

In Our Backyard

Post-fire research continues to support the local community and beyond.



More than a year after the 2025 Los Angeles fires, Caltech labs are pressing forward with research projects to provide answers in service of public health and safety. Through investigations such as testing for heavy metal contamination, monitoring air quality, and assessing the burn area's erosion hazards, Institute scientists immediately launched into action in the days and weeks following the fires, bringing scientific tools and expertise to tackle fundamental questions for the broader public—even as many of these researchers were impacted by the fires themselves.

“Our community came together to help each other with housing and all manner of other needs, while simultaneously directing our skills and energy as scientists at societally important problems created by the fires—the unique and poorly understood sources of pollution, life-threatening debris flows, and more,” says John Eiler, the Robert P. Sharp Professor of Geology and Geochemistry and Ted and Ginger Jenkins Leadership Chair of the Division of Geological and Planetary Sciences (GPS). “This was possible only because our small size and close connections with each other allowed us to mobilize for science in service to the community.”

Measuring Heavy Metal Contamination

A few miles north of Caltech's campus, the 14,000-acre Eaton fire burned thousands of structures, most built before 1978, the year the government started regulating lead in building materials. Lead and other toxic heavy metals were released into the air as those older structures burned. Lead is highly toxic to young children; Environmental Protection Agency (EPA) regulations allow for only 5 micrograms of lead per square foot of dust on floors and 40 micrograms per square foot on windowsills.

After evacuating his family from his Altadena home, Caltech's François Tissot, professor of geochemistry and a Heritage Medical Research Institute Investigator, reached out to his lab members. “I asked my team to let me know if anyone was interested in using our resources to help assess the hazards from the fire, ash, and smoke,” he says. “Everyone immediately said, ‘Yes.’”

When Tissot looked for articles or studies related to the pollution caused by these types of wildfires, he came up empty. He soon realized that his lab's work would begin to fill a huge gap in knowledge. As he said during his January 2026 Watson Lecture: “There is no systematic study of this kind of urban fire. It's a new type of fire.”

Clad in safety gear, **François Tissot** surveys his damaged home after the Eaton Fire.

By Lori Dajose (BS '15)

In their cosmochemistry laboratory, the Tissot group typically uses sophisticated instrumentation to measure concentrations of elements in meteorite samples that date back to the formation of our solar system. After the blaze, the team opted to use its technology to study bulk ash samples taken outdoors as well as finer dust samples taken from surfaces in homes in and around the burn area. Led by graduate student Merritt McDowell and postdoctoral research associate Theo Tacail, the team worked with local residents to collect and process over 300 samples from 52 homes—including Tissot's—within five weeks after the fire; Tissot's lab provided these measurements free of charge thanks to support from the Caltech GPS division.

“The tools we have in the lab are extremely complex, but the first measurement we always make is a concentration measurement,” Tissot says. “We need to know how much of an element is in the sample so that we know what to do with it. How much lead, how much of the heavy metals, how much of the toxic elements have been released by this particular fire? These were the crucial questions.”

The team discovered unsafe levels of lead, above the EPA limits, in homes as far away as 7 miles from the burn zone; the farthest they tested. The researchers returned to the same homes in January 2026 to resample the same areas and compare lead levels a year after the fire. As for Tissot's own house, because the structure is too contaminated for remediation, he and his family are still waiting to see if their insurance company will allow them to rebuild. “There is no cleaning it,” he said in response to a question at his Watson Lecture. “Ninety-nine percent of everything we owned was thrown away.”

Tissot has begun collaborations with colleagues in atmospheric chemistry and atmospheric dynamics to combine their lead data with a model of dust dispersion and transport. The goal is to build a tool that can be used for other urban firestorms to assess risks from heavy metals, particularly lead, carried by smoke plumes.

“The fires are going to become an important project within my group for the next few years,” Tissot says. “It takes time for the data to be impactful, for us to have interactions with policymakers and government officials. We need to make sure the data we produce has an impact beyond just helping people locally and improves responses for all future fires, because they will continue to happen. We want to get our data in front of the people who have the power to make decisions.”

Assemblymember John Harabedian represents the fire-affected foothill communities of Altadena, Pasadena, and Sierra Madre in the California legislature. In the weeks and months following the Eaton Fire, he and members of

his staff have met with Tissot and other Caltech scientists to monitor and understand new findings.

“University research plays a critical role in response and recovery,” says Harabedian, who has advanced legislation to expand access to health care, stabilize housing, and assess environmental hazards in the aftermath of urban wildfires. “Scientific data helps us protect human health and build more resilient communities as we work to prepare for, and ideally prevent, future disasters.”

Monitoring Air Quality

The Eaton fire destroyed many existing air quality monitors in the Altadena area, which prompted researchers in the laboratory of Paul Wennberg, Caltech’s R. Stanton Avery Professor of Atmospheric Chemistry and Environmental Science and Engineering, to launch a new project to provide air quality data to the community in the fire’s aftermath.

Led by graduate student Haroula Baliaka and associate research scientist Coleen Roehl, the team deployed a network of moderate-cost solar-powered sensors throughout Altadena called PHOENIX (Post-fire airborne Hazard Observation Environmental Network for Integrated Xposure-monitoring). These sensors detect and measure the concentrations of particulate matter in the air based on the particles’ sizes, which range from 1 to 10 micrometers across.

The sensors were installed on top of homes and other local buildings, and community members were eager to

Did You Know?

Caltech professor Arie Haagen-Smit first linked air pollution to automobile exhaust and other industrial fuel combustion in the 1950s.

participate. Within a month after the fire, the team had worked with 28 different business owners, residents, and schools—including Roehl herself—to install PHOENIX sensors. “As an Altadena resident and atmospheric scientist, I was strongly compelled to participate in the PHOENIX project and to help in providing critical air quality data to my community,” Roehl says.

The PHOENIX data in the weeks after the fire showed that, on average, low levels of particulate matter in the air were recorded for the majority of each day, with concentrations classified as “good” by the EPA. However, the sensors showed that concentrations tended to spike into unhealthy levels at certain times of day for up to 60 minutes, usually in the morning. Baliaka says this phenomenon was potentially associated with cleanup activities and construction trucks kicking up dust and other particles as they rumbled through town. “PHOENIX was the most rewarding thing I did during my PhD,” Baliaka says. “It was very community driven, speaking to the residents and hearing their stories. It’s rewarding to be able to provide them with the data they need to make decisions for their health.”

Even before the fires, Baliaka’s research focused on air quality measurements. In particular, she utilizes a nationwide network of sensors, called ASCENT (Atmospheric Science and Chemistry mEasurement NeTwork), each composed of multiple instruments that detect not only particulate concentrations but the composition of those particles. The Los Angeles node of ASCENT is located in Pico Rivera, 13 miles from the burn area. ASCENT is funded by the National Science Foundation and was created by Caltech alumna Sally Ng (PhD ’07), the Institute’s Elizabeth W. Gilloon Professor of Environmental Science and Engineering.

In the aftermath of the Eaton fire, Baliaka looked at the data from the Pico Rivera ASCENT site and was surprised to find that potassium levels in the air, usually a signal of a wildfire, were not as high as she expected. However, ASCENT measured peak lead levels 110 times higher than usual for the area, confirming that the burned buildings did in fact release lead into the air throughout the Los Angeles region.

As Altadena rebuilds, the team is continuing to monitor air quality during construction. “We want the members of our local Pasadena community to have access to trustworthy air quality data,” Wennberg says. “We anticipated that having high-quality data available would help build confidence in the quality of the cleanup work undertaken by the Army Corp of Engineers.”

Graduate student **Haroula Baliaka**, left, from **Paul Wennberg’s** lab, and volunteer **Nikos Kanakaris** assemble a PHOENIX air-quality monitor.

Erosion and the Fire–Flood Cycle

The Los Angeles area is one of the most well-studied examples of the fire–flood cycle, in which a burned landscape produces a burst of flooding and erosion during its first major rainstorm following a fire. In the aftermath of the Eaton fire, researchers knew that the region could expect heavy debris flows with the next rainstorm.

In the 1930s, after a major winter storm sent a deadly wave of mud and rock cascading down from the San Gabriel Mountains through the Crescenta Valley, Los Angeles County built large basins at the foot of the mountains to trap and contain the surging debris flows before they reach residential neighborhoods. Today, there are about 120 of these basins along the San Gabriel Mountains. After the Eaton fire, the question emerged: Would these engineered debris basins be sufficient to contain the coming debris flows or would residents need to evacuate?

“In February, after the fire, the weather report was indicating a major rainstorm was coming, and we were particularly worried that the catchment above the Sierra Madre Dam might be too small to contain the coming debris flows,” says Emily Geyman, a graduate student in the Caltech laboratory of Michael Lamb, a professor of geology. As an ultrarunner, Geyman had run through the San Gabriel Mountains every weekend during her three years at Caltech prior to the fire; now, she returned to the trails to measure their erosion.

Lamb, a geomorphologist, studies how mountains erode and how to translate that science into the development of hazard assessments for public safety. The San Gabriel Mountains are among the fastest-eroding mountain ranges in the US, and urban development has spread right up against the mountain front. After the Eaton fire, Lamb, Geyman, and Zhiang Chen, then a Caltech postdoc, tested a new model of how fire leads to increased erosion in the San Gabriel Mountains, calculating the expected sizes of upcoming debris flows by using drones to measure the amount of dry sediment that had accumulated in the channel network. The work was carried out with support from local, regional, and federal government agencies—including the Los Angeles County Department of Public Works, the California Geological Survey (CGS), and the United States Forest Service. Indeed, their model correctly predicted the volume of debris flow during the next rainstorm—more than 677,000 cubic meters, or enough to fill more than 270 Olympic-sized swimming pools with mud, sand, and boulders.

The predictions also proved correct for the Sierra Madre Dam. Before the February 2025 rainstorm, county crews worked around the clock to excavate the dam and create more space to catch the debris. While the basin did fill up and slightly spill over its capacity, it protected the nearby residents from catastrophic levels of debris flows.



Michael Lamb surveys an area of possible debris flow in the San Gabriel Mountains.

“These results supported emergency management agencies by prioritizing debris-basin cleanouts, calibrating and validating debris-flow models for the burned catchments, and forecasting potential debris-flow risks for upcoming storm events,” says Don Lindsay, supervising engineering geologist at the CGS. “CGS continues to work with Michael Lamb’s group collecting lidar data to track sediment supply and vegetation recovery with time to reassess potential post-fire hazards and communicate our findings to Los Angeles County for consideration in its response plan.”

The team is now developing a method that can be applied to other fire-prone mountain ranges. This project will involve scanning mountains with drone laser altimeters (sensors that use laser light to measure elevation) in the immediate aftermath of a fire and calculating how much sediment could fuel an upcoming debris flow.

“Our work at Caltech is building on decades of studies from others, most notably state and federal government scientists, and the Herculean efforts by LA County Public Works to literally move mountains of rocks,” Lamb said during his January 2025 Watson Lecture following the fires. “Collectively, the continuation of government-supported science and debris-basin defenses is needed for us to live in the beautiful landscapes at the foothills of the San Gabriel Mountains.”

For more on how Caltech researchers jumped into action following the 2025 Los Angeles fires, listen to the *After the Fires* podcast produced by the Caltech Science Exchange.

