Towards Volcanic Hazards Assessment Using Transient Detection in the Natron Rift, Tanzania

D. Sarah Stamps
Virginia Tech
Department of Geosciences
Geodesy and Tectonophysics Laboratory

Volcanic eruptions can pose hazards to nearby populations, agriculture, and infrastructure. 2007-2010 explosive eruptions of the volcano Ol Doinyo Lengai in the Natron Rift, Tanzania disrupted life for local Maasai peoples, tourists, and air traffic. The Natron Rift lacked a monitoring network during the most recent eruptions, which limited scientists' and decision makers' abilities to assess hazards. In this project, we established the TZVOLCANO network to monitor Ol Doinyo Lengai and volcano-tectonic interactions in the Natron Rift, which currently consists of 6 continuous GNSS stations and 1 broadband seismometer. Most of the TZVOLCANO network stations stream low and high latency data to the GAGE facility for public access, of which real-time positioning data are also made openly available through an EarthCube CHORDS portal. In a step towards detecting hazardous transient signals in low latency GNSS data, we developed a Jupyter Notebook that uses unsupervised machine learning algorithms (K-Means and Gaussian Mixtures) to detect anomalies and trained neural networks to predict vertical motions. The Jupyter Notebook successfully identified a M4.3 earthquake that occurred on 13 December 2022. High latency GNSS data in the form of velocity solutions have been used to investigate magmatic sources with inverse numerical modeling (dMODELS) that may feed Ol Doinyo Lengai. Inversions of our most recent velocity solution spanning early 2016 to early 2023 indicate a shallow inflating prolate spheroid magma source with a volume change of ($0.7e10^6$ +- $0.001e10^6$ m^3) located beneath the vent (2820 +- 4 m). We also evaluate GNSS time-series for transient signals using the Targeted Projection Operator (TPO) for a suite of potential magmatic sources. TPO results suggest transient signals in late 2022 indicative of an inflationary period. Our results are regularly communicated to Tanzanian partners, and we have conducted extensive outreach to those living near Ol Doinyo Lengai.

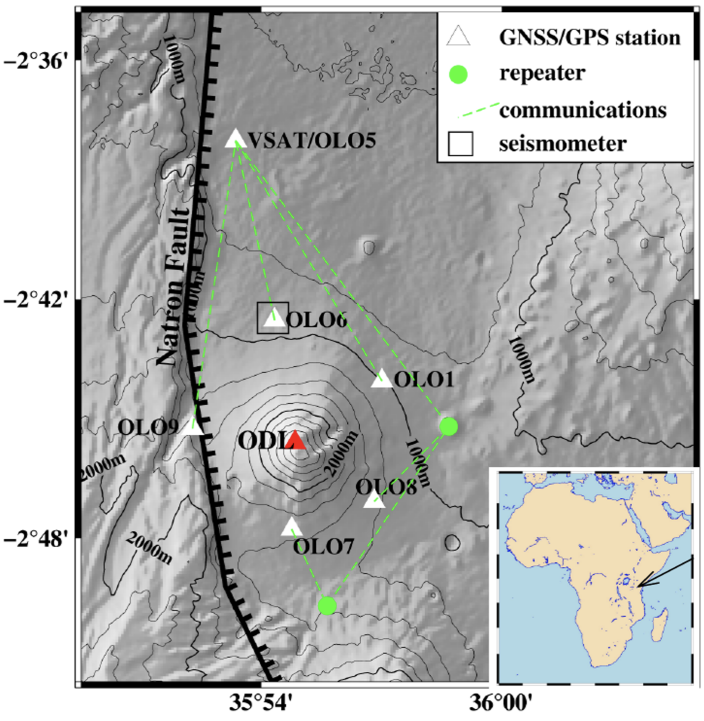

Figure. The TZVOLCANO network (Daud et al., in revisions).

Key collaborators: Daud Ntambila (Virginia Tech, USA and Ardhi University, Tanzania), Elifuraha Saria (Ardhi University, Tanzania), Maurizio Battagila, (USGS/VDAP, University of Rome, Italy), Mong-Han Huang (University of Maryland, USA), Kang-Hyeun Ji (Korea Institute of Geosciences & Mineral Resources, S. Korea), Aubreya Adams (Colgate University, USA), Mike Dye (Resonant Systems, Inc. USA), Myles Mason (University of North Carolina, USA)