APSENSING.

Unlocking Submarine Volcanic Activity with DAS

Kikai Caldera, Japan

Project Overview

The Kikai Caldera is a largely submerged volcanic system located ~50 km south of Kyushu Island, Japan. It produced one of the largest known eruptions (~7,300 years ago), classified as Volcanic Explosivity Index (VEI) 7, exceeding the magnitude of the Santorini and Krakatau eruptions (VEI 6), and is considered among the largest eruptions of the Holocene, with significant impacts on prehistoric communities in the region.

Today, the caldera hosts an active magma system beneath a central lava dome, indicating ongoing subsurface activity. However, due to its offshore location, conventional seismic monitoring is limited, resulting in a poorly constrained understanding of present-day volcanic processes beneath Kikai Caldera.

Solution

To address the lack of offshore monitoring at the Kikai Caldera, researchers from the Japan Agency for Marine-Earth Science and Technology (JAMSTEC) and Kobe University deployed two AP Sensing Distributed Acoustic Sensing systems of the DAS N52 series, using existing subsea telecommunication cables around the caldera. Nearly 90 km of fiber-optic cable connecting nearby islands was repurposed into a dense seismic array, providing continuous strain measurements (Figure 1).

During the observation period, various seismic events were recorded, some of which were not listed in the Japan Meteorological Agency (JMA) catalogue. Figure 2 shows an example of such an event detected by the DAS system. The arrival-time progression along the cable indicates that the event originated from within the Kikai Caldera region.

Background

- A large submerged caldera in the East China Sea
- Site of one of the largest eruptions during the Holocene, approximately 7,300 years ago
- Still volcanically active, with an active magma system beneath the central dome

Solution & Benefits

- Deployment of two units of AP Sensing's DAS N52 series demonstrates a scalable approach for offshore geoscience monitoring
- Existing seafloor telecommunication cables repurposed into a dense seismic array
- Enables high-resolution insights into active volcanic processes beneath the seafloor

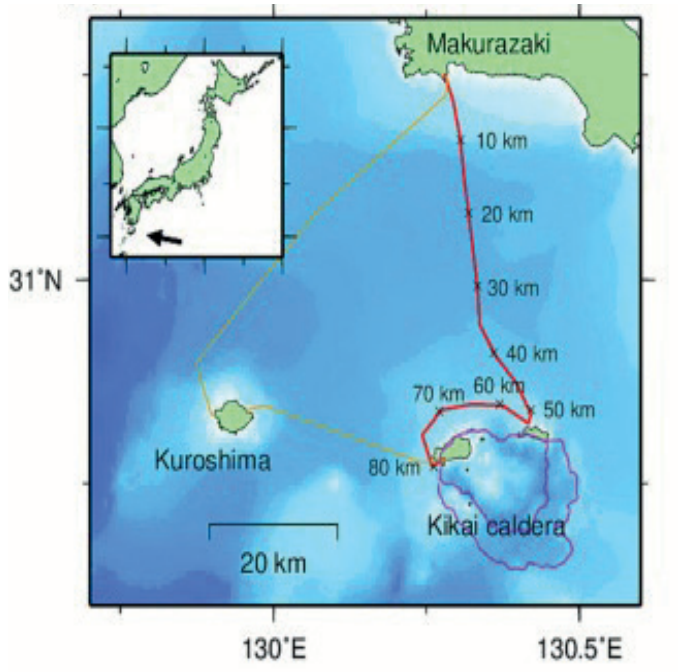
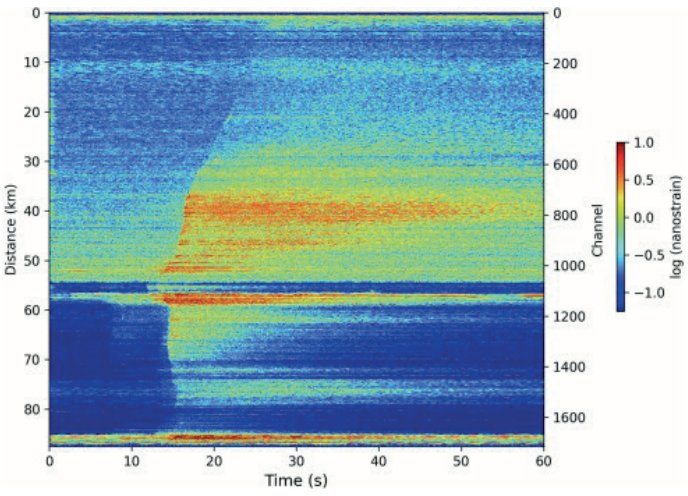


Figure 1: Location of Kikai Caldera and DAS-enabled seafloor telecom cables (red and orange lines, with indication of distances from Makurazaki station) used in this study

One key advantage demonstrated in this study is the improved accuracy of seismic event localization using DAS. The DAS-derived locations show better agreement with observed wave arrival times, highlighting higher reliability compared to conventional approaches. This improvement results from the dense spatial sampling along the seafloor cable, which provides near-source coverage, whereas conventional monitoring relies on sparse island-based stations with limited azimuthal coverage.



Overall, this approach transforms existing telecommunication infrastructure into a real-time offshore monitoring system, enabling seismic observations in a previously under-instrumented environment.

Results & Benefits

The DAS system deployment at the Kikai Caldera delivered key scientific and operational outcomes, improving understanding of offshore volcanic activity in this previously under-instrumented region.

The system enabled detection of previously unrecorded seismic events not included in the Japan Meteorological Agency (JMA) catalogue, improving monitoring completeness. This highlights the value of DAS in offshore environments, where sparse station coverage is complemented by continuous spatial sampling along the seafloor cable.

Although active seismicity was observed, the overall event rate remained relatively low, with no immediate indicators of eruptive escalation at the time of observation. However, persistent background seismicity highlights the importance of continuous, high-resolution monitoring to detect potential system changes over time.

Beyond scientific results, the study demonstrates a scalable and cost-effective approach for offshore geophysical monitoring. By repurposing existing telecommunication fiber networks into a distributed sensing array, continuous real-time observation can be achieved without deploying new seafloor sensors, effectively transforming subsea cables into permanent geophysical observatories for long-term monitoring of remote submarine volcanic systems.

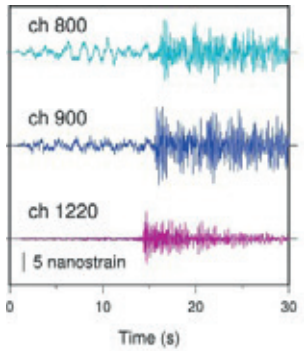


Figure 2: Example event recorded by DAS and not listed in JMA catalogue, originated from Kikai Caldera. DAS strain records at selected channels for this event

The content in this case study is based on the following paper:
M. Nakano, T. Nakajima, E. Araki, H. Sugioka, A. Ito, H. Matsumoto, T. Yokobiki, T. Tonegawa, S. Ono. Seismic activities at Kikai Caldera, Japan, detected using distributed acoustic sensing via seafloor telecommunication cables, Journal of Volcanology and Geothermal Research, Volume 469, 2026, 108498, ISSN 0377-0273,
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