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Biennial report for Permanent Supersite/Natural Laboratory

Kamchatka-Kuriles Supersite

History	*https://geo-gsnl.org/supersites/permanent-supersites/kamchatka_kuriles_supersite/*
Supersite Coordinator	*Alina Shevchenko* *German Research Centre for Geosciences,* *Telegrafenberg, 14473 Potsdam*

1. Abstract

The volcanoes of the Kamchatka-Kuriles region are of paramount importance to volcanologists due to their exceptional geological activity, diversity, and accessibility. This region hosts a dense concentration of active volcanoes, including some of the most explosive and highest-volume eruptions recorded in recent history. The variety of volcanic features, ranging from stratovolcanoes to calderas, provides a comprehensive natural laboratory for studying different types of volcanic processes and eruption styles. Additionally, the Kamchatka-Kuriles arc offers unique opportunities to investigate subduction zone volcanism, contributing to the understanding of tectonic activity, magma genesis, and the potential hazards associated with explosive eruptions. The insights gained from studying this volcanically rich area are crucial for advancing global volcanic research and improving volcanic hazard assessment and mitigation strategies.

The Kamchatka-Kuriles Supersite was established in 2020 to develop collaboration between Kamchatkan volcanologists and the international volcanological community and to provide free access to high-resolution EO and in-situ data for volcanological research and hazard assessment. Since then, high resolution EO and in-situ data have been acquired and used for published research in a number of first-class journals and at conference presentations. An increasing number of scientists from all over the world explore these volcanoes and have requested data in 2023 and 2024. Since the previous supersite report from June 2022, 48 Pleiades datasets, 160 TerraSAR-X datasets, and 265 COSMO-SkyMed datasets have been obtained over 13 volcanic edifices. However, due to the current political situation, since 2022, the in-situ data distribution between the supersite team has become complicated. Despite these unfavorable conditions, we managed to perform and publish one research based on the in-situ data acquired before 2022. Another research is currently ongoing based on the obtained EO data. Unfortunately, due to the conditions set by the sanctions and regime, collaboration and data exchange between local scientists and the international scientific community is not possible anymore.

Scientists/science teams

Researcher/team	*Name, affiliation, address, e-mail, website/personal page of team leader*
Researcher 1	*Alina Shevchenko, German Research Centre for Geosciences, Telegrafenberg, 14473 Potsdam, alinash@gfz-potsdam.de, https://www.gfz-potsdam.de/staff/alina.shevchenko*
Researcher 2	*Thomas Walter, German Research Centre for Geosciences, Telegrafenberg, 14473 Potsdam, twalter@gfz-potsdam.de, https://www.gfz-potsdam.de/en/staff/thomas.walter*

Scientists/science teams issues

No science team members were added as institutional collaborations and data exchange are overshadowed by the political situation.

1. In situ data

Type of data	Data provider	How to access	Type of access
Seismic	*Kamchatka branch of the Geophysical Service of Russian Academy of Sciences*	*http://www.emsd.ru/~ssl/monitoring/main.htm*	*unregistered public*
Seismic	*The GEOFON program, GFZ*	*https://geofon.gfz-potsdam.de/waveform/archive/network.php?ncode=D0&year=2015*	*unregistered public; restricted data currently not available*
Camera monitoring	*Institute of volcanology and seismology*	*http://geoportal.kscnet.ru/volcanoes/webcams.php*	*unregistered public*
Aerial DEMs	*Institute of volcanology and seismology*	*Contact supersite coordinator*	*currently not available*

In situ data issues

Due to the ongoing political situation, access to the main part of the initially indicated in-situ data dependent on the fieldwork and aerial archive data was restricted. The data presented in the research below were acquired before the access restriction. For now, institutional collaborations and data exchange are strictly limited.

2. Satellite data

Type of data	Data provider	How to access	Type of access
TerraSAR X. COSMO-SkyMed, Radarsat 2, ALOS-1/2, etc.	*DLR, ASI, CSA, JAXA, etc.*	*Link to data repository or description of procedure for data access*	*GSNL scientists*

Pleiades	*CNES*	*POC requests access from CNES for individual users, data further accessible via GEP*	*GSNL scientists*
Cosmo-SkyMed	*ASI*	*POC requests access from ASI for individual users, data further accessible via GEP*	*GSNL scientists*
TerraSAR-X	*DLR*	*Available after acceptance of PI proposal by DLR, data further accessible via GEP*	*GSNL scientists*

Satellite data issues

Pleiades: We were not able to acquire the data fully covering the quota since some of the objects are usually covered with clouds.

COSMO-SkyMed: The 200 acquisition quotas (100 per year) were covered.

TerraSAR-X: We ordered 160 datasets within the 300 images quota (150 per year). Often our orders were not processed due to technical reasons.

We haven't ordered Radarsat-2 data.

3. Research results

Over the second two years of the Supersite activity, we were focused on the geothermal processes at Uzon Caldera and nearly located Geysers Valley, which is also subject to hazardous landslides. We used two types of in-situ data: (1) archive aerial collected in 1996 and UAV data that were collected during 2018-2019 fieldwork. Our aim was to investigate how mass wasting can affect the functioning of geysers and hot springs and how it can lead to geothermal explosions. Our data let us reveal the rapid and profound changes that can affect geothermal field and ultimately lead to a dangerous, unanticipated eruption. We were able to identify a newly emerging explosion site. Photogrammetric analysis of data acquired before and after the explosion reveals morphological and thermal details of the new vent. The explosion site produced an aureole zone of more than 150 m^3 of explosively redeposited gravel and clay, a slightly elliptical crater with a diameter of 7.5 m, and a crater rim 0.30 m high. However, comparison with archives of photogrammetric data suggests that this site was thermally active years earlier and contained a crater that was obscured and covered by landslides and river sediments. The results allow us to develop a conceptual model and highlight the hazard potential of thermal features buried by landslides and clastic deposits. Sudden explosions may occur at similar sites elsewhere, highlighting the need for careful assessment and monitoring of geomorphological and hydrological changes at geyser sites in other regions.

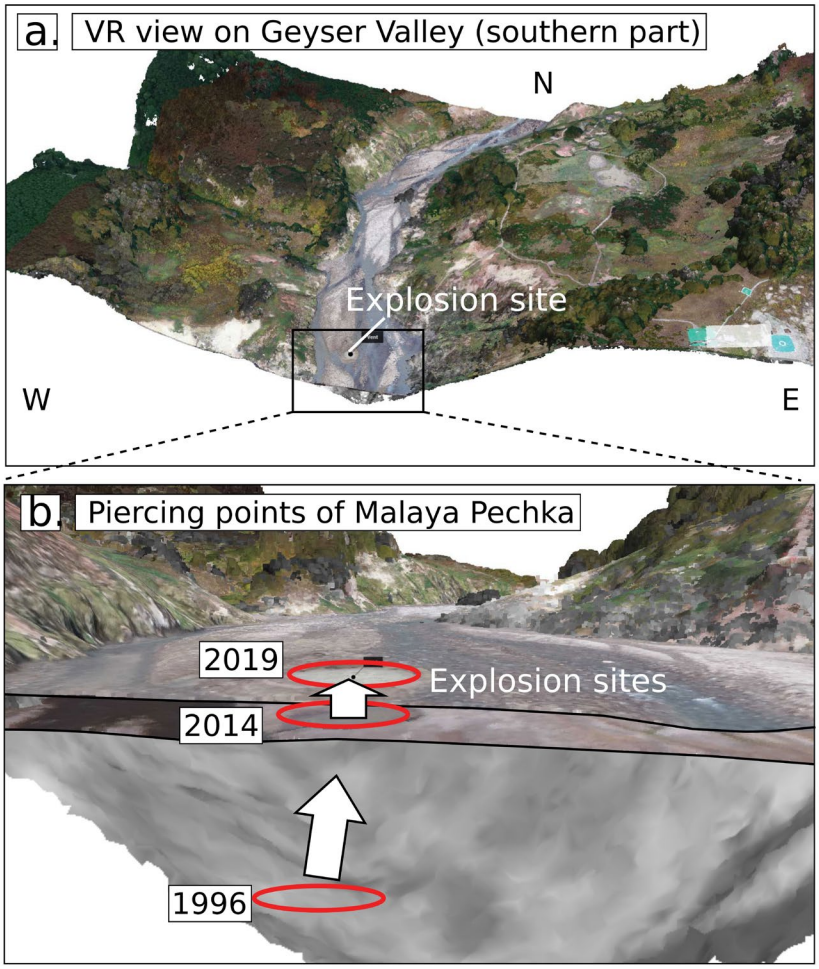

Figure 1 *Perspective view of the development of the explosion site. (a) Virtual 3D view from the south showing the Geyser Valley and the location of the explosion site. (b) Close-up of the Malaya Pechka site, shown as three overlapping datasets: the steep valley in 1996, the image after lahar and alluvial deposition in 2014, and further sediment added in 2018/2019. The sediments are composed of gravel, sand, and silt/clay.*

Publications

Peer reviewed journal articles

Allahbakhshi M., Shevchenko A.V., Belousov A.B., Belousova M.G., Kämpf H., Walter T.R. 2023. Geothermal Explosion at the 2014 Landslide-Covered Area of the Geyser Valley, Kamchatka, Russian Far East. GeoHazards, 4 (1), 60-76. https://doi.org/10.3390/geohazards4010005

Makus, P., C. Sens-Schonfelder, L. Illien, T.R. Walter, A. Yates, and F. Tilmann, 2023, Deciphering the Whisper of Volcanoes: Monitoring Velocity Changes at Kamchatka's Klyuchevskoy Group With Fluctuating Noise Fields. Journal of Geophysical Research-Solid Earth. 128(4). e2022JB025738. https://doi.org/10.1029/2022JB025738

Walter, T.R., E.U. Zorn, C.E. Harnett, A.V. Shevchenko, A. Belousov, M. Belousova, and M.S. Vassileva, 2022, Influence of conduit and topography complexity on spine extrusion at Shiveluch volcano, Kamchatka. Nature Communications Earth & Environment. 3(1). https://doi.org/10.1038/s43247-022-00491-w

Conference presentations/proceedings

Shevchenko A.V. and Walter T.R. Observing a century of volcanic morphodynamics using photogrammetric analysis of recent and archive data. GeoBerlin conference 2023, Berlin, Germany, 3–7 September 2023.

Research products

Type of product	Product provider	How to access	Type of access
Digital elevation models and orthophotos of various Kamchatka-Kurile volcanoes	*Shevchenko A.V.*	*By request to the Supersite coordinator*	*limited to GSNL scientists*

Research product issues

We have generated several high-resolution DEMs from the Pleiades and archive aerial data that can be further used for research and hazard assessments. However, due to the current political situation, collaborative research on the Kamchatka-Kurile volcanoes is limited.

4. Dissemination and outreach

The Supersite coordinator made an announcement about the Supersite during the GeoBerlin 2023 conference presentation.

5. Funding

There is no dedicated funding for the Kamchatka-Kuriles Supersite. All research was funded by separate third party funding of the partners and supersite users.

6. Stakeholders interaction and societal benefits

The interaction with the main Stakeholders (Volcanological Station of Kamchatka) was limited due to the current political situation.

7. Conclusive remarks and suggestions for improvement

The two-year activity of the Supersite was complicated due to the current political situation, which prevented the required collaborations between the scientific community and stakeholders, and dissemination and outreach. Nonetheless, we were able to achieve some scientific results using the in-situ and EO data:

- *We showed that the explosion site at Geysers Valley corresponds to the location of a geothermal site that was first buried under sediment and then covered by a lake that was dammed after the 2007 landslide.*

- *We developed a conceptual model that highlights the presence of critical temperatures in buried sedimentary layers that may also trigger other geothermal explosions in the Geyser Valley.*
- *We generated high-resolution DEMs for most of the active volcanoes of Kamchatka and Kuriles.*

However, there are several issues that could prevent further development of the Supersite:

- *The collection of the new in-situ data is currently impossible because of the IVS-GFZ joint fieldwork inability.*
- *The scientific collaboration between IVS and GFZ (and many other European institutions) is now strictly limited.*

While the involvement of local scientists is a mandatory requirement for establishing a Supersite, considering that the impediment is due to contingent political factors, and that it would be a pity to lose the continuity of the Supersite EO data time series so far acquired, we propose to adopt one among the following two solutions:

1. *Continue to acquire the EO data according to the pre-set plans for the next two years, releasing the data only to non-Russian scientists;*
2. *Continue to acquire the EO data according to the pre-set plans for at least the next two years, archiving the data for future studies.*

Dissemination material for CEOS (discretionary)

In addition to the results shown in Section 3, we present below some of the results derived from COSMO-SkyMed data:

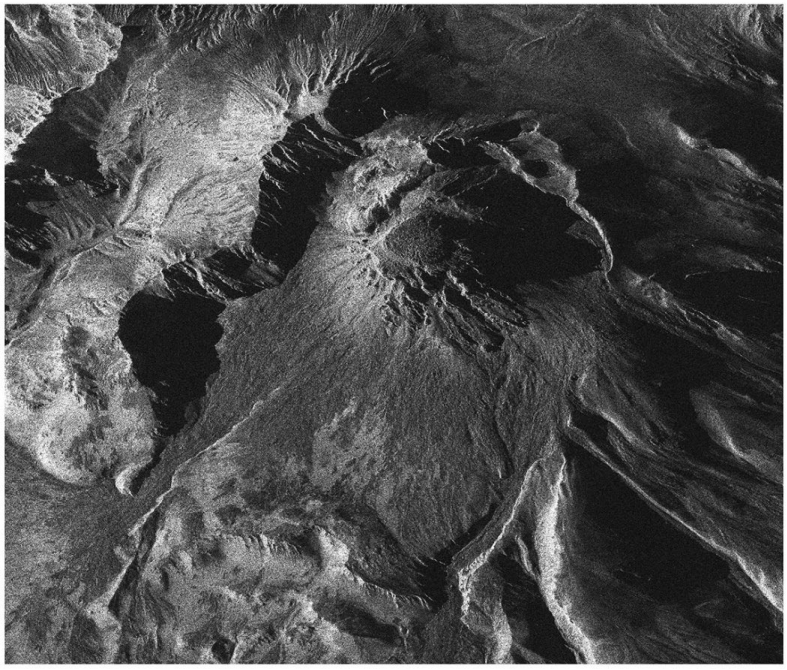

Figure 2 *COSMO-SkyMed amplitude image from 25.03.2023 shows the morphology of Shiveluch volcano before the almost complete destruction of the lava dome due to the violent eruption on 10.04.2024.*

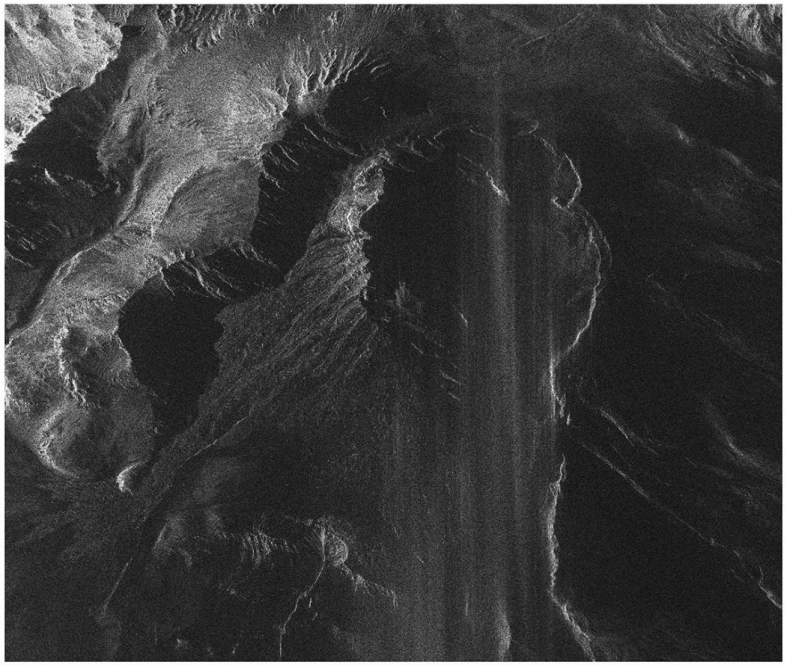

Figure 3 *COSMO-SkyMed amplitude image from 10.04.2023 reveals destruction of the lava dome and large crater and collapse scar formation. The acquired data made it possible to see the effect shortly after the violent eruption when the volcano was hidden under the massive ash plume.*