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Rapid Sierra Nevada uplift tracked by scientists at the University of Nevada, Reno

Nevada Geodetic Lab uses GPS and radar for most precise measurements over entire mountain range

RENO, Nev. – From the highest peak in the continental United States, Mt. Whitney at 14,000 feet in elevation, to the 10,000-foot-peaks near Lake Tahoe, scientific evidence from the University of Nevada, Reno shows the entire Sierra Nevada mountain range is rising at the relatively fast rate of 1 to 2 millimeters every year.

“The exciting thing is we can watch the range growing in real time,” University of Nevada, Reno’s Bill Hammond, lead researcher on the multi-year project to track the rising range, said. “Using data back to before 2000 we can see it with accuracy better than 1 millimeter per year. Perhaps even more amazing is that these miniscule changes are measured using satellites in space.”

Miniscule as they may be, the data indicate that long-term trends in crustal uplift suggest the modern Sierra could be formed in less than 3 million years, which is relatively quick when compared to estimates using some geological techniques.

Hammond and his colleagues in the University’s Nevada Geodetic Laboratory and University of Glasgow use satellite-based GPS data and InSAR (space-based radar) data to calculate the movements to this unprecedented accuracy. The calculations show that the crust moves upward compared to Earth’s center of mass and compared to relatively stable eastern Nevada.

The data may help resolve an active debate regarding the age of the modern Sierra Nevada of California and Nevada in the western United States. The history of elevation is complex, exhibiting features of both ancient (40–60 million years) and relatively young (less than 3 million years) elevation. The “young” elevation is the uplift Hammond and colleagues have tracked.

“The Sierra Nevada uplift process is fairly unique on Earth and not well understood.” Hammond said. “Our data indicate that uplift is distributed along the entire length of the 400-mile-long range, between 35 and 40 degrees north latitude, that it is active, and

could have generated the entire range is less than 3 million years, which is young compared to estimates based on some other techniques. It basically means that the latest pulse of uplift is still ongoing."

Possibly contributing to the rapid uplift is the tectonic extension in Nevada and a response to flow in the mantle. Seismologists indicate the mountain range may have risen when a fragment of lower plate peeled off the bottom of the lithosphere allowing the "speedy" uplift, like a ship that has lost its keel. In comparison, other ranges, such as the Alps or Andes, are being formed in an entirely different process caused by contraction as two plates collide.

"We've integrated GPS and InSAR measurement techniques, drawing from experience we developed in the past five years in our work with tectonic deformation, to see how the Sierra is gradually being pushed upwards," Hammond said. "Combined with more GPS stations, and more radar data, detecting motions in the Earth is becoming more precise and ubiquitous. We can see the steady and constant motion of the Sierra in addition to episodic events such as earthquakes."

Hammond's team includes Geoff Blewitt, Hans-Peter Plaq and Corné Kreemer of the University of Nevada, Reno's College of Science and Zhenhong Li of the Centre for the Observation and Modeling of Earthquakes, Volcanoes and Tectonics, School of Geographical and Earth Sciences, University of Glasgow in the UK.

GPS data for Hammond and his team's research is collected through the team's MAGNET GPS Network based at the University of Nevada, Reno plus more than 1200 stations from the NSF EarthScope Plate Boundary Observatory and more than 10,000 stations from around the entire planet. These stations include hundreds that cover Nevada, California, Oregon, and Washington. The space-based radar data comes from the European Space Agency with support from NASA.

This research was funded in the United States by the National Science Foundation and NASA and in the United Kingdom by the Natural Environment Research Council.

Their paper, "Contemporary Uplift of the Sierra Nevada, western United States, from GPS and InSAR Measurements" will be published in the peer-reviewed journal *Geology* in July and has just been made available online.

For more information on Hammond, go to http://www.nbmg.unr.edu/Staff/Hammond.html. For the Nevada Geodetic Laboratory go to http://geodesy.unr.edu.

The University of Nevada, Reno has the largest GPS data-processing center in the world, which processes information from about 10,000 stations around the globe continuously, 24/7. The Nevada Geodetic Laboratory has all publicly available GPS data going back to 1996 and reprocesses all 15-million data files as new data streams

come in – every 30 seconds – solving for tens of thousands of parameters at once. It enables real-time positioning for any users. People around the world use it extensively for research such as modeling earthquakes and volcanoes. The information is freely available to anyone on the Internet.

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Photo Cutline: Bill Hammond, professor in the University of Nevada, Reno's Nevada Bureau of Mines and Geology, with a GPS installation near Mt. Rose overlooking Lake Tahoe. Photo by Jean Dixon, courtesy of University of Nevada, Reno.

Nevada's land-grant university founded in 1874, the University of Nevada, Reno has an enrollment of 18,000 students and is ranked in the top tier of the nation's best universities. Part of the Nevada System of Higher Education, the University has the system's largest research program and is home to the state's medical school. With outreach and education programs in all Nevada counties and with one of the nation's largest study-abroad consortiums, the University extends across the state and around the world. For more information, visit www.unr.edu.

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