How A.I. captured a volcano's changing lava lake

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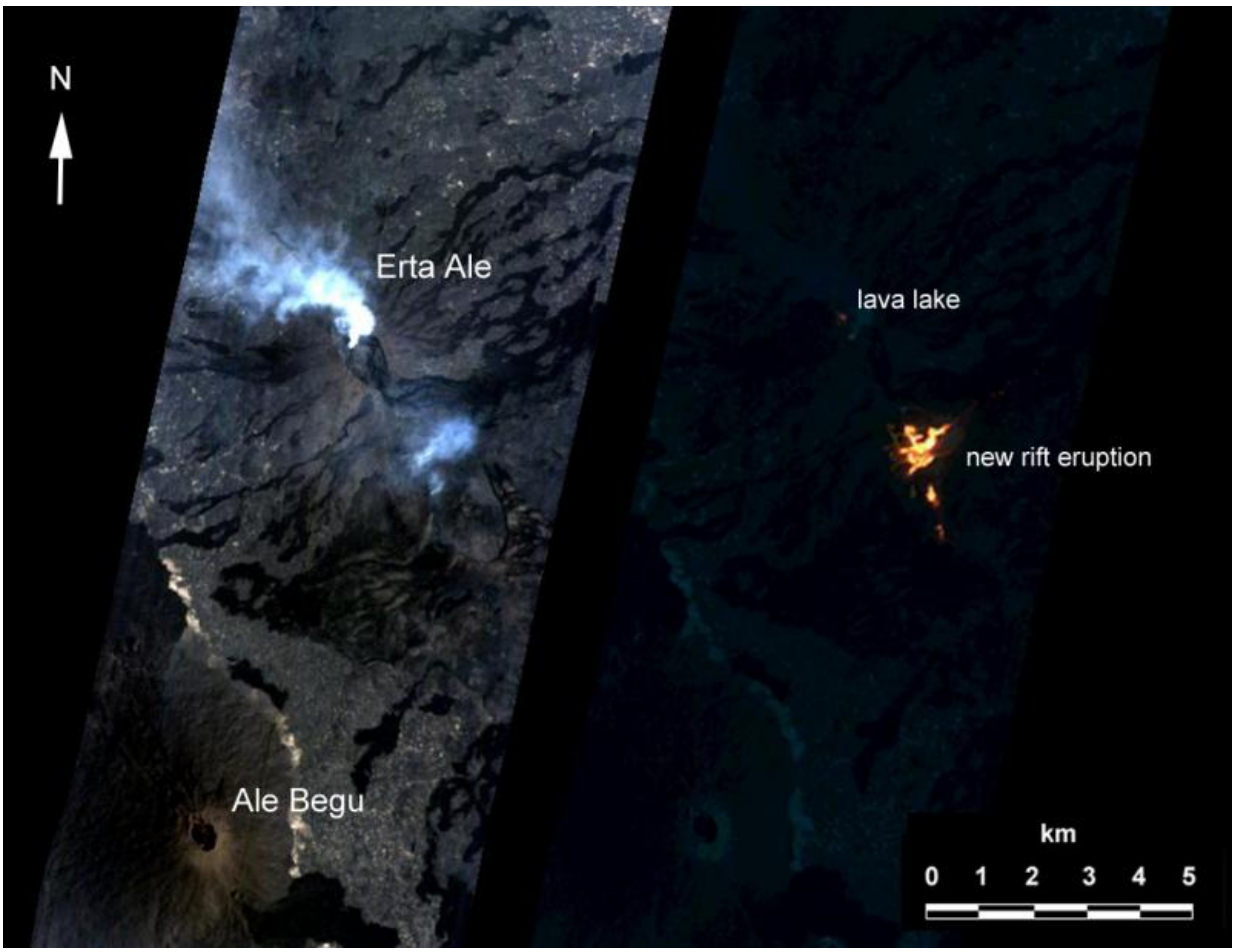

Artificial intelligence onboard NASA's Earth Observing 1 (EO-1) spacecraft assisted in imaging an eruption at Erta'Ale volcano, Ethiopia, from an altitude of 438 miles (705 kilometers). The observation was scheduled autonomously via the Volcano Sensor Web, which was alerted to this new activity by data from another spacecraft. Credit: NASA/JPL/EO-1 Mission/GSFC/Ashley Davies

One of our planet's few exposed lava lakes is changing, and artificial intelligence is helping NASA understand how.

On January 21, a fissure opened at the top of Ethiopia's Erta Ale volcano—one of the few in the world with an active lava lake in its caldera. Volcanologists sent out requests for NASA's Earth Observing 1 (EO-1) spacecraft to image the eruption, which was large enough to begin reshaping the volcano's summit.

As it turned out, that spacecraft was already busy collecting data of the lava lake. Alerted by a detection from another satellite, an artificial intelligence (A.I.) system had ordered it to look at the volcano. By the time scientists needed these images, they were already processed and on the ground.

It's a fitting capstone to the A.I.'s mission. That software, called the Autonomous Sciencecraft Experiment (ASE), has guided the actions of EO-1 for more than 12 years, helping researchers study natural disasters around the globe. ASE will conclude its operations this month, when EO-1's mission comes to an end. ASE leaves behind a legacy that suggests great potential for A.I. in future space exploration.

Besides the recent eruption, ASE helped scientists study an Icelandic volcano as ash plumes grounded flights across Europe in 2010. It also tracked catastrophic flooding in Thailand. The software cut the turnaround time for data from weeks to just days, as users could put in requests in real-time.

ASE was developed by NASA's Jet Propulsion Laboratory in Pasadena, California, and uploaded in 2003 to EO-1, an earth science satellite managed by Goddard Space Flight Center in Greenbelt, Maryland. The

software directed EO-1 to alert researchers whenever it detected events of scientific interest, and autonomously tasked the spacecraft to take photos during subsequent orbital passes.

Additionally, it manages a "sensor web," a network of other satellites and ground sensors that all "talk" to one other, helping to prioritize which events to focus on.

"It's a milestone in A.I. application," said Steve Chien, principal investigator of ASE and head of the Artificial Intelligence Group at JPL. "We were supposed to do this for six months, and we were so successful that we did it for more than 12 years."

The software typically notified researchers within 90 minutes of detecting an event. It then downlinked data and re-tasked EO-1 within a few hours—a process that previously took weeks when scientists and operations teams on the ground had to coordinate.

A.I. can free a spacecraft to act first, within carefully programmed parameters, allowing it to capture valuable science data that would otherwise be lost, said Ashley Davies, lead scientist for ASE and a volcanologist at JPL.

"It's putting some scientific smarts onboard a spacecraft," Davies said.

The recent eruption of Erta Ale highlights the speed and impact of space A.I. When a 1.9 mile-long (3 kilometer) fissure opened in late January, it caused parts of the caldera to collapse—exactly the kind of fast-moving event that is hard to capture data on unless you're watching for it.

Fortunately, the JPL sensor-web has a wide reach. It's comprised of other satellites besides EO-1, and even on-the-ground sensors. When one of those other satellites picked up rapid temperature changes at the

volcano's summit, that's when it pinged EO-1, which began planning to image the site.

"We caught this event at the perfect time, during an early, developing phase of the eruption," Davies said. Now he and other scientists had a much better sense of how the discharge of lava is evolving over time. "This simply wouldn't have happened without the Volcano Sensor Web."

Both Chien and Davies agreed that autonomy has enormous potential when it comes to studying events far from Earth, where vast distances make it impossible to know what's happening until the event has already passed. For example, A.I. could make it much easier to capture those dynamic moments when a comet passes by or volcanoes begin erupting on a distant moon.

More information: For more information about the Autonomous Sciencecraft Experiment, visit ase.jpl.nasa.gov/

Provided by NASA

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