# 2025-2026 Twinning Program Research Projects

## PROJECT 1: Earthquake detection using machine learning tools in the Valles Caldera, New Mexico

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**Project Summary:**
The Valles Caldera, located in northern New Mexico is a resurgent caldera with a central dome. The perceived lack of seismicity in the Valles Caldera has been attributed to elevated crustal temperatures inhibiting brittle failure (House & Roberts, 2020; Sanford et al., 1991), however sparse availability of seismic data in this region has made earthquake detection further difficult. Thus, in the absence of a seismic network, local and microseismic events within the caldera may remain undetected. Studying the microseismicity of the caldera is very important as it would help us accurately evaluate the seismic hazard risk of the region and its impact on the nearby cites and structures, it will provide key insights on the geometry (dip and shape) and extend of active faults in the study area and further understanding of the hydrothermal processes associated with the Valles Caldera. Recent temporary seismic installations of three channel 5Hz nodes and broadband stations during the Summer of Applied Geophysical (SAGE) summer campaigns of 2019 and 2022 have revealed microseismicity in this relatively aseismic volcanic region. We are looking for a keen undergraduate intern to use machine learning techniques to investigate microseismicity in the Valles Caldera using the six broadband stations installed for a period of around four months (June-mid October) in 2023 and 2024. The proposed project will utilize automated machine learning tools to detect any seismic activity in the Valles Caldera. The research will mainly consist of three steps: (1) seismic P and S wave phase detection using automated seismic phase EQTransformer (Mousavi et al., 2020); (2) phase association and initial event location using rapid earthquake association and location method (REAL; Zhang et al., 2019); and (3) initial 1D earthquake location using absolute location algorithm VELEST (Kissling et al., 1994). The initial analysis will be done with two months of data from the six broadband stations for year 2024 and then expand the processing with all data available from 2023-2024.

**Role and probable activities for a student researcher in this project:**

1. Will learn and test open-source Python based machine learning tools to detect earthquakes from broadband seismic dataset for the Valles Caldera
2. Will learn basic seismology software such as SAC (seismic analysis code) and GMT (generic mapping tool) to view seismogram data and plot earthquake maps
3. Hands on experience with broadband seismic station installation/servicing during summer 2026 in New Mexico. The student will have opportunities to help out in temporary broadband station installations in the Valles Caldera or help in the seismic station maintenance for the NMTSO permanent network in the Permian Basin or in the Socorro region.
4. Compose a short technical report for submission to CRESCENT and prepare presentation/ poster for conference.

**Preferred Skills**

1. Basic familiarity with python, shell scripting and basic terminal commands
2. Geophysics background is preferred, with interest in seismology and earthquake or geologic hazard studies
3. The student should have access to a Mac laptop or Mac computer, as most of the processing needs high computing power and the codes have been tested on mac systems.