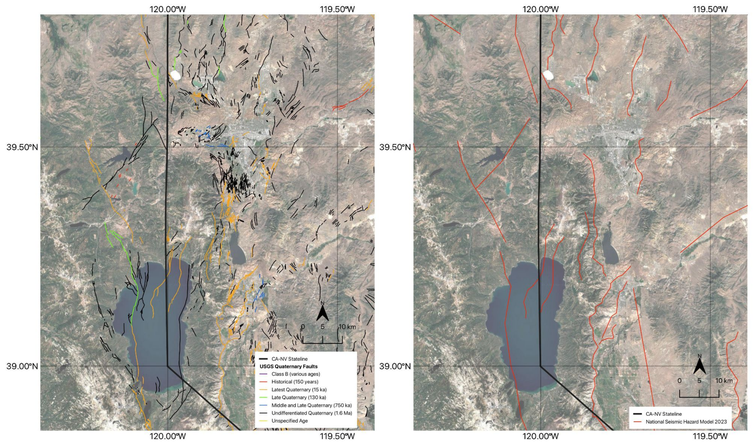


**Figure 3:** Comparison between mapped faults from the USGS Quaternary Faults & Folds Database (left) and the 2023 National Seismic Hazard Model (NSHM) (right).

## Subsurface Investigations

Several shallow geophysical investigations through downtown Reno have revealed basin thickness and basement offsets along steep faults (Fig. 4-6). Some of these faults are correlated to few-meters tall surface scarps and others have little to no geomorphic expression (Fig. 4). Basin depth changes and tilting of Tertiary sediments correspond with ~100s meters basin depth change at the "Virginia Street Fault" which is not mapped on the surface (Fig. 5-6).

Resolving the fault geometry, sense and timing of displacement, would elucidate how the Mount Rose Fault system connects across the Truckee Meadows through the city (teal zone Fig 7).

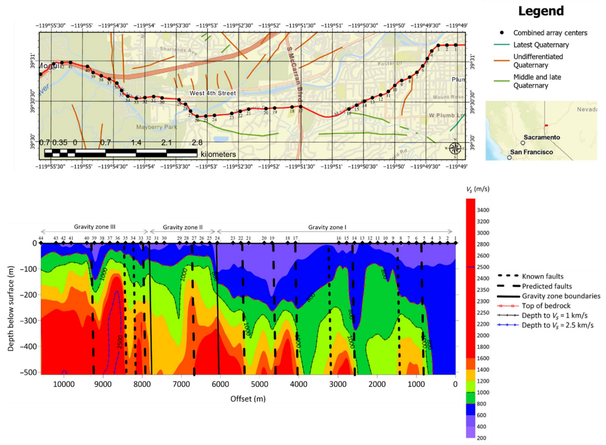


**Figure 4:** Distributed acoustic sensing (DAS) survey in Downtown Reno (modified from Mirzanejad & Seylabi, 2025). **A:** Site layout showing DAS line, multi-channel analysis of surface waves (MASW) centers, and USGS Quaternary Fault traces. **B:** Final interpolated velocity profile with location of existing faults, predicted faults, and gravity zone correlations.

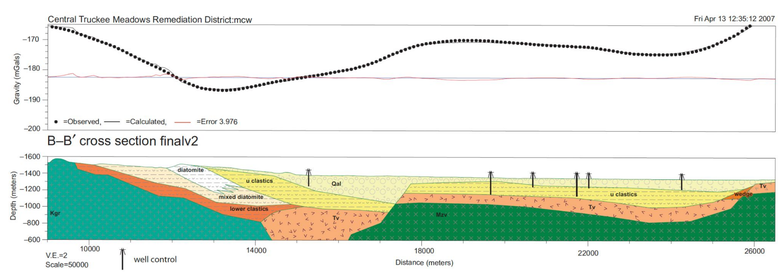


**Figure 5:** Schematic geologic cross-section and Bouguer gravity profile along E-W section in Reno-Verdi study area (modified from Cashman et al. 2012). The gravity anomaly is interpreted to be the "Virginia Street Fault".

Subsurface investigations conducted in this region, such as the distributed acoustic sensing (DAS) surveys done Mirzanejad & Seylabi (2025) in Downtown Reno (Fig. 4), show velocity anomalies across mapped and suspected faults. Seismic sections (Fig. 6) suggest similar features in the same area.

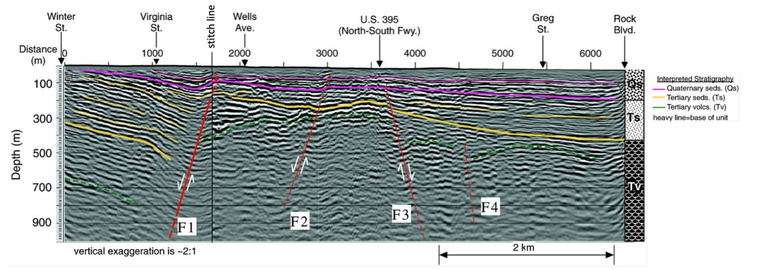


**Figure 6:** Seismic profile through Truckee River in Downtown Reno by Stephenson et al. (2013) indicates west-down bedrock offset under downtown Reno, also implied by dip changes in late Cenozoic sediments (e.g. Cashman et al. 2012).

## Future Work for the Sierra Nevada Earthquake Consortium (SNEC)

- Refine the region's Quaternary fault maps using more recent high resolution datasets and transmit suggestions to USGS for incorporation into Quaternary Faults and Folds database.
- Incorporate findings from paleoseismic studies including recent dates, provide constraints for future NSHM updates.
- Propose and execute new subsurface geophysical investigations to locate faults and identify non-surface rupturing faults.
- Perform additional ShakeOut scenarios based on updated mapping.
- Constrain 3D orientation and length of insufficiently constrained major faults
- Determine whether the faults with geomorphic surface expression should be considered the most hazardous or whether buried faults still pose modern threats, such as those responsible for recent urban earthquake swarms.

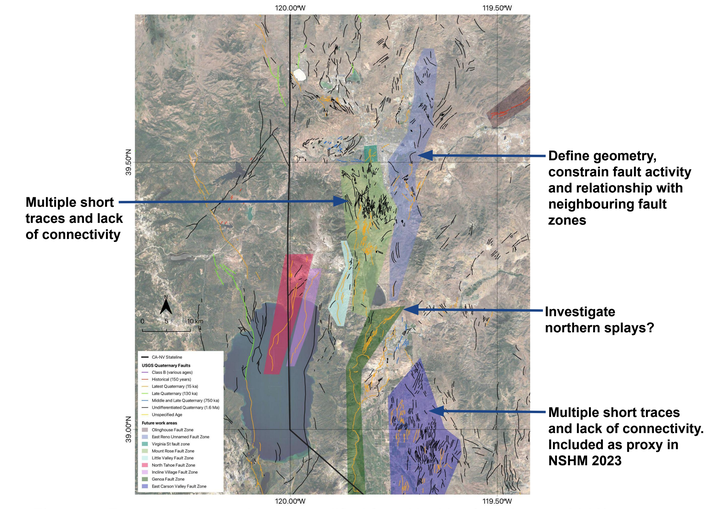


**Figure 7:** Future work areas based (modified from Koehler & Anderson, 2019).

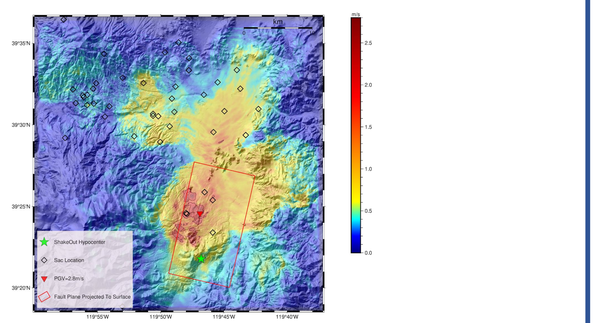


**Figure 8:** M6.3 ShakeOut scenario for south of Reno area (modified from Eckert et al., 2021)

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