Seismic studies to understand earthquake hazards and risks in Las Vegas basin

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Motivation: University of Nevada Las Vegas has a small but strong presence in engineering geophysics. One big project at the moment is a collaborative effort to understand the hazards and risks posed by earthquakes in the Las Vegas basin. It turns out that the more we learn about the earthquake potential for our area, the larger we find the hazard to be. The research team includes seismologists, structural geologists, geotechnical engineers, structural engineers, and outreach specialists. Our famous resort city in the desert (Las Vegas, Nevada, US) occupies a fault-bounded basin filled with alluvium up to 5 km deep. Earthquake hazards are posed by major faults in neighboring Death Valley, and within and much closer to the basin, that are capable of events up to magnitude 7 or greater. We are finding that ground shaking hazards are amplified locally due to lithology and basin geometry, with the greatest hazard occurring in the deepest part of the basin which also houses the softest clay sediments. Liquefaction of loose, saturated coarse-grained sediments is another potential hazard. Some evidence of paleo-liquefaction has been identified, and our tendency to overwater golf courses and lawns has caused a new, shallow aquifer that creates potential for liquefaction where it never existed before!

Earthquake risks around Las Vegas are significant. As the metropolitan area sustains its record growth rate, the potential for damage from a major earthquake continues to grow apace. Recent upgrades to seismic construction standards will help to mitigate risk. However, today we are a long way from truly understanding the potential consequences of a devastating earthquake, which must happen before we can adequately prepare.

Seismic research: Seismic studies are the current focus of the project. A team of seismology faculty and students (Catherine Snelson, Darlene McEwan, Shelley Zaragosa) are conducting large-scale experiments across the basin, using targeted and opportunistic explosive events as seismic sources to image the fault-bounded geometry of the basin, focusing on Quaternary/Tertiary boundaries and also looking deep into the mantle to understand local and regional wave propagation patterns.

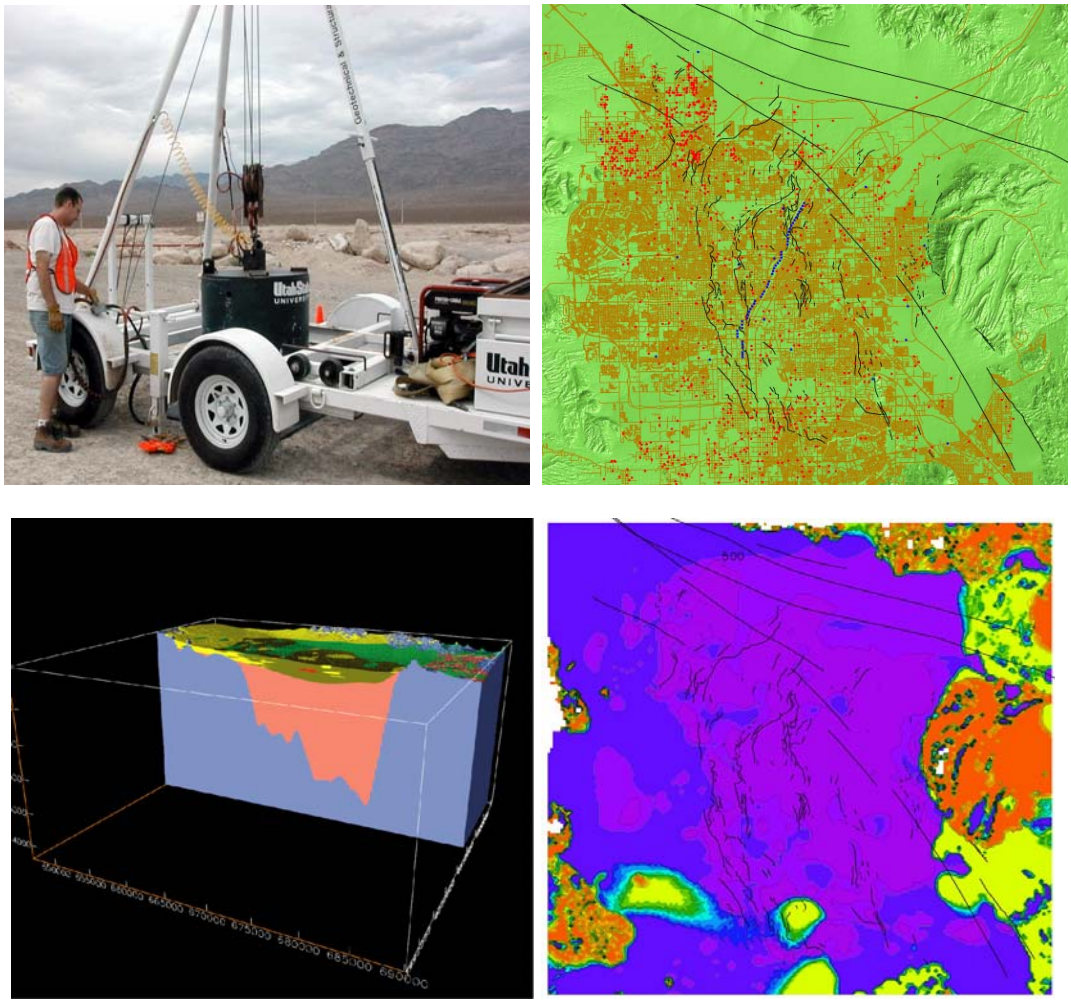
The geotechnical research team (Barbara Luke, Ying Liu, Xiaohui Jin, Bagathbabu Dumpala, Jennifer Nuesca) is collecting “shallow” (to several hundred meters) shear wave velocity data using active- and passive-source surface wave methods, to feed seismic site response analyses. They work with structural geologists (Wanda Taylor, Willy Rittase, JC Evans) to build a correlation of velocity to lithology, which, considering the plentiful supply of borehole logs across the developed area, is a much denser dataset. They are building an amplification-hazard map, to help planning for future development, mitigation for existing infrastructure, and planning for disaster relief. Their outcomes become input for the structural engineers (Ron Sack and John McAvoy (UNLV); Arya Ebrahimpour, Jared Keller and Josh Baird (Idaho State University)), who then evaluate the seismic safety of existing and planned construction, particularly critical “lifelines”.

Outreach: The outreach team (Gaye Coté, Jaime Wixon, Heather Proa, Lynn Jane Ho) takes the message of earthquake awareness and safety to various groups around Las Vegas. They use a small shake table to demonstrate earthquake effects in tangible ways. Depending on the audience, they demonstrate the effects of ground shaking on structures, modal vibrations and

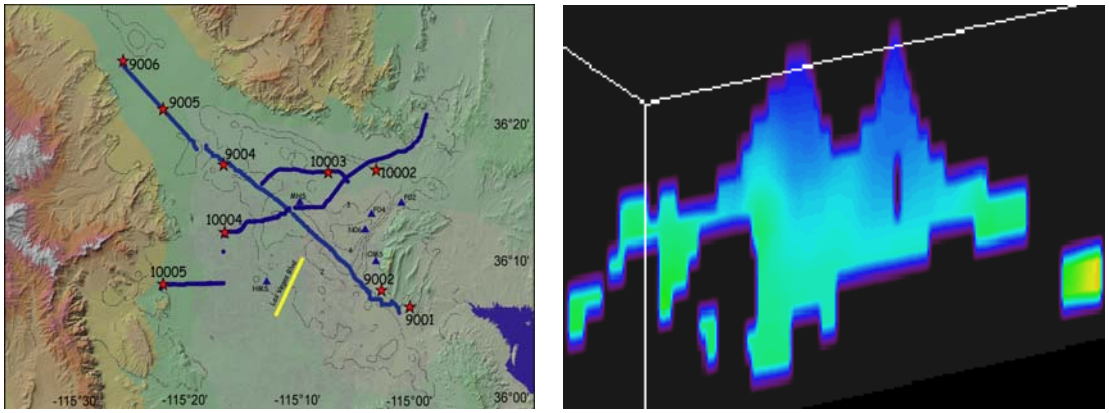
amplification, liquefaction, and earthquake safety in the home. The outreach activities are great recruiting tools for science and engineering at UNLV.

Outside support: The UNLV team collaborates with researchers at Lawrence Livermore National Laboratory (LLNL), Nevada Seismological Laboratory, Idaho State University, University of Texas El Paso, and Utah State University. The project is funded by the US Department of Energy (DOE) Office of Science. It builds upon a precursor, headed by LLNL, to study the impact on Las Vegas infrastructure of seismic loading resulting from potential underground nuclear testing at the Nevada Test Site, which is about 100 km away. Such testing has long been halted, but the DOE has a mission to maintain readiness in the event of the call to resume testing.

For more information, please look us up at www.unlv.edu.



Shallow shear wave velocity profiles are correlated with lithology to develop near-surface velocity maps. a) Collecting surface wave data, with Utah State University and their dropped-weight source. b) Map of Las Vegas valley, superimposing locations of velocity measurements, borehole logs, faults, roadways, and topography. c) Lithologic model of the basin, based on geologic and geophysical data. d) Preliminary near-surface shear wave velocity model.



"SILVVER" refraction experiment across the Las Vegas valley. a) Test layout. b) Preliminary velocity model.


Demonstrating non-structural seismic hazards to schoolchildren