Nearly 1,000 earthquakes recorded in Arizona over 3 years

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Nearly 60 USArray stations were installed in Arizona from 2006 to 2009 as part of the EarthScope project. Station 118A, seen in this photo, recorded ground motion north of Wilcox in southeastern Arizona from April 6, 2007 to Jan. 21, 2009. Credit: Incorporated Research Institutions for Seismology (funded by NSF EarthScope)

Arizona State University researchers use EarthScope data to build the first comprehensive earthquake catalog for Arizona.

Earthquakes are among the most destructive and common of geologic phenomena. Several million earthquakes are estimated to occur worldwide each year (the vast majority are too small to feel, but their motions can be measured by arrays of seismometers). Historically, most of Arizona has experienced low levels of recorded seismicity, with

infrequent moderate and large earthquakes in the state. Comprehensive analyses of seismicity within Arizona have not been previously possible due to a lack of seismic stations in most regions, contributing to the perception that widespread earthquakes in Arizona are rare. Debunking that myth, a new study published by Arizona State University researchers found nearly 1,000 earthquakes rattling the state over a three-year period.

Jeffrey Lockridge, a graduate student in ASU's School of Earth and Space Exploration and the project's lead researcher, used new seismic data collected as part of the EarthScope project to develop methods to detect and locate small-magnitude earthquakes across the entire state of Arizona. EarthScope's USArray Transportable Array was deployed within Arizona from April 2006 to March 2009 and provided the first opportunity to examine seismicity on a statewide scale. Its increased sensitivity allowed Lockridge to find almost 1,000 earthquakes during the three-year period, including many in regions of Arizona that were previously thought to be seismically inactive.

"It is significant that we found events in areas where none had been detected before, but not necessarily surprising given the fact that many parts of the state had never been sampled by seismometers prior to the deployment of the EarthScope USArray," says Lockridge. "I expected to find some earthquakes outside of north-central Arizona, where the most and largest events had previously been recorded, just not quite so many in other areas of the state."

One-thousand earthquakes over three years may sound alarmingly high, but the large number of earthquakes detected in the study is a direct result of the improved volume and quality of seismic data provided by EarthScope. Ninety-one percent of the earthquakes Lockridge detected in Arizona were "microquakes" with a magnitude of 2.0 or smaller, which are not usually felt by humans. Detecting small-magnitude

earthquakes is not only important because some regions experiencing small earthquakes may produce larger earthquakes, but also because geologists use small magnitude earthquakes to map otherwise hidden faults beneath the surface.

Historically, the largest earthquakes and the majority of seismicity recorded within Arizona have been located in an area of north–central Arizona. More recently, a pair of magnitude 4.9 and 5.3 earthquakes occurred in the Cataract Creek area outside of Flagstaff. Earthquakes of magnitude 4.0 or larger also have occurred in other areas of the state, including a magnitude 4.2 earthquake in December 2003 in eastern Arizona and a magnitude 4.9 earthquake near Chino Valley in 1976.

"The wealth of data provided by the EarthScope project is an unprecedented opportunity to detect and locate small-magnitude earthquakes in regions where seismic monitoring (i.e. seismic stations) has historically been sparse," explains Lockridge. "Our study is the first to use EarthScope data to build a regional catalog that detects all earthquakes magnitude 1.2 or larger."

His results appear in a paper titled, "Seismicity within Arizona during the Deployment of the EarthScope USArray Transportable Array," published in the August 2012 issue of the *Bulletin of the Seismological Society of America*. Ramon Arrowsmith and Matt Fouch, professors in ASU's School of Earth and Space Exploration, are Lockridge's dissertation advisors and coauthors on the paper. Fouch is also a geophysicist at the Carnegie Institution's Department of Terrestrial Magnetism in Washington, DC.

"The most surprising result was the degree to which the EarthScope data were able to improve upon existing catalogs generated by regional and national networks. From April 2007 through November 2008, other networks detected only 80 earthquakes within the state, yet over that

same time we found 884 earthquakes, or 11 times as many, which is really quite staggering," says Lockridge. "It's one of countless examples of how powerful the EarthScope project is and how much it is improving our ability to study Earth."

Lockridge is also lead author on a study that focuses on a cluster of earthquakes located east of Phoenix, near Theodore Roosevelt Lake. The results from this study will be published in Seismological Research Letters later this year. In his current studies as doctoral student, Lockridge is using the same methods used for Arizona to develop a comprehensive earthquake catalog for the Great Basin region in Nevada and western Utah.

Provided by Arizona State University