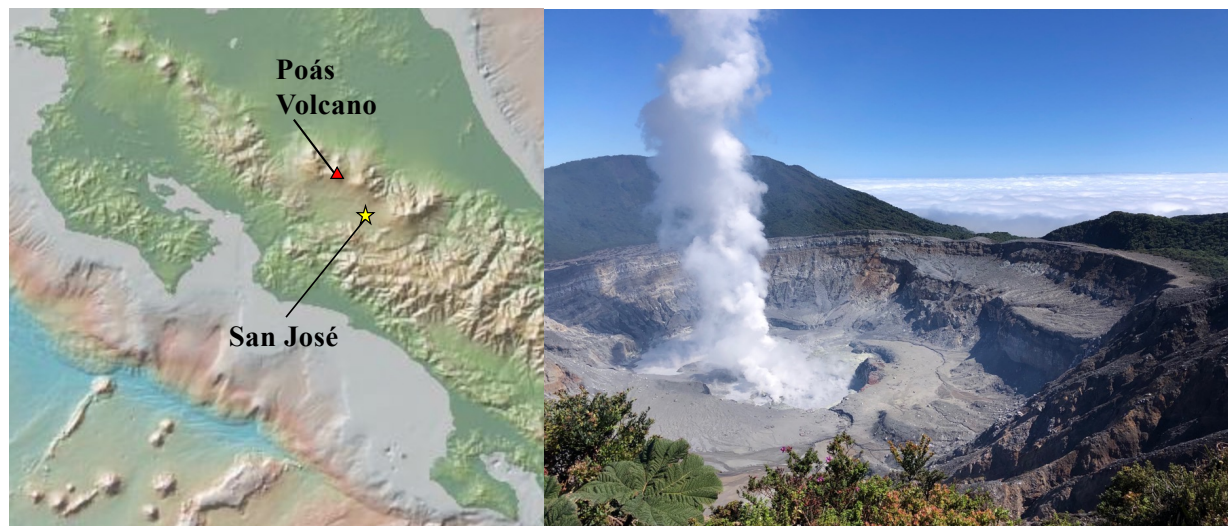# Project Report: AVERT at Poás, Costa Rica
2023 – 2025

Overview and Goals

The AVERT Project (Anticipating Volcanic Eruptions in Real Time) has been led by the Lamont-Doherty Earth Observatory of Columbia University, with funding from the Gordon and Betty Moore Foundation. In the years 2023–2025, AVERT worked in partnership with OVSICORI (Observatorio Vulcanológico y Sismológico de Costa Rica) to install new instrumentation on Poás volcano. The over-arching goal of the project is to ***promote the collection of multi-sensor data on volcanoes, and provide that data openly and in near real time***. Such data streams are rarely available globally and yet are necessary to enable effective eruption forecasts. The specific goals of the AVERT-OVSICORI partnership on Poás volcano were to:

- improve monitoring on this high threat volcano in Costa Rica
- install a multitude of sensors that provide new early warning
- deploy novel instrumentation via international community participation

Over the two-year timeline, all goals were met. The specific accomplishments are outlined below.

Poás Volcano

AVERT and OVSICORI scientists met throughout 2023 in order to jointly develop a planned deployment on an active and accessible volcano in Costa Rica. Poás was chosen as the target due to: 1) its eruptive activity that poses frequent threats to the hundreds of thousands of visitors a year and over two million people in the greater San José metropolitan area, 2) its high accessibility for instrument deployment, and 3) the challenges presented in forecasting its predominantly phreatomagmatic activity. The current activity is focused in Poás crater, which hosts a semi-permanent lake and three active vents. Few instruments existed on the more remote northern flank of Poás, and so a major goal was to increase instrumentation there. We also planned to increase the types of sensors used to monitor activity around the crater, including the first continuous magnetometers, infrared camera and CO_2-soil probe. Finally, we were hoping to test the viability

of the newly established Starlink satellite internet to telemeter data from the volcano to AVERT and OVSICORI servers in near-real time. In addition to enhancing monitoring capacity, our goal was also to bring the international community to Poás to test novel instrumentation in a series of open, field workshops. Over the course of this project, Poás experienced two months-long episodes of volcanic activity, one from 11/23-05/24 and another from 01/5-07/25, which involved ash and vapor emissions accompanied by increases in lake temperature, CO_2 soil and S plume flux, seismic tremor, and inflation. One of the largest eruptions in the last several decades occurred on April 21, 2025, generating an ash plume over 4.5 km in altitude and depositing ash in parts of San José.

Timeline of the AVERT-OVSICORI Poás Project

Year	Where	What
2023	LDEO, OVSICORI	Start of joint field planning between AVO and AVERT in monthly zoom calls.
	Poás	Five-day field campaign in 11/23 that successfully deployed new instrumentation (4 seismometers, 3 continuous magnetometers, 1 CO_2 soil probe; 1 GNSS) at 4 new sites (VPPC, VPNC, VPRS, VPCC). Starlink was installed at VPMI.
2024	Poás	2/17-2/24 Field Workshop with ~ 34 scientists from 5 countries to deploy novel instrumentation, including a quadrupole mass spectrometer, micro-gravimeter, drone-based gas sensors and lake samplers, and aerosol collectors. New permanent installations included an infrasound array and infrared camera.
	Poás	New weather station installed at VPMI 09/24
	LDEO	Follow-up workshop 09/23-09/24 with 20-25 participants to debrief, share data and plan
2025	Poás	3/09-3/14 Field Workshop with 40 scientists from 6 countries to deploy novel instrumentation, including drone-based and ground-based CO_2 soil sensors, lake and spring samplers, drone-based gas collectors, gravity and magnetic surveys. New permanent installations included an aerosol sampler and a fiber optic cable along the crater rim to measure temperature, tilt, strain and acceleration. Improvements were made to the MEMs gravimeter and infrared camera systems, and new infrasound sensors were deployed.
	OVSICORI	Follow-up meeting 09/20-09/23 to hand-off instruments and establish all data in open archives. A thermocouple was added to calibrate the infrared camera images and a new web cam was installed at VPMI.

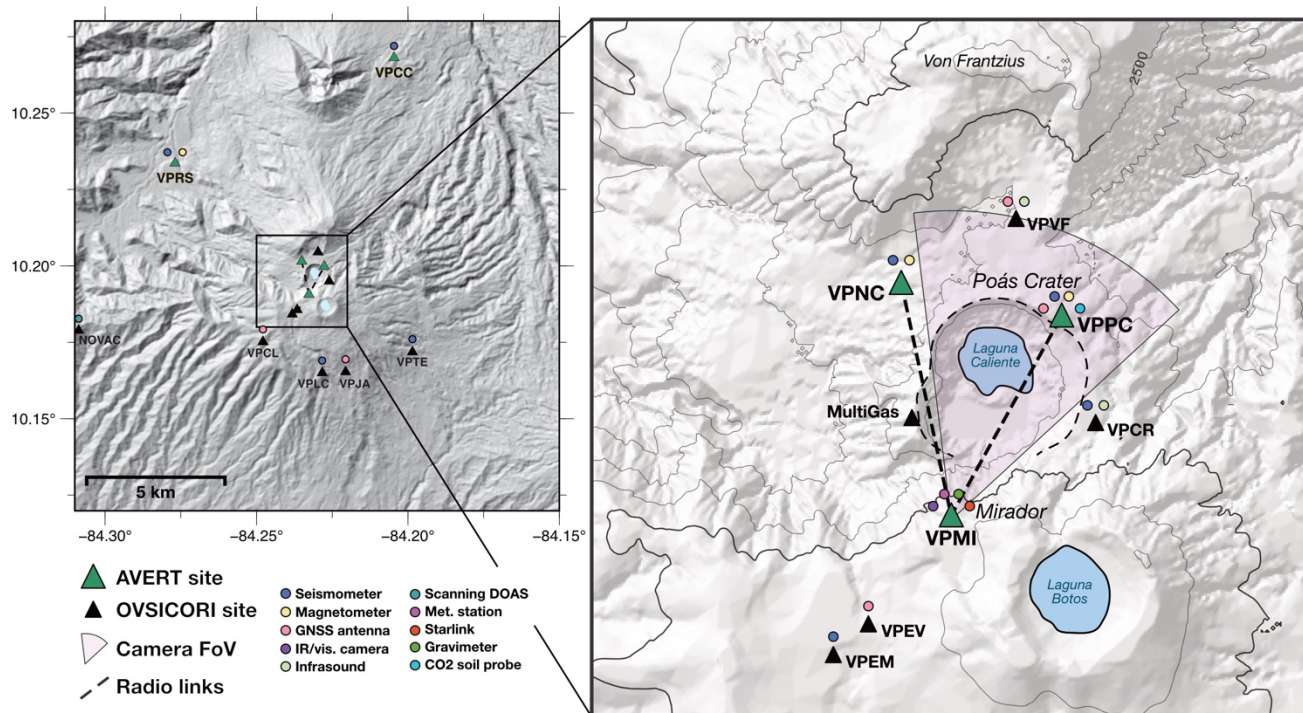## Accomplishments of AVERT-OVSICORI partnership on Poás

Maps below illustrate the stations, telemetry and instrumentation in place after the AVERT-OVSICORI field campaigns on Poás.

There were 4 primary accomplishments at Poás following on the goals of the AVERT Project:

1. Enhanced Monitoring. Although there were already several seismic stations on Poás prior to 2023, the monitoring capabilities have been substantially strengthened as a result of the AVERT partnership with OVSICORI. Four new stations were established, two in the north (VPRS, VPCC) where monitoring was sparse and two on the active crater rim (VPPC and VPNC) where

monitoring is most critical and challenging. This increased the number of stations on Poás by 50% and more than doubled the number of seismometers, now distributed more radially about the crater. A science news article on the November 2023 field deployments can be found here:
https://news.climate.columbia.edu/2024/02/29/high-in-a-cloud-forest-tapping-into-the-breathing-of-a-volcanic-beast/

2. <u>Multiple-Sensors</u>. Prior to the AVERT Project partnership, Poás was monitored with a combination of seismic, GNSS, MultiGas, Scanning DOAS and web cam instrumentation. As of 2025, the instrumentation on Poás now also includes three continuous magnetometers, an infrared camera, a CO_2 soil probe, a weather station, an infrasound array, and a fiber optic cable with temperature, tilt, strain and acceleration and satellite telemetry. **In terms of the sheer variety of sensors, Poás is now the best instrumented volcano in Costa Rica.**

3. <u>Novel Sensors</u>. Particularly as a result of the 2024 and 2025 international Field Workshops, new instruments deployed on Poás represented the first of their kind for any Costa Rican volcano:
- First continuous magnetometers (VPPC, VPNC, VPRS)
- First continuous CO_2 soil probes (VPPC). The CO_2 records were particularly valuable in showing increases prior to 2025 eruptive episodes.
- First calibrated IR camera (at VPMI).
- First fiber optic cable (for temperature, tilt, strain and acceleration)
- First continuous MEMS gravimeter (for any volcano)
- First 24-hour autonomous measurement of noble gases using a mini-Reudi quadrupole mass spectrometer (for any volcano)

4. <u>Develop a Collaborative Community</u>
The field workshops carried out on Poás in 2024 (34 people from 5 countries) and 2025 (40 participants from 6 countries) were unique experiences that brought many early career scientists

together to work collaboratively on an active volcano for a week. In addition to the novel instrumentation deployed, the workshops have spawned new projects with and among Costa Rican scientists. Detailed and illustrated reports for each workshop can be found here:

https://avert.ldeo.columbia.edu/news/poas-2024-workshop-report
https://avert.ldeo.columbia.edu/news/poas-2025-workshop-report

Hand-off to OVSICORI. A key guiding principle of the AVERT project is to assure legacy of all instrumentation and open archiving of all data. A total of 14 new sensors were deployed on Poás as part of AVERT Project, at a total cost of ~$150,000 (including travel, shipping and supplies). The cost of the three workshops was an additional ~80,000. All instruments have been handed-off to OVSICORI for incorporation into their monitoring networks, with all data openly available in as real-time as possible. The chart below lists all sensors established in partnership with AVERT as well as the data streams and archives, as of Summer 2025.

New Instrumentation Installed as part of the AVERT-OVSICORI Project.

Sensors in bold purchased by AVERT and donated to OVSICORI.
Data archives highlighted in yellow are in progress.

Station	Instrument	Data Archive	Model
VPRS	**BB Seismometer**	EarthScope	Nanometrics Trillium Compact 120H
VPRS	**Magnetometer**	EarthScope	Bartington Mag-13 Three Axis Field Sensor
VPCC	**BB Seismometer**	EarthScope	Nanometrics Trillium Compact 120H
VPNC	**BB Seismometer**	* EarthScope	Nanometrics Trillium Compact 120H
VPNC	**Magnetometer**	* EarthScope	Bartington Mag-13 Three Axis Field Sensor
VPPC	**Soil Probe, CO_2**	* EarthScope	Vaisala
VPPC	**GNSS**	* EarthScope	Reftek Resolute Polar w/ Tallysman Antenna
VPCC	**BB Seismometer**	* EarthScope	Nanometrics Trillium Compact 120H
VPCC	**Magnetometer**	* EarthScope	Bartington Mag-13 Three Axis Field Sensor
VPMI	**Satellite Internet**	* OVSICORI	Starlink
VPMI	**Infrared Camera**	* OVSICORI	Teledyne DALSA Calibir GXM
VPMI	**Weather Station**	* EarthScope	Vaisala
VPMI	**Micro-Gravimeter**	LDEO to Glasgow	MEMS wee-G
VPMI	**Web camera**	OVSICORI	Basler acA2440-20gc
VPCR	Infrasound Array	OVSICORI to Earthscope	From Corentin Coudron Collaboration
VPEM	**Infrasound Array**	OVSICORI to Earthscope	Chapparal

* Currently available on AVERT data portal

Participants in AVERT-OVSICORI Field Deployments on Poás
More than 50 scientists, students and staff took part in the AVERT-OVSICORI field deployments on Poás. The cooperation and partnership in the field was a hallmark of this project that directly led to its success.

Field Team November 2023

Nick Frearson	LDEO/Columbia Univ
Einat Lev	LDEO/Columbia Univ
Conor Bacon	LDEO/Columbia Univ
Maarten deMoor	OVSICORI
Geoffroy Avard	OVSICORI
Leo van der Laat	OVSICORI
John Bolanos	OVSICORI
Alejandro Badilla	OVSICORI
Carlos Sanchez	OVSICORI
Henriette Bakkar Hindeleh	OVSICORI
Walter Jimenez Urrutia	OVSICORI
María Martínez Cruz	OVSICORI

Field Workshop 2024

Maarten deMoor	OVSICORI
Geoffroy Avard	OVSICORI
Leo van der Laat	OVSICORI
Arno Gendre	OVSICORI
John Bolanos	OVSICORI
Alejandro Badilla	OVSICORI
Pierre Boymond	OVSICORI
Carlos Sanchez	OVSICORI
María Martínez Cruz	OVSICORI
Jose Brenes	Univ National
Paulo Ruiz	Univ of Costa Rica
Carlos Ramírez	SeGeoAm
Conor Bacon	LDEO/Columbia Univ
Terry Plank	LDEO/Columbia Univ
Einat Lev	LDEO/Columbia Univ
Sarah Shi	LDEO/Columbia Univ
Rebecca Ju	Moore Foundation
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Ben Roche	Université Libre Bruxelles
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Elizabeth Passey	University of Glasgow
Kristian Anastasiou	University of Glasgow
Donato Giovannelli	University of Naples Federico II
Bernardo Barosa	Univ of Napoli, Italy
Melanie Moses	University of New Mexico
Matthew Fricke	University of New Mexico

Scott Adam Nowicki	University of New Mexico
Rafael Fierro	University of New Mexico
Carter Benjamin Gabriel Frost	University of New Mexico
Felipe Rojas Vilches	University of New Mexico
John Carl Ericksen	University of New Mexico
Alan Seltzer	Woods Hole Oceanographic Institution
Michael Broadley	Woods Hole Oceanographic Institution
Wade Johnson	EarthScope

Field Workshop 2025

Maarten deMoor	OVSICORI
Geoffroy Avard	OVSICORI
Leo van der Laat	OVSICORI
Arno Gendre	OVSICORI
John Bolanos	OVSICORI
Alejandro Badilla	OVSICORI
Pierre Boymond	OVSICORI
Carlos Sanchez	OVSICORI
María Martínez Cruz	OVSICORI
Carlos Ramírez	SeGeoAm
Mauricio Mora	Univ of Costa Rica and RSN
Diego Badilla	ICE Costa Rican Electric Company
Rosa Alfaro Solís	Univ National
Jose Brenes	Univ National
Yemerith Alpízar	National Technical Univ
Tarsilo Girona	University of Alaska, Fairbanks
Sandy Drymoni	Jet Propulsion Lab, Caltech, CA
Jason Williams	University of Alaska, Fairbanks
James Copple	University of Alaska, Fairbanks
Matthew J. Westhoff	Alaska Center for Unmanned Aircraft Systems Integration
Noé García-Martínez	Univ of Alacante, Spain
David Benavente	Univ of Alacante, Spain
Corentin Caudron	Université Libre Bruxelles
Sonia Heuninck	Université Libre Bruxelles
Olivier Fontaine	Université Libre Bruxelles
Henriette Bakkar Hindeleh	Université Libre Bruxelles/OVSICORI
Scott Nowicki	Southwest Indian Polytechnic Institute , New Mexico
Felipe Rojas Vilches	Univ of New Mexico
Elizabeth Passey	University of Glasgow
Kristian Anastasiou	University of Glasgow
Conor Bacon	LDEO/Columbia Univ
Terry Plank	LDEO/Columbia Univ
Einat Lev	LDEO/Columbia Univ
Ally Peccia	LDEO/Columbia Univ
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