Earthquake Research Priorities for Nevada, EHP FY19

Nevada Bureau of Mines and Geology and Nevada Seismological Laboratory

The earthquake research priorities outlined in this synopsis are defined by the Nevada Bureau of Mines and Geology (NBMG) and the Nevada Seismological Laboratory (NSL) and are intended to be included in the U.S. Geological Survey Earthquake Hazards Program (EHP) Request for Proposals for the Intermountain West region. The priorities reflect updates of consensus views of research needs developed at workshops in 2007 and 2009 (summarized in Briggs and Hammond, 2011), as well as comments from participants at the 2018 Working Group on Nevada Seismic Hazards held in Reno, Nevada (http://www.nbmg.unr.edu/Geohazards/Earthquakes/2018SeismicHazardsWorkshop.html). The priorities are based on the quality and detail of previous geologic, seismic, and geodetic investigations, implications of previous loss-estimation modeling, proximity to population centers, and data needs for future updates of the National Seismic Hazard Map.

The areas of the state that have the highest exposure to seismic risk and the greatest need for future earthquake research are the major population centers located in western and southern Nevada including the Reno-Carson City corridor and the Las Vegas metropolitan area, respectively. The NBMG and NSL strongly support the efforts by the U.S. Geological Survey to obtain better seismologic, geologic, and geodetic information about earthquake hazards in both of these areas.

The 2018 workshop recognized several general priorities for future research that will benefit planned updates of the National Seismic Hazards Map including:

1) Develop an organized, updateable, on-line database of active faults that summarizes and synthesizes existing knowledge of fault trace location and paleoseismic parameters.
2) Better characterize poorly understood faults including their paleoseismic histories, slip rates, geometry, and potential interconnectivity (See priority fault lists below).
3) Use of existing lidar datasets (i.e. Washoe County, Lake Tahoe basin, Pahrump Valley) and development of collaborative efforts to acquire new lidar along Quaternary faults (USGS 3DEP program).
4) Continued maintenance, monitoring, and expansion of geodetic and seismic networks.
5) Continued expansion of working group efforts including formal organization of sub-disciplines, encouragement of participation from active researchers, and written syntheses of geology, geodesy, earthquake seismology, and exploration geophysics research.
6) Prompt peer review and publication of earthquake research studies.

The following sections summarize research priorities for faults in the Reno-Carson City corridor, faults in the Las Vegas metropolitan area, and other topics applicable to the entire state.

Priority Faults for Earthquake Research in the Reno-Carson City urban corridor:

The majority of Quaternary faults in the Reno-Carson City urban corridor have not had detailed paleoseismic investigations and have not been included in the National Seismic Hazard Map. Quaternary geologic, geomorphic, and paleoseismic studies focused on earthquake chronologies, slip rate, single event displacement, recurrence, and segmentation are needed. The following faults have been identified as needing additional geologic, geodetic, and seismic study.

- **Quaternary faults in the Reno basin and Washoe Valley.**
    - Mount Rose Fault zone
    - East Reno fault zone (range front along eastern side of Truckee Meadows)
    - Little Valley fault
    - Washoe Valley range front
- **Quaternary faults in the Carson Valley and Carson City area**
    - Carson range front (Genoa and Kings Canyon faults)
    - Little Valley fault
    - Eastern Carson Valley fault zone
    - Carson City fault
    - Carson lineament
    - New Empire fault
    - Indian Hills fault
    - Eastern Prison Hill fault
    - Kings Canyon fault
- **Quaternary faults in the Lake Tahoe area.**
    - Incline Village fault
    - North Tahoe fault
    - West Tahoe – Dollar Point fault
- **Quaternary faults in the North Valleys area.**
    - Peterson Mountain fault
    - Fred's Mountain fault
    - North Peavine Mountain fault zone
    - Last Chance/Long Valley fault zone
    - Un-named faults in Lemmon Valley
    - Spanish Springs Valley fault
    - Spanish Springs Peak fault
- **Quaternary faults in the Northern Walker Lane.** Based on the number of paleoseismic studies on the following faults, they are considered a lesser priority than the faults listed above. However, questions remain related to the spatial and temporal patterns of strain release and the influence of past behavior on future rupture potential on these closely spaced faults.
    - Mohawk Valley fault zone
    - Honey Lake fault
    - Warm Springs Valley fault
    - Pyramid Lake fault

Priority Faults for Earthquake Research in the Las Vegas metropolitan area:

The seismic potential of late Quaternary faults in the Las Vegas metropolitan area is poorly understood. The major Quaternary faults in this area are primarily normal faults, however the existence of strike-slip faults is possible and poorly defined. Similar to the Reno area, Quaternary geologic, geomorphic, and paleoseismic studies are few and additional studies are needed to better characterize the seismic potential of faults in this area. The following faults and other research topics have been identified as needing additional geologic, geodetic, and seismic study.

- **Quaternary Intra-basin faults in Las Vegas Valley**. These faults are collectively known as the Las Vegas Valley fault system which includes the Eglington, Valley View, Decatur, and West Charleston faults and the Cashman Field and Whitney Mesa fault zones. Studies that focus on the paleoseismic history, deformation style, slip rate, and recurrence of faults within the system, as well as evidence for surface-rupture within the basin are needed. In particular, studies that validate or refine the slip rate of the Eglington fault, which is a major controlling source in contemporary hazard models, are desired.

- **Frenchman Mountain fault**. The location and dip direction of the Frenchman Mountain fault suggests that it directly underlies much of the eastern, highly populated, part of the Las Vegas valley, and may possibly be kinematically linked with faults of the Las Vegas valley fault system. Studies focused on the recent history of events and the subsurface geometry of the Frenchman Mountain fault will help better characterize its seismic potential.

- **Pahrump Valley faults**.
    - Pahrump Fault
    - West Spring Mountains Fault

- **Other regional late Quaternary faults in the vicinity of the Las Vegas metropolitan area**.
    - Black Hills Fault
    - California Wash fault

- **Basin effects.** Develop demonstrably realistic, calibrated synthetic seismograms for the 3-D Las Vegas basin resulting from expected “scenario earthquakes” with M6 to M7 on regional and local faults.

- **Strain transfer in southern Nevada.** The style and rate in which strain is transferred from the southern Walker Lane/Eastern California shear zone into southern Utah remains poorly constrained. Geologic, geodetic, and seismic studies that address how much of this strain occurs close to Las Vegas would help better constrain regional seismic hazard models.

Additional research topics that apply to both the Reno-Carson urban corridor, the Las Vegas metropolitan area, and the state in general.

- Utilize calibrated ground motions from seismic stations in Nevada to improve the ground motion prediction equation/ground motion parameter estimates (GMPEs) used in the National Seismic Hazard Model, including terms that account for basin effects.
- Use recently acquired lidar data sets to more accurately map the traces of Quaternary active faults, and search for and map previously undiscovered active faults or fault traces.
- Conduct collaborative efforts to acquire high-resolution lidar data and perform aerial imagery surveys (Structure from Motion) to map high-risk urban areas to identify new paleoseismic trench sites.
- Use high resolution relocation studies (e.g., double-difference) of microseismicity in and around the urban areas of Nevada to place constraints on potential structures that may be involved in future significant earthquake ruptures.
- Utilize ground motions from recent earthquakes to evaluate the structure and response of the Reno-area basin with shear-velocity surveys to basement to test basin models and improve estimates of seismic hazard.

- Perform geological, geodetic, and seismic studies along major historical ruptures, active faults, and actively deforming regions in the more rural parts of the state. Study of these topics would certainly provide valuable information on earthquake processes, earthquake effects, and seismic hazards.
- Develop improved systematic and robust analysis methods to reliably and repeatedly estimate fault slip rates and slip obliquity from geodetic data, quantify uncertainties, resolve discrepancies between geodetic and geologic slip estimates, and resolve the possible contribution of off-fault deformation to improve earthquake source modelling.
- Gather data and perform analyses that elucidate the frequency, distribution and role of active magmatic processes that effect stress transfer and earthquake occurrence from e.g., diking, variability in magma chamber inflation rates, and interaction between tectonic and volcanic processes.
- Develop methods, procedures, processes and team structures to combine, integrate and reconcile fault system scale deformation models that provide slip rates. Focus these efforts to bring multiple contributing models together into community-based consensus models that satisfy NSHMP goals and promote stability, defensibility, breadth of support and societal benefit of the models.
- Conduct studies that improve constraints on modes of strain release that may not be characterized by large earthquakes on major fault systems, where deformation recorded in the geodetic strain accumulation field may be distributed, off-main-fault, accommodated via flexures, folds or other aseismic processes.
- Development of improved deformation and slip rate models that account for time-variable deformation throughout the seismic cycle owing to non-elastic rheology.
- Develop improved methods for construction of crustal strain rate maps, and improve the utilization of these maps to relate strain rate and style to seismicity, earthquake occurrence, and hazard.
- Conduct studies to make better measurements and analysis of seismic swarms and elucidate the role that these event clusters play in accommodating crustal strain, relationship to the occurrence and timing of larger earthquakes, and time variable hazard.
- Conduct studies that provide direct constraints on the dips of normal fault dips at seismogenic depths in the lithosphere.

References

Briggs, R.W. and Hammond, W.C., 2011, Evaluation of geodetic and geologic datasets in the Northern Walker Lane-Summary and recommendations of the workshop: U.S. Geological Survey Open-File Report 2011-1282m 76 p.