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The Los Alamos Seismic Network: 50 Years of Monitoring North-Central New Mexico Seismicity and Seismic Hazards for Los Alamos National Laboratory

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The seismicity of north-central New Mexico is at a relatively low level and not well understood. Local tectonics of the Pajarito Plateau and the Rio Grande rift are complex and fault motions are small. Further, the limited regional-scale seismic station coverage limits both detection and location of seismicity. The Los Alamos Seismic Network (LASN) has been operated by Los Alamos National Laboratory (LANL) since 1973 and provides the primary earthquake monitoring for the entire region. LASN's spatial extent has grown to roughly 600 sq km over the last 12 years by the addition of 11 stations to the original 7, but it is still best suited for local seismicity monitoring for LANL's Seismic Hazards Program Plan (SHPP). Nonetheless, LASN has detected more than 2500 small earthquakes from 1973 to present. Roughly 900 of these have been located within 150 km of LANL. On average, about 20-25 local earthquakes per year are recorded, most with magnitudes less than 1.5. These are generally not listed in other network catalogs. In general, seismicity occurs at a steady rate and is spatially diffuse and scattered. More of the seismicity occurs in the northern portion of the region than to the south. Some earthquakes are associated with diverse, poorly understood tectonic features such as the Pajarito fault system, the Rio Grande rift, the Gallina fault, and the Nacimiento Uplift, but most are not near known or well-mapped faults. Numerous earthquake swarms are superimposed on this background seismicity. Other than large swarms that occurred near the Albuquerque Volcanoes, none appear to be associated with magma movement. Residual magma is believed to exist beneath Valles Caldera, yet that area is remarkably quiet seismically. Recent LASN station expansion have allowed the detection of very small events in and near the caldera. Plans for the network include expanding station coverage to the north, south, and in the caldera, and upgrading remaining short-period analog stations with broadband digital equipment. We will show the history of LASN from 1973 to present, and describe the current station configuration, spatial coverage and instrument improvements that have allowed it to detect smaller, more distant events. We will also present an updated LASN earthquake catalog for north-central New Mexico and review the historic, pre-LASN seismicity of the region. Of particular interest to LANL's SHPP was the occurrence of two felt earthquakes, in July of 2020 and 2021, approximately 50 km away from Los Alamos in the Gallina fault region. The 2021 event was a magnitude 4.2 and is the largest earthquake recorded by LASN. It was felt widely across the Los Alamos area and produced peak ground accelerations of roughly 0.004 g in several LANL facilities. Looking to the future, we will discuss plans to continue improving the network instrumentation, data processing, and analysis systems. Using automated sorting and phase picking techniques, we are developing machine-learning approaches to process LASN data in real-time, so that more timely updates to the seismicity catalog, focal mechanism solutions and local site response can be obtained.