Geohazard Supersites and Natural Laboratories

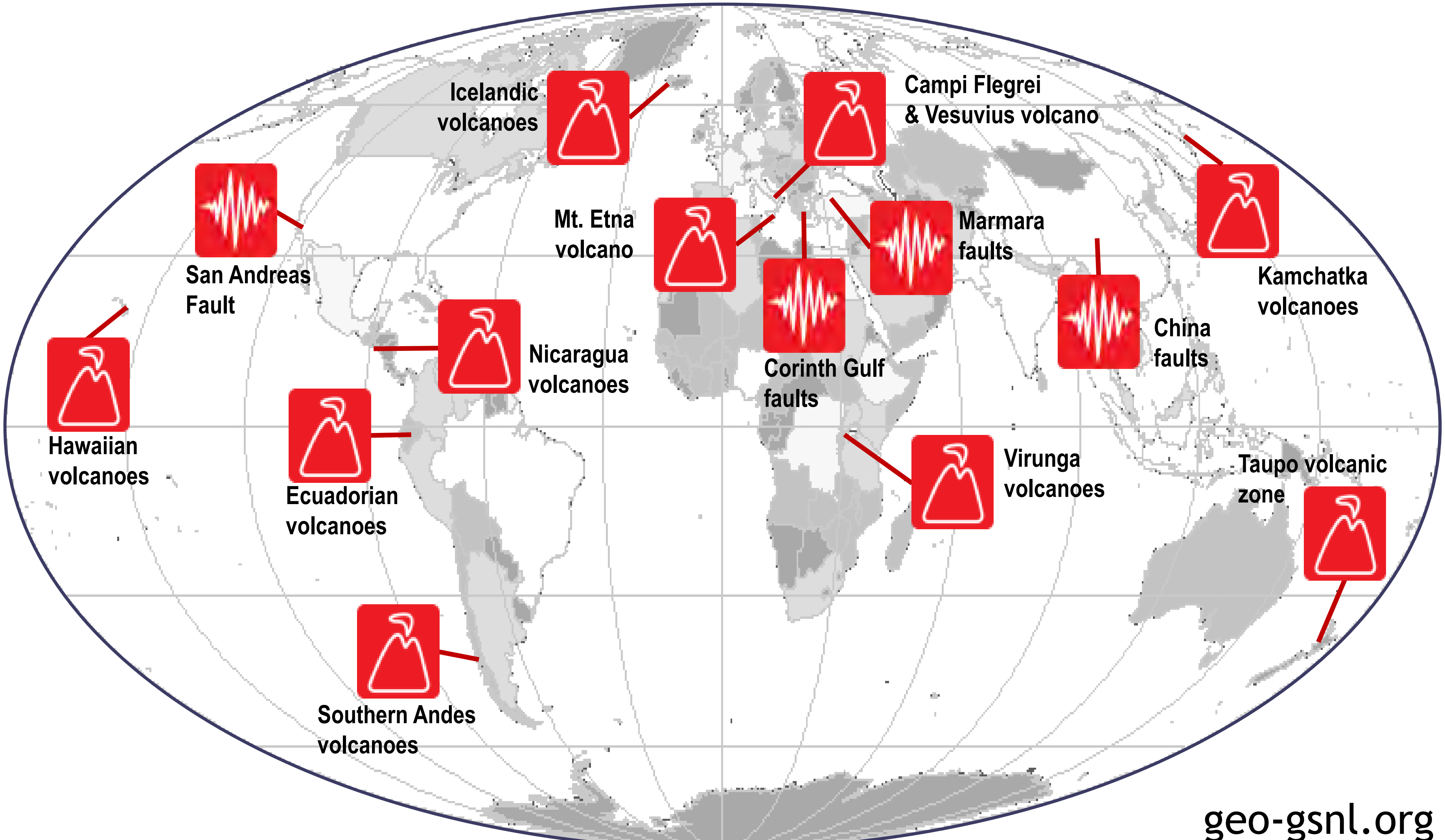
GSNL

GROUP ON EARTH OBSERVATIONS

Summary descriptions of the 14 GSNL Geohazard Supersites

March 2022

The Supersite network in 2022



geo-gsnl.org

Supersite Coordinators and Institutions

	Supersite	Coordinator	Institution
1	***Hawaiian volcanoes***	M. Poland	USGS-HVO, USA
2	***Icelandic volcanoes***	F. Sigmundsson	Univ. of Iceland - IMO
3	***Etna volcano***	G. Puglisi	INGV - Italy
4	***Campi Flegrei/Vesuvius***	S. Borgstrom	INGV - Italy
5	***Western North Anatolian Fault***	S. Ergintav,	KOERI, Turkey
6	***Taupo Volcano***	I. Hamling	GNS Science, NZ
7	***Ecuador volcanoes***	P. Mothes	Inst. Geofísico, Ecuador
8	***Corinth Gulf/Ionian Islands***	S. Lalechos	EPPO-OASP, Greece
9	***San Andreas Fault Nat. Lab.***	C. Wicks	USGS, USA
10	***Southern Andes volcanoes***	L. Lara	SERNAGEOMIN, Chile
11	***Virunga volcanoes***	C. Balagizi	GVO, DR Congo
12	***Kamchatka volcanoes***	A. Shevchenko	IVS, Kamchatka - Russia
13	***China faults***	Y. Shao	AIR - CAS, China
14	***Nicaragua volcanoes***	I. Cruz Martínez	INETER-Nicaragua

Geohazard Supersites and Natural Laboratories

The Hawaiian Volcanoes Supersite

Michael Poland and Ingrid Johanson
U.S. Geological Survey

Supersite description

The Hawaiian Volcanoes Supersite covers Kīlauea and Mauna Loa volcanoes on the Island of Hawaiʻi. These volcanoes are monitored by the U.S. Geological Survey's Hawaiian Volcano Observatory.

- Kīlauea is one of the most active volcanoes on Earth, with a major flank eruption and caldera collapse in 2018, and renewed eruptions in 2020
- Mauna Loa is the largest volcano on Earth; the last eruption was in 1984
- Historical eruptions have destroyed thousands of homes; an eruption in 1790 killed hundreds of people
- Hawaiʻi is a natural laboratory for volcano science, monitoring methods, modelling studies, and communication practices

Supersite data

Satellite data:

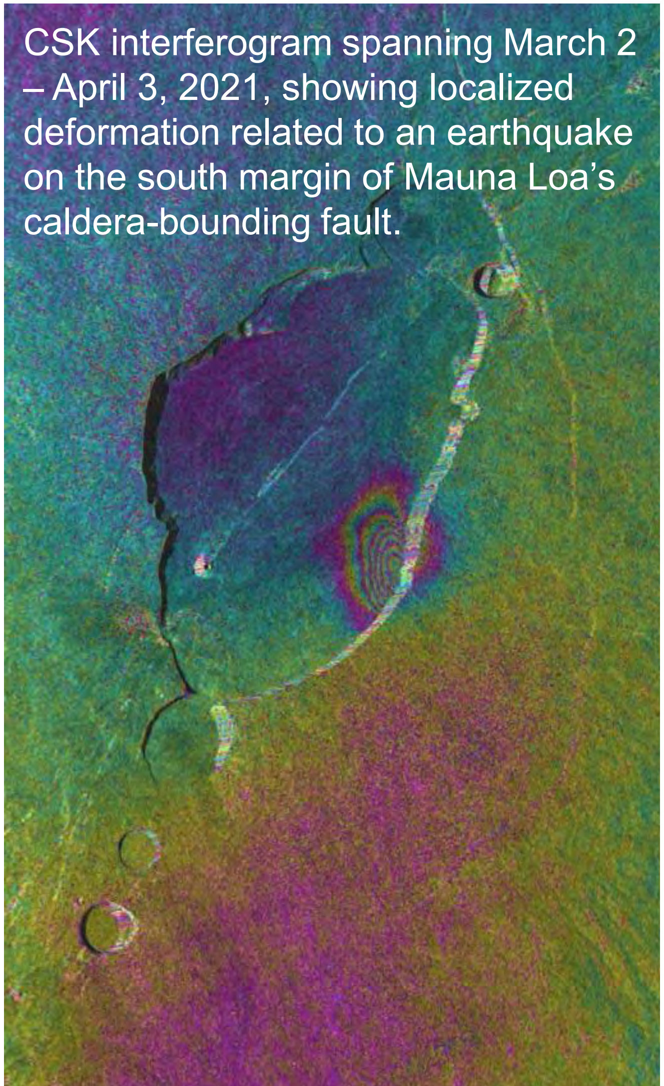
- Older SAR datasets (e.g., RSAT2, ALOS2), no longer provided
- Newer SAR datasets (e.g., SAOCOM), experimental/in development
- COSMO-SkyMed SAR data
- TerraSAR-X SAR data
- Pleiades stereo-optical data

In-situ data:

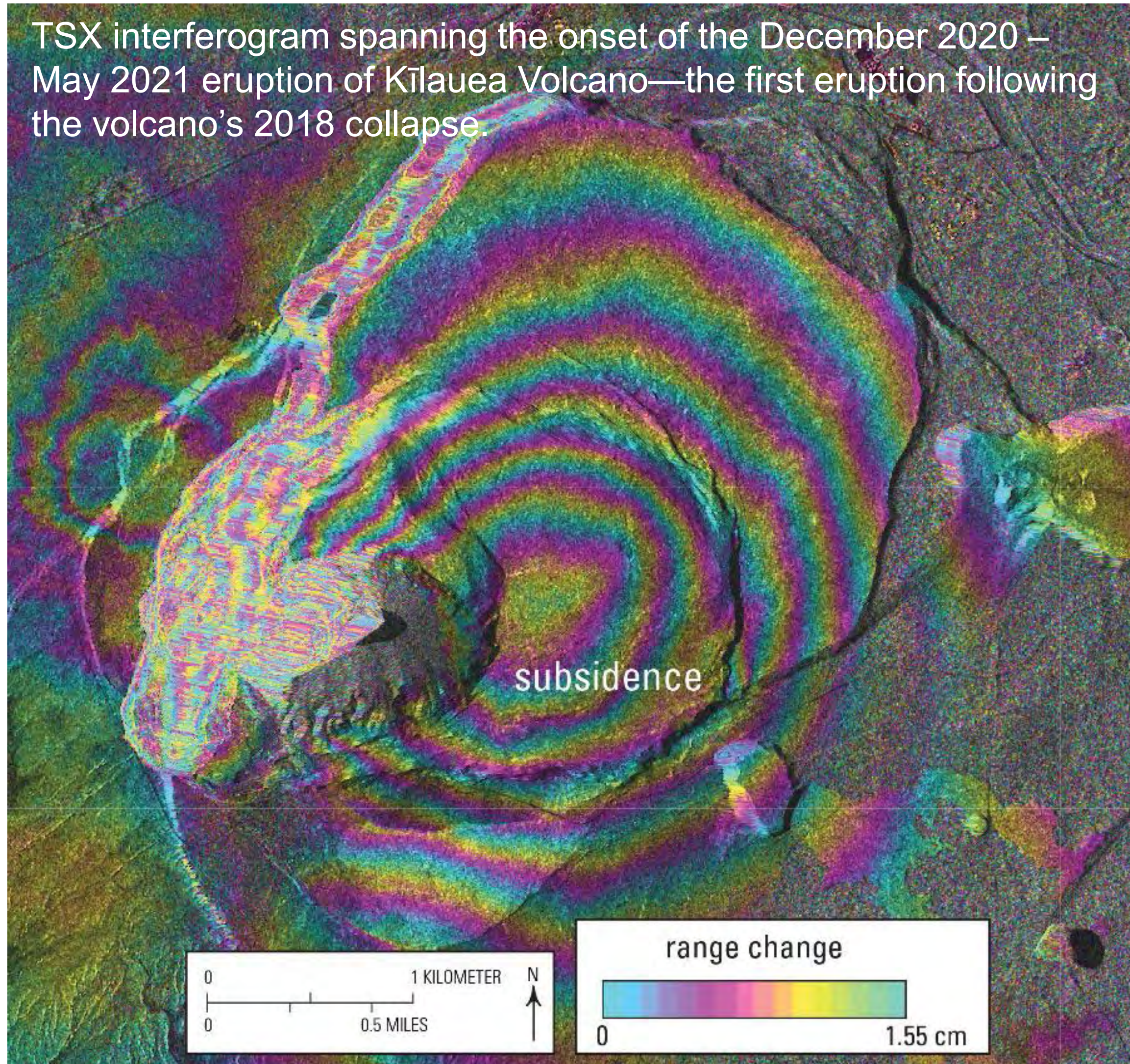
- Geodetic (GNSS, tilt, gravity)
- Seismic
- Gas emissions
- Camera imagery
- Lidar


TerraSAR-X SAR image (October 5, 2021)

Supersite science



CSK interferogram spanning March 2 – April 3, 2021, showing localized deformation related to an earthquake on the south margin of Mauna Loa's caldera-bounding fault.



TSX interferogram spanning the onset of the December 2020 – May 2021 eruption of Kīlauea Volcano—the first eruption following the volcano's 2018 collapse.

Supersite science (sample publications)

Anderson, K. R., I. A. Johanson, M. R. Patrick, G. Mengyang, P. Segall, M. P. Poland, E. K. Montgomery-Brown, and A. Miklius (2019), Magma reservoir failure and the onset of caldera collapse at Kīlauea Volcano in 2018, Science, 366(6470), eaaz1822, http://doi.org/10.1126/science.aaz1822.

Moore, S., Wauthier, C., Fukushima, Y., and Poland, M.P., 2018. A retrospective look at the February 1993 east rift zone intrusion at Kīlauea volcano, Hawaii. Journal of Volcanology and Geothermal Research, 358, p. 241–251.

Wauthier, C., Roman, D.C., and Poland, M.P., 2016, Joint analysis of geodetic and earthquake fault-plane solution data to constrain magmatic sources: A case study from Kīlauea Volcano: Earth and Planetary Science Letters, v. 455, p. 38–48, doi:10.1016/j.epsl.2016.09.011.

Zhai, G., and Shirzaei, M., 2016, Spatiotemporal model of Kīlauea's summit magmatic system inferred from InSAR time series and geometry-free time-dependent source inversion: Journal of Geophysical Research, v. 121, no. 7, p. 5425–5446, doi:10.1002/2016JB012953

Baker, S., and Amelung, F., 2015, Pressurized magma reservoir within the east rift zone of Kīlauea Volcano, Hawaiʻi; Evidence for relaxed stress changes from the 1975 Kalapana earthquake: Geophysical Research Letters, v. 42, no. 6, p. 1758–1765, doi:10.1002/2015GL063161.

Jo, M.-J., Jung, H.-S., Won, J.-S., Poland, M.P., Miklius, A., and Lu, Z., 2015, Measurement of slow-moving along-track displacement from an efficient Multiple-Aperture SAR Interferometry (MAI) stacking: Journal of Geodesy, v. 89, no. 5, p. 411-425, doi: 10.1007/s00190-014- 0786-9.

Chen, J., Zebker, H.A., Segall, P. and Miklius, A., 2014. The 2010 slow slip event and secular motion at Kilauea, Hawai`i inferred from TerraSAR-X InSAR data. Journal of Geophysical Research, 119(8): 6667–6683, doi:10.1002/2014JB011156.

Shirzaei, M., Walter, T.R. and Bürgmann, R., 2013. Coupling of Hawaiian volcanoes only during overpressure condition. Geophysical Research Letters, 40(10): 1994-1999, doi:10.1002/grl.50470.

Richter, N., Poland, M.P. and Lundgren, P.R., 2013. TerraSAR-X interferometry reveals small-scale deformation associated with the summit eruption of Kīlauea Volcano, Hawaiʻi. Geophysical Research Letters, 40(7): 1279-1283, doi:10.1002/grl.50286.

Lundgren, P., Poland, M., Miklius, A., Orr, T., Yun, S.-H., Fielding, E., Liu, Z., Tanaka, A., Szeliga, W., Hensley, S. and Owen, S., 2013. Evolution of dike opening during the March 2011 Kamoamoa fissure eruption, Kīlauea Volcano, Hawaiʻi. Journal of Geophysical Research, 118(3): 897-914, doi:10.1002/jgrb.50108.

Dietterich, H.R., Poland, M.P., Schmidt, D.A., Cashman, K.V., Sherrod, D.R. and Espinosa, A.T., 2012. Tracking lava flow emplacement on the east rift zone of Kīlauea, Hawaiʻi, with synthetic aperture radar coherence. Geochemistry, Geophysics, Geosystems, 13(Q05001), doi:10.1029/2011GC004016.

Baker, S. and Amelung, F., 2012. Top-down inflation and deflation at the summit of Kīlauea Volcano, Hawaii observed with InSAR. Journal of Geophysical Research, 117(B12406), doi:10.1029/2011JB009123.

Jung, H.S., Lu, Z., Won, J.S., Poland, M.P. and Miklius, A., 2011. Mapping three-dimensional surface deformation by combining multiple-aperture interferometry and conventional interferometry: application to the June 2007 eruption of Kilauea Volcano, Hawaii. IEEE Geoscience and Remote Sensing Letters, 8(1): 34-38, doi:10.1109/LGRS.2010.2051793.

Supersite benefits

- Increased access to SAR data (frequent high-resolution X-band data have been particularly valuable)
- Exploiting the natural laboratory nature of Kilauea allows for testing and development of new techniques (like 3D displacements from InSAR)
- Increased data availability has aided eruption monitoring and forecasting, as well as responses to eruptive activity
- Interpretations of volcanic activity based on Supersite-related data have been communicated to local emergency/land managers
- A staggering volume of scientific insights have resulted into magma storage and transport, lava flow activity, eruption dynamics, caldera collapse, and other aspects of volcanic activity—the preceding slide is just a small sampling of the derived literature!

Geohazard Supersites and Natural Laboratories

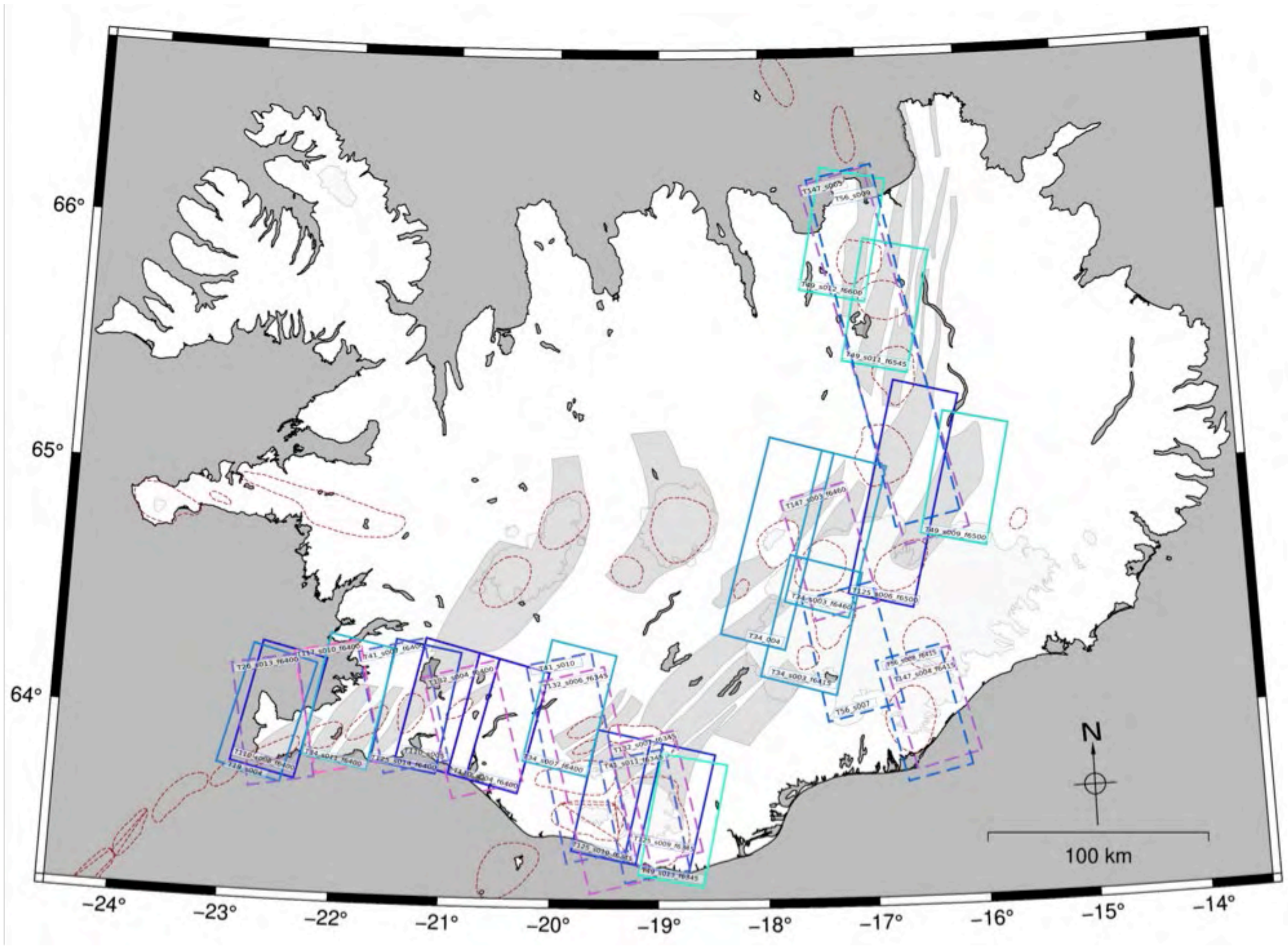
The Icelandic Volcanoes Supersite

Supersite coordinator: Michelle Parks, Icelandic Meteorological Office

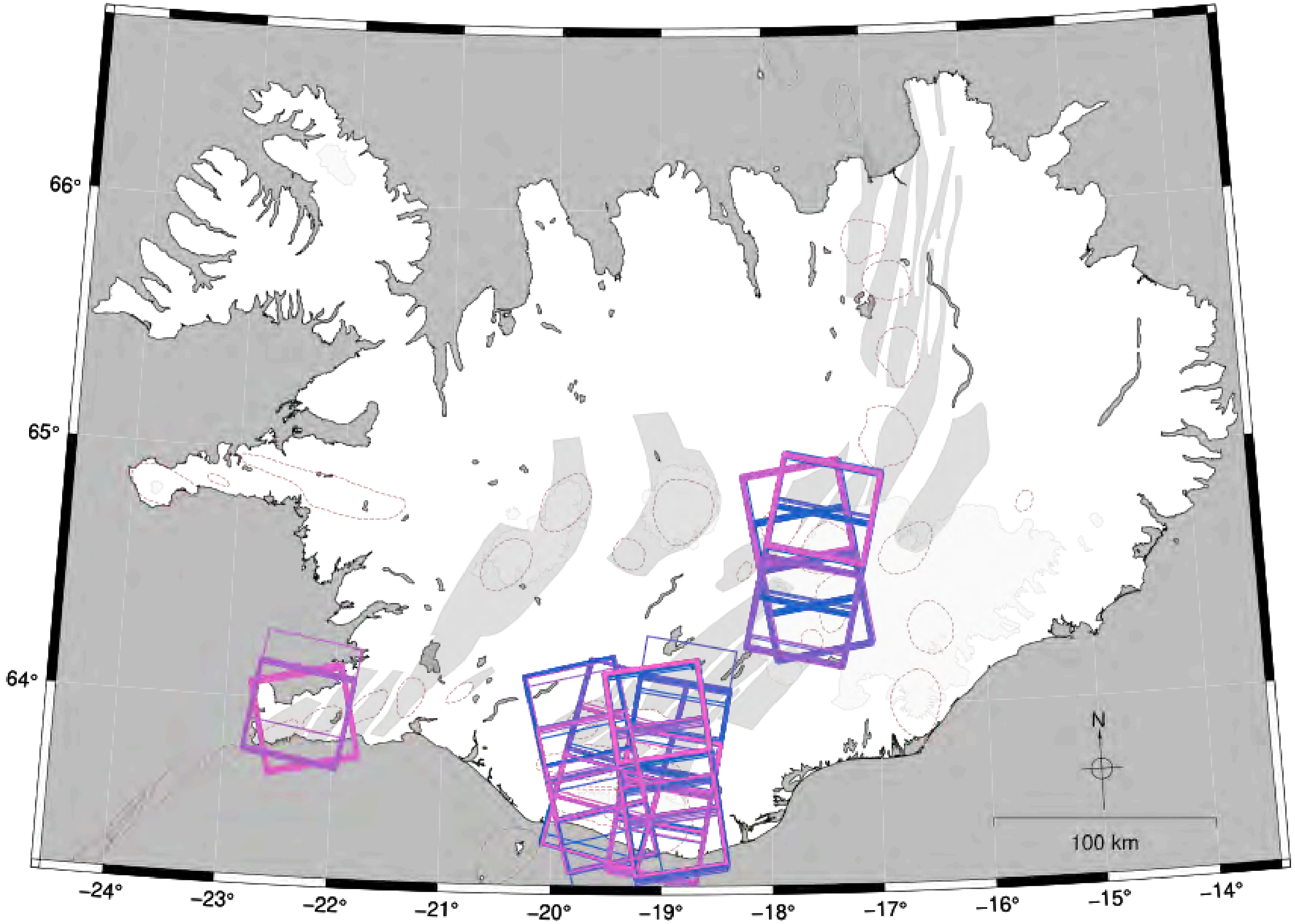
Supersite description

- In January 2022, Michelle Parks took over the role of coordinator of the Icelandic Volcanoes Supersite. Michelle is a Specialist in Volcano Deformation at the Icelandic Meteorological Office – the recognized state volcano observatory in Iceland.
- The Supersite covers the most active volcanic systems in Iceland.
- The last two years has proved to be an exceptionally active period in Iceland – with a 14-month long volcano-tectonic unrest on the Reykjanes Peninsula (commencing in December 2019); which culminated in an effusive fissure eruption on the 19 March 2021 in Fagradalsfjall. In addition to this, Askja volcano entered a period of unrest at the start of August 2021, which is still ongoing. Supersite data are being used for operational response during episodes of both volcanic unrest and eruption, and studies related to magmatic, hydrothermal and viscoelastic responses.
- During 2021, 733 CSK images were provided through ASI, 198 TSX through DLR and 1086 Sentinel-1 images via Copernicus. Approx. 4130 km^2 of Pléiades optical stereo images were provided by CNES.

TerraSAR-X coverage across Iceland.



Current COSMO-SkyMed (CSK) acquisitions across Iceland.



Supersite data

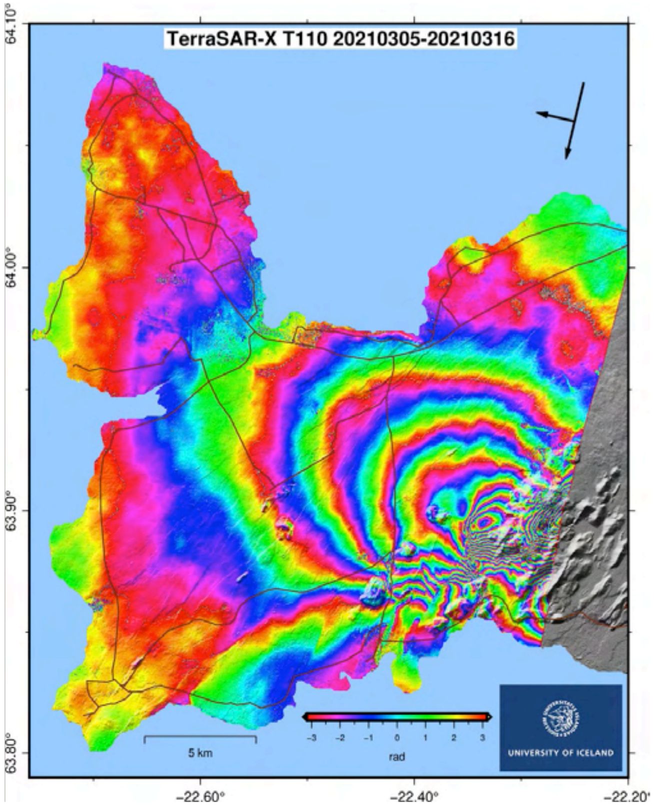
- The most important satellite data used by the science teams involved in the Icelandic Volcanoes Supersite are: Sentinel-1, COSMO-SkyMed and TerraSAR-X data for InSAR analysis. Pléiades optical stereo images are also used to obtain digital elevation models (DEMs) at ice-covered volcanoes.

- Open access in-situ data provided by IMO include: GNSS observations, seismicity data and gas measurements.

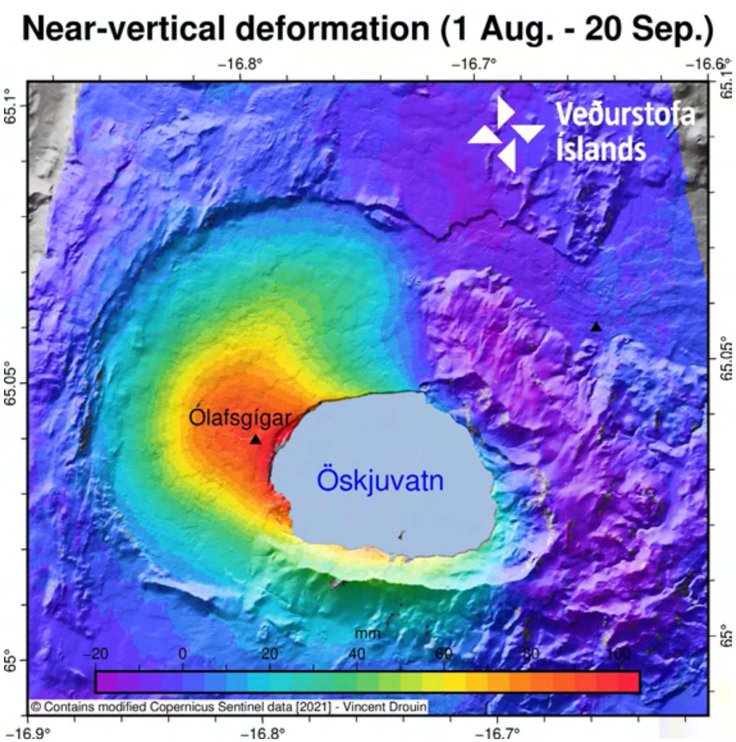
- Extensive information on Icelandic volcanoes can be found at: http://www.icelandicvolcanoes.is

Supersite science – some recent examples.

An extended period of volcano-tectonic unrest commenced on the Reykjanes in December 2019. This comprised a series of magmatic intrusions, intense seismicity and culminated in an effusive fissure eruption on the 19 March 2021 in Fagradalsfjall. In addition to this, Askja volcano entered a period of unrest at the start of August 2021, which is still ongoing.



Reykjanes Peninsula – deformation related to pre-eruptive dike intrusion and earthquakes.



Ongoing inflation at Askja caldera.

Supersite science - Publications

Ducrocq C, Geirsson H, Árnadóttir T, Juncu D, Drouin V, Gunnarsson G, Kristjánsson BR, Sigmundsson F, Hreinsdóttir S, Tómasdóttir S and Blanck H (2021a). Inflation-Deflation Episodes in the Hengill and Hrómundartindur Volcanic Complexes, SW Iceland. *Front. Earth Sci.* 9:725109. doi: 10.3389/feart.2021.725109.

Li, S., Sigmundsson, F., Drouin, V., Parks, M. M., Ofeigsson, B. G., Jónsdóttir, K., ... & Hreinsdóttir, S. (2021). Ground Deformation After a Caldera Collapse: Contributions of Magma Inflow and Viscoelastic Response to the 2015–2018 Deformation Field Around Bárðarbunga, Iceland. *Journal of Geophysical Research: Solid Earth*, *126*(3), e2020JB020157.

Parks, M., Sigmundsson, F., Sigurðsson, O., Hooper, A., Hreinsdóttir, S., Ófeigsson, B., Michalczewska, K. (2020), Deformation due to geothermal exploitation at Reykjanes, Iceland *Journal of Volcanology and Geothermal Research*, 391, 106388. https://www.sciencedirect.com/science/article/pii/S0377027317305887

Sigmundsson, F., Einarsson, P., Hjartardóttir, Á.R., Drouin, V., Jónsdóttir, K., Árnadóttir, T., Geirsson, H., Hreinsdóttir, S., Li, S., Ófeigsson, B.G. (2020). Geodynamics of Iceland and the signatures of plate spreading, *Journal of Volcanology and Geothermal Research*, 391, 106436. https://www.sciencedirect.com/science/article/pii/S0377027317306376

Sigmundsson, F., Pinel, V., Grapenthin, R., Hooper, A., Halldórsson, S.A., Einarsson, P., Ófeigsson, B. G., Heimisson, E. R., Jónsdóttir, K., Gudmundsson, M.T., Vogfjörð, K., Parks, M., Li, S., Drouin, V., Geirsson, H., Dumont, S., Fridriksdottir, H. M., Gudmundsson, G. B., Wright, T., Tadashi Yamasaki, T., Unexpected large eruptions from buoyant magma bodies within viscoelastic crust, Nature Communications, 11, 2403, 2020. https://www.nature.com/articles/s41467-020-16054-6

Supersite benefits

- The Icelandic Volcanoes Supersite provides a wealth of information related to the monitoring and improved understanding of volcano-tectonic activity across Iceland. Results from the analysis of supersite data are frequently presented at Civil Protection meetings and influence decision making processes, thus benefiting the scientific community, decision makers and the local population.

- Increased data access for InSAR analysis, for monitoring of ground deformation, has provided significant social benefits in the form of improved understanding of ongoing deformation and the status of volcanic activity. For example, this data and anaysis contributed to maintaining safe access to the Fagradalsfjall eruption site in 2021 – for tourists, scientists, Civil Protection staff and local rescue teams.

Geohazard Supersites and Natural Laboratories

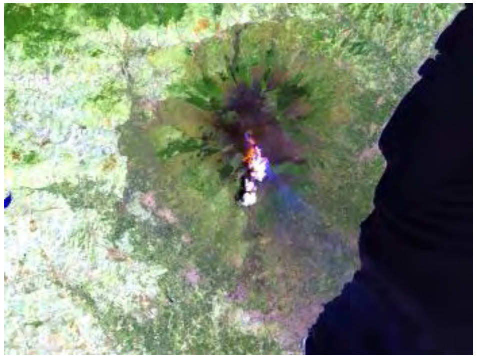
The Mt. Etna Volcano Supersite

Giuseppe Puglisi
Istituto Nazionale di Geofisica e Vulcanologia, Sezione di Catania - Osservatorio Etneo
(National Institute of Geophysics and Volcanology, Catania branch, Mt. Etna Observatory)

ISTITUTO NAZIONALE DI GEOFISICA E VULCANOLOGIA

Mt. Etna Volcano Supersite description

- Permanent Supersite since 2014
- Implemented during EC PF7 Project MED-SUV
  - Data Portal (*http://med-suv.essi-lab.eu/web/portal*)
  - Web site (*https://www.brgm.fr/en/reference-completed-project/med-suv-project-mediterranean-supersite-volcanoes*)
- Scientific challenges:
  - To increase the capability to interpret the clues of a volcanic unrest
  - To deepen the knowledge of volcanic processes
  - To better assess the volcanic (lava flows, volcanic plumes, vents opening, …), and seismic hazards (earthquakes, cracks)



MEDiterranean SUpersite Volcanoes MED-SUV

INGV

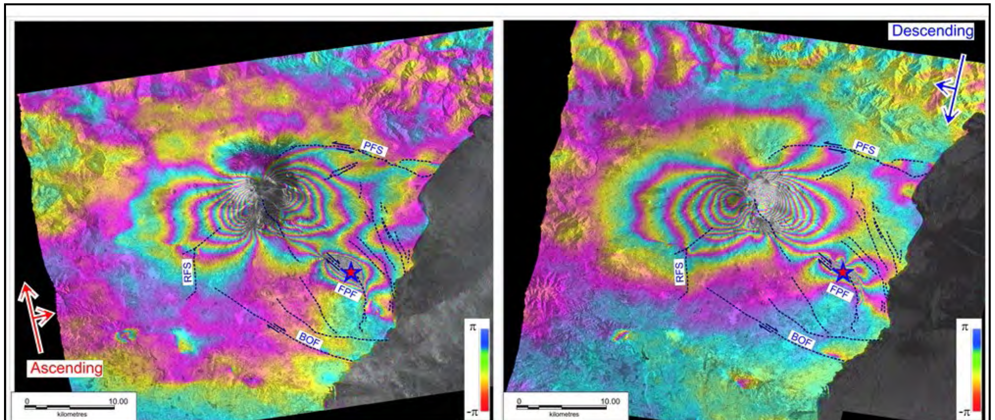
Mt. Etna Volcano Supersite data

Type of data	Data provider	How to access	Quota	Type of access
ERS-1/ERS-2 /ENVISAT	ESA	Direct link to: http://eo-virtual-archive4.esa.int/?q=Etna , or through the MED-SUV Portal	any available acquisition	Registered public
Sentinel	ESA	Direct link to: https://scihub.copernicus.eu , or through the MED-SUV Portal	any available acquisition	Registered public
TerraSAR-X	DLR	Direct link to https://supersites.eoc.dlr.de, or through the MED-SUV Portal	130 scenes/year	GSNL scientists
COSMO-SkyMed	ASI	Through the ASI server of the MED-SUV Portal	200 products / year	GSNL scientists
RADARSAT-2	CSA	PoC requests access from CSA for individual users; a specific CSA server is under implementation on the MED-SUV Portal		GSNL scientists
Landsat 8	USGS	Direct link to http://earthexplorer.usgs.gov MED-SUV will update the ending points for grant access	any available acquisition	Registered public
NPP/Suomi	NOAA	Direct link to http://earthexplorer.usgs.gov MED-SUV will update the ending points for grant access	any available acquisition	Registered public
MODIS	NASA	Direct link to http://modis.gsfc.nasa.gov/data/ MED-SUV will update the ending points for grant access	any available acquisition	Open
PLEIADES	CNES	Link to CNES site for individual authorized users; a specific access point is under implementation on the GEP Portal	1200 Km^2	Registered public

Type of data	Data provider	How to access	Type of access
Seismic waveform	INGV	Link to Network Italian Seismic Network Web Service through MED-SUV Portal Search	Open to anonymous users
Seismic events	INGV	Link to Network Italian Seismic Network Web Service through MED-SUV Portal Search	Open to anonymous users
GPS data	INGV	Due to a server failure and to the end of the support by UNAVCO, GSAC services are moving into a new standard (GLASS) adopted inside EPOS framework. Part of the network is discoverable at the INGV RING direct link http://ring.gm.ingv.it/	Open to anonymous users
GPS data survey (1994-2013)	INGV	Same as above	Open to anonymous users
GPS coordinates / displacement vectors	INGV	Same as above	Open to anonymous users
Hydrophone / OBS waveform	INGV	MED-SUV File Manager	Limited to registered users
Thermal cameras	INGV	MED-SUV File Manager	Limited to registered users
Tilt	INGV	MED-SUV File Manager	Limited to registered users

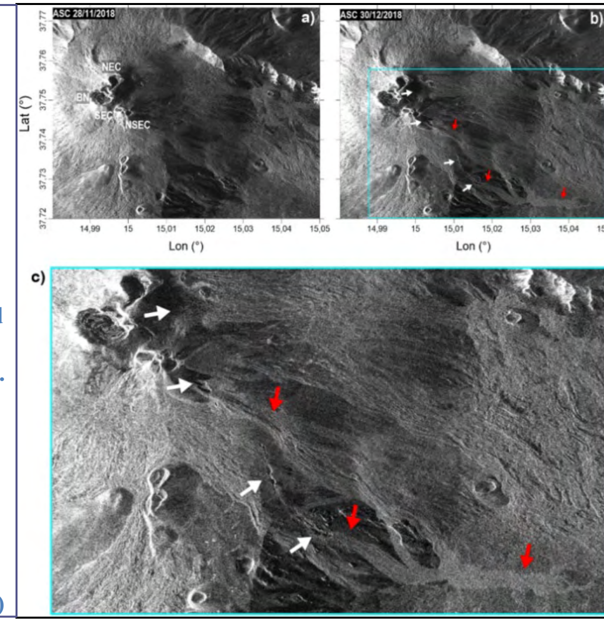
Mt. Etna Volcano Supersite science

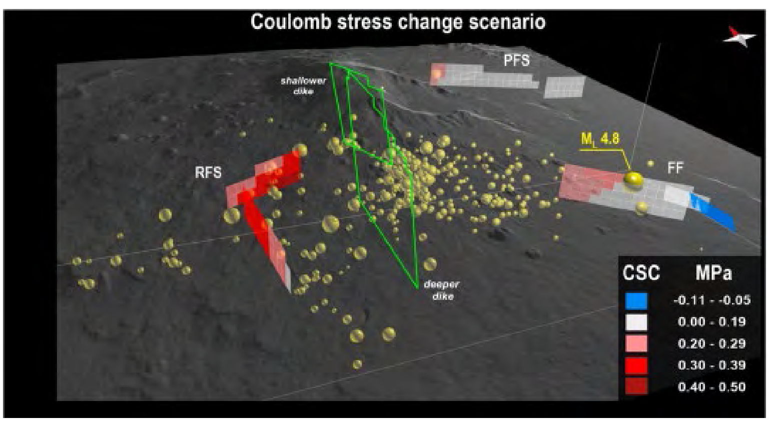
Ground deformations, morphological changes and interaction volcanic activity - atmosphere



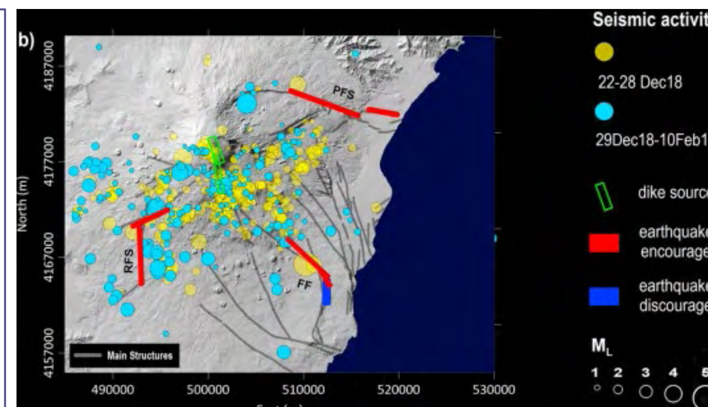
Ascending and descending Sentinel 1 interferogram related to the December 2018 eruptive intrusion and seismic swarm: the ascending and descending Sentinel 1 interferograms relevant to 22122018 – 28122018 passes (Bonforte et al., Terra Nova, 2019; doi: 10.1111/ter.12403)

Morphological changes related to December 2018 Eruption:
a)pre- (28 November 2018) and
b) post- (30 December 2018) eruption COSMO-SkyMed ascending SAR amplitude images. Eruptive fissures (white arrows), lava flows (red arrows).
c) zoom area of panel b)
(from GNSL bi-annual report 2020)



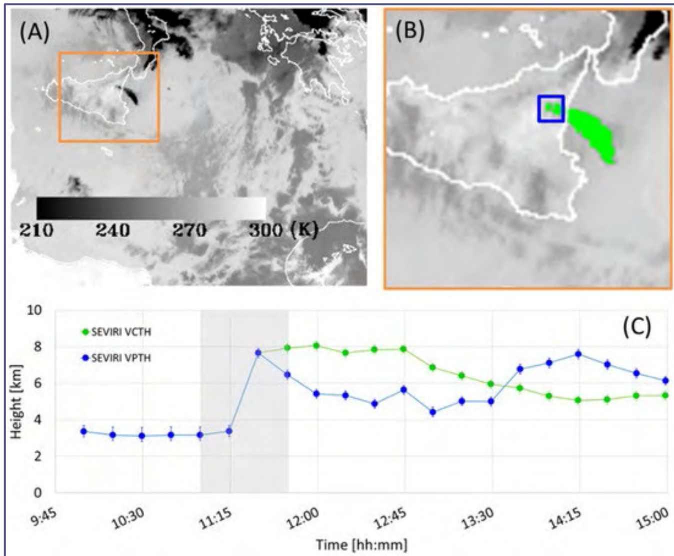


Coulomb stress change (CSC) analysis related to the December 2018 eruption. Left - CSC values retrieved along the investigated structures;. Right - encouraged (red) and discouraged (blue) fault motions are reported; the main structures (black lines) and the projection at the surface of the two dikes (green polygons) are also shown. The seismicity pre & eruption (yellow circles) and post-eruption (light blue circles) is also reported. (De Novellis et al., GRL, 2019; doi: 10.1029/2019GL082467)



Mt. Etna Volcano Supersite science

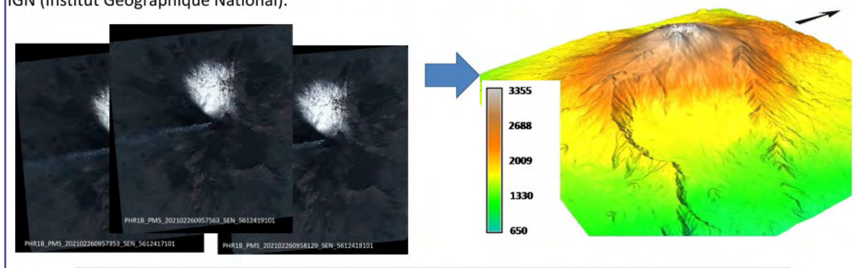
Ground deformations, morphological changes and interaction volcanic activity - atmosphere



(A) Brightness temperature at 10.8 µm from the SEVIRI image acquired on 24 December 2018.
(B) Detail of image (A); the blue square area and the green area are used for the Volcanic Plume Top Height (VPTH) and Volcanic Cloud Top Height (VCTH) computation, respectively.
(C) Corresponding plot of VPTH (blue points-line) and VCTH (green points-line) time series from SEVIRI data collected every 15 min on 24 December 2018. (Corradini et al., Rem. Sens., 2020; doi: 10.3390/rs11161916)

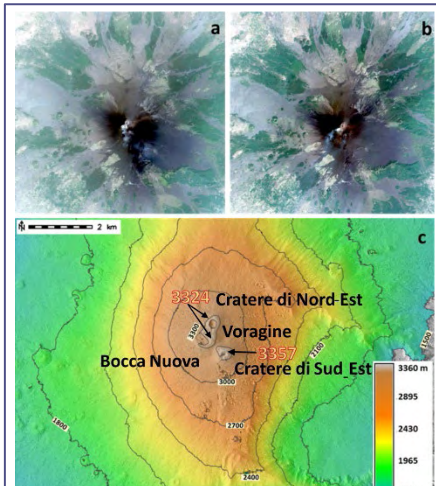
Pléiades Imagery at Mt Etna 2021

A cloud-free Pléiades triplet was acquired over Mt Etna on February 26, 2021. The 3D processing of the tri-stereo Pléiades imagery is performed using the free and open source MicMac (Multi-images Correspondances, Méthodes Automatiques de Corrélation) photogrammetric library developed by the French IGN (Institut Géographique National).

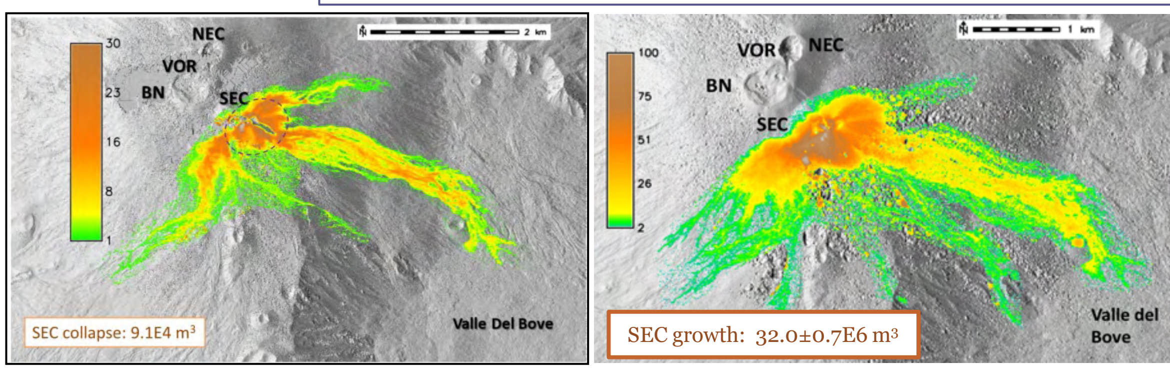


A 1-meter spatial resolution digital elevation model was produced

Morphological changes related to December 2020 – February 2021 eruptive activity at the South East Crater (SEC) from Pléiades images.
(Above) Production or the DEM.
(Below) Maps of the morphological changes (crater collapse and lava floes emplacement) (from report to CNES) left from Dec 2020-Feb2021; right from Dec 2020 to 25 July2021



Two other Pleiades triplets acquired on 13 and 25 July 2021 allowed to find the South East Crater (SEC) as new peak of Mt. Etna reaching 3357 m asl.



Mt. Etna Volcano Supersite benefits

Scientific benefits:

- Increased access to satellite- and ground-based data (e.g. recent access to Pléiades images)
- Catalyst of international and national collaborations, mostly linked to the EPOS framework:
  - EC FP7 projects: MED-SUV (2013-2016; for the set-up);
  - EC H2020 projects: ENVRIPlus (2015-2019), EVER-EST (2015-2018), EUROVOLC (2018-2021), e-Shape (2019-2022), IMPROVE (2021 – 2025);
  - Horizon Europe projects: DT-GEO (2022-2026), GEO-Inquire (2022-2026);
  - INGV projects: IMPACT (2020 - 2022) and ATTEMPT (2021-2022).
- Improve access funding: beside the indirect support from the above projects, the EPOS JRU Italia supports the Supersite operation activities.

Social benefits:

- At the local level the national and regional (Sicilian) departments of Civil Protections indirectly benefit from the scientific improvements due to the use of EO data of the Supersite.

Dissemination and outreach:

- Mt. Etna Volcano Supersite has promoted an Italian project funded by the National Civil Service (Servizio Civile Nazionale) which supported volunteers involved in the activity of the management of the data base (update, implementation, etc.) and in the implementation of specific dissemination and outreach initiatives (unfortunately COVID-19 pandemic stopped this project)
- Activity during national and international meetings

Geohazard Supersites and Natural Laboratories

The Vesuvius – Campi Flegrei Supersite

Sven Borgstrom (Coordinator)
sven.borgstrom@ingv.it

Istituto Nazionale di Geofisica e Vulcanologia
"Vesuvius Observatory" - Naples branch (Italy)

Supersite description

Coordinator: Sven Borgstrom, INGV-OV (Italy) sven.borgstrom@ingv.it

Research & Surveillance: monitoring ground deformations as a precursor of a possible eruption, change detections, modeling of the deformation source (depth, extent etc.). A better knowledge of the area finalized to improve the Emergency Plan for Vesuvius and Campi Flegrei areas;

Campi Flegrei currently at the *attention* (yellow) alert level since 2012 according to the Emergency Plan from the Italian Civil Protection Department. The city of Naples (~ 1 Ml. people) located between two active volcanic areas.

Supersite data

InSAR/Optical/IR data availability (current & archive)

- C band (S-1A/B, ERS-1/2, ENVISAT, RADARSAT-2), X band (CSK, TSX/TDX, monostatic);
- LANDSAT8, ASTER, AVHRR, MODIS, PLEIADES data, the latter to be requested;

INGV-OV in situ data (monitoring networks)

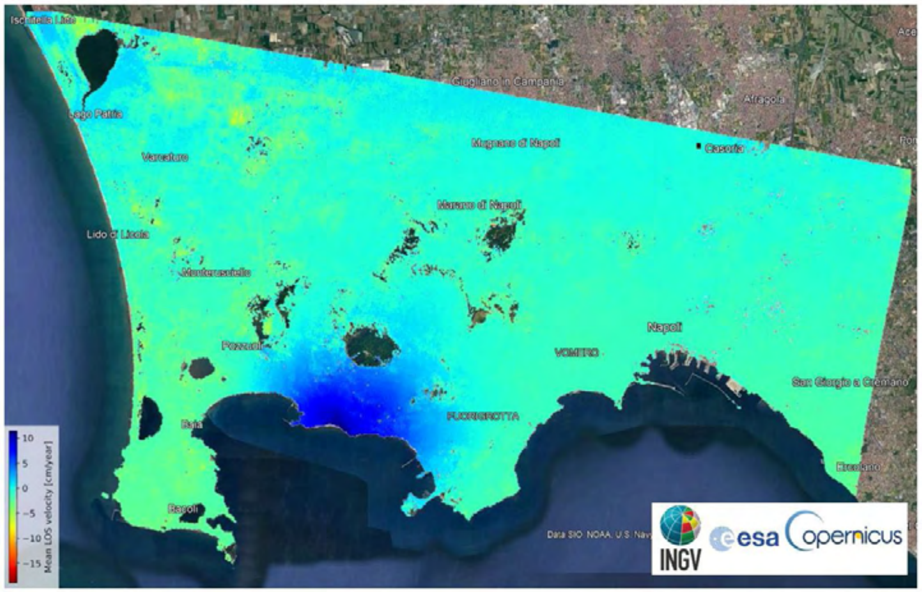
- Seismic, cGNSS, Leveling, Tide Gauge, Tiltmetric (surface, borehole), Gravimetric, Dilatometric, Geochemical, Thermal Infrared imagery.

The in-situ data provided by INGV are discoverable and accessible through the e-Infrastructure implemented in the frame of the previous EC FP-7 “MED-SUV” project, to be furtherly populated.

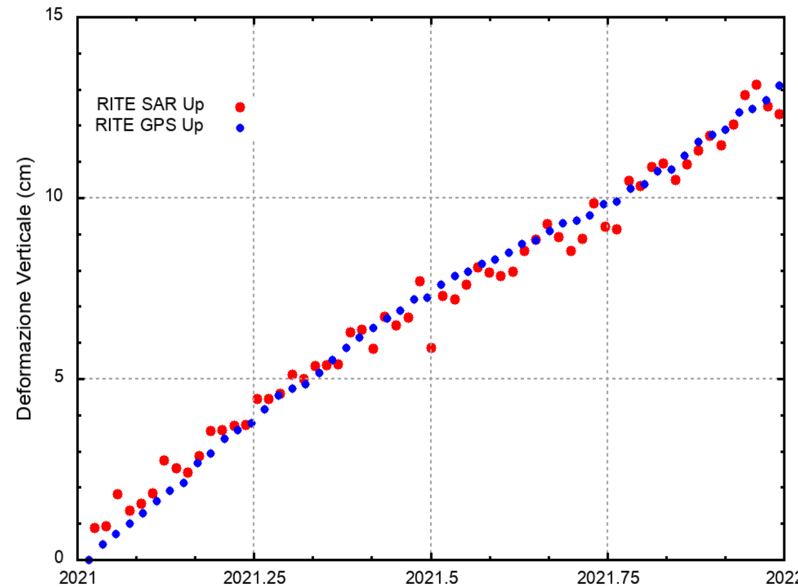
Improvements of the infrastructure are still on going, in the perspective of its exploitation in EPOS (European Plate Observing System);

Critical issues expected in a possible misalignment between the continuous availability of satellite data and the data availability from the in-situ data provider, should be now overcome by the recent release of the INGV data policy.

Scientific results - Campi Flegrei



a)

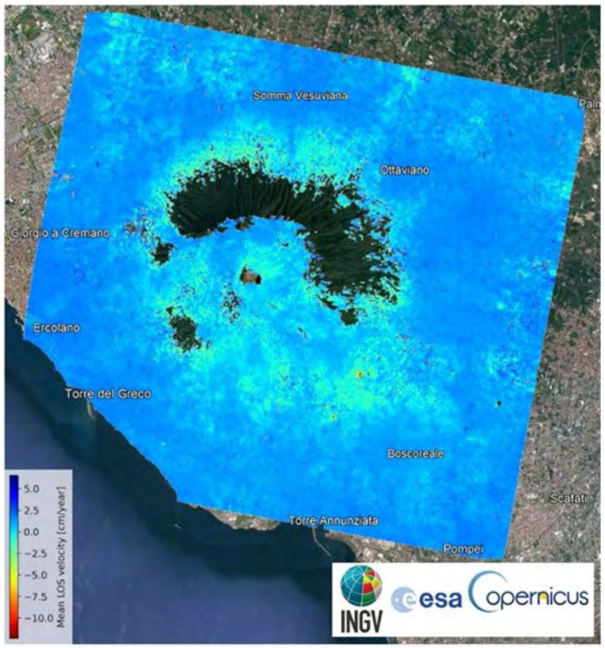


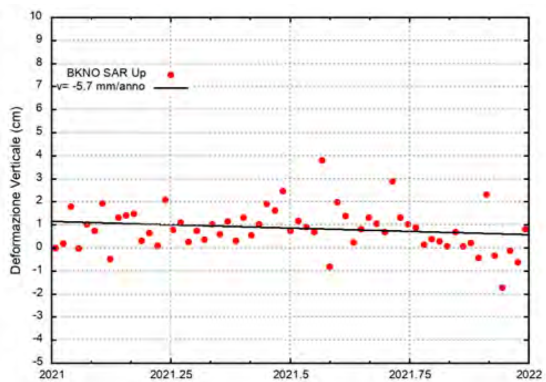
b)

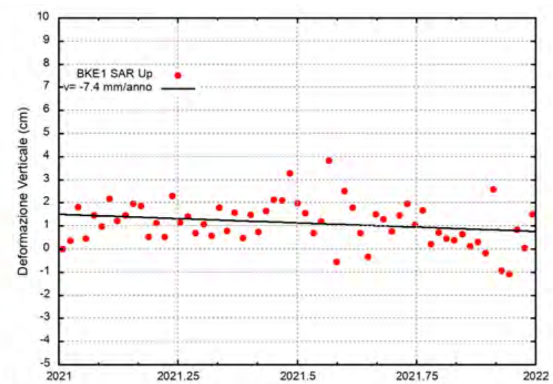
a) Mean LOS velocity map (Sentinel-1A/B) (2021.01.03 - 2021.12.29) - Campi Flegrei
IWS data, TOPS mode, Descending track (22), swath 1

b) Multi-temporal analysis (2021.01.03 - 2021.12.29), Vertical displacement
InSAR time-series (red dots) and cGNSS station (blu dots), RITE (RIone TErra) site (Pozzuoli)

Scientific results - Mt. Vesuvius







a) b)

a) Mean LOS velocity map (Sentinel-1A/B) (2021.01.03 - 2021.12.29) - Mt. Vesuvius
IWS data, TOPS mode, Descending track (22), swath 1

b) InSAR time-series (2021.01.03 - 2021.12.29), Vertical displacement, on «BKNO» and «BKE1» cGNSS stations (mean InSAR velocities comparable with GNSS results)

Supersite benefits

Conclusive remarks

Pros:

- Improved knowledge as a whole of the area, finalized to a technical support for the updates of the National Emergency Plan for Vesuvius and Campi Flegrei areas. Main stakeholders benefitting from Supersites activities: Civil Protection authorities (National, Regional, interested Municipalities), the Scientific Community;
- Surveillance reports (half yearly) addressed to the Italian Civil Protection Department;
- Publications and workshop presentations addressed to the Scientific Community;
- Increased international collaborations.

Cons:

- No funding resources officially available for the Vesuvius-Campi Flegrei Supersite, only from ongoing projects, institutional bodies (i.e. the Italian Civil Protection Department), in-kind contributions from the science teams.

Geohazard Supersites and Natural Laboratories

The Marmara Supersite

Semih Ergintav

semih.Ergintav@boun.edu.tr

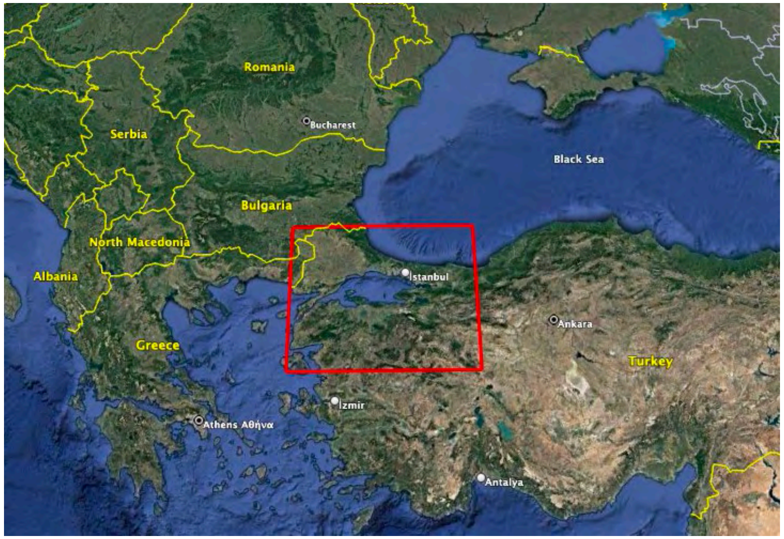
Boğaziçi University, Kandilli Observatory and Earthquake Research Institute (KOERI) , Turkey

Supersite description

Coordinator: Semih Ergintav, KOERI

- Permant Supersites since 2014
- Implemented during EC funded

  MarSite Supersite Project (2012-2016)



Scientific challenges:

All the significant seismic sources in the Marmara Sea have the potential to generate damaging levels of ground motion in Istanbul which hosts a rapidly growing population of >15 million making it the cultural, financial, and industrial heart of Turkey. This initiative let researchers that investigate the seismic hazard in the Marmara Region to be able to access SAR data sets

Satellite-based radar images of motion along the Main Marmara Fault are helping scientists understand when, where, and how creep occurs and its implications to map the slip deficits and to create a realistic hazard mapping,

Without the joint interpretation of satellite and in-situ data, organized by GSNL, this study could not be made, related with the understandings of fault kinematics/dynamics.

Supersite data

Satellite data

Type of data	Data provider	How to access	Type of access
ERS-1/ERS-2	ESA	http://eo-virtual-archive4.esa.int	registered public
ENVISAT	ESA	http://eo-virtual-archive4.esa.int	registered public
Pleiades	CNES	https://spacedata.copernicus.eu/web/cscda/missions/pleiades	GSNL scientists
TerraSAR-X	DLR	PoC requests access from DLR for individual users, data then accessible via DLR web page	GSNL scientists
Cosmo-SkyMed	ASI	PoC requests access from ASI for individual user, data then made accessible for the specific user by POC	GSNL scientists
SENTINEL-1A/B	ESA	https://scihub.esa.int/	registered public
ALOS-1/2	JAXA	https:auig2.jax.jp/ips/home	Successful proposers

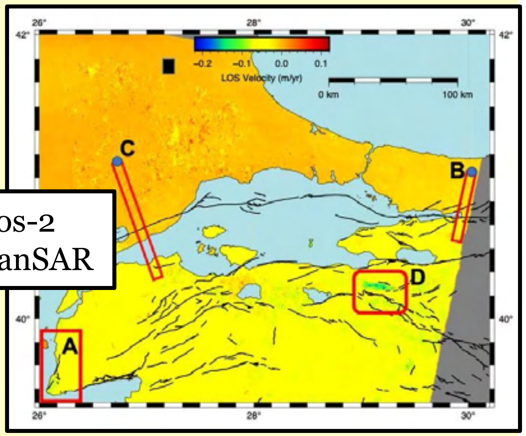
In situ data

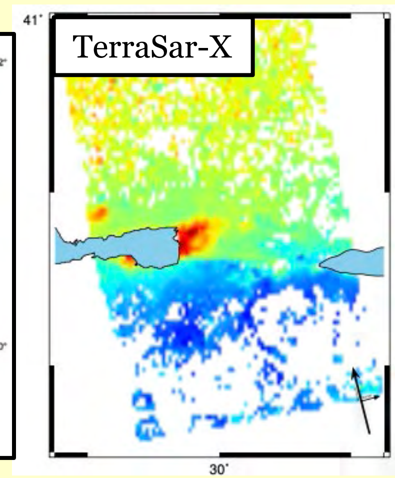
Type of data	Data provider	How to access	Type of access*
National GPS network data	General Directorate of Land Registry & General Command of Mapping	http://rinex.tusaga-aktif.gov.tr	Public
Meteo	KOERI	MarSite ftp server	Public
Tide Gauge	KOERI General Command of Mapping	Data Specific Service http://tudes.hgk.msb.gov.tr/tudesportal/	Public Public for Turkish Science Community
Strainmeter	UNAVCO	UNAVCO	public
National Seismic network (Broadband, Accelerometer, OBS, borehole)	KOERI	eida.koeri.boun.edu.tr	public
Multinational/Local Seismic networks	KOERI	eida.koeri.boun.edu.tr	Public

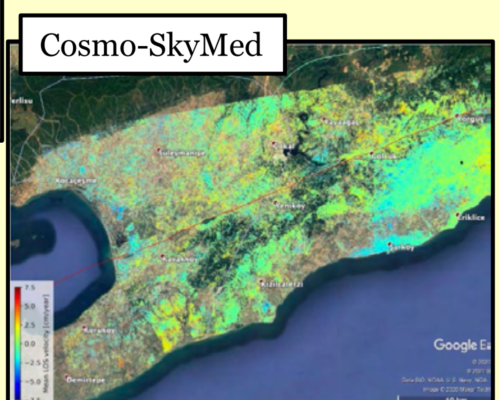
Preliminary results of the realistic mapping of slip deficit along main Marmara fault (1/2)

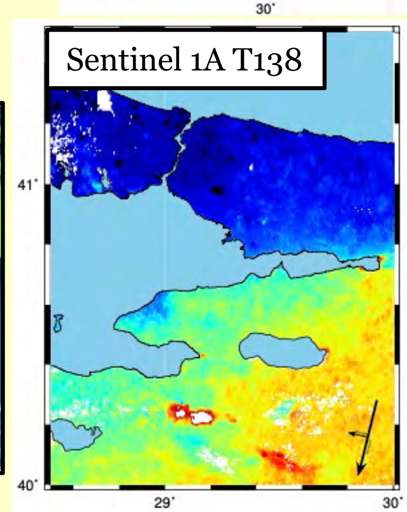
Example data sets, used in the modelling

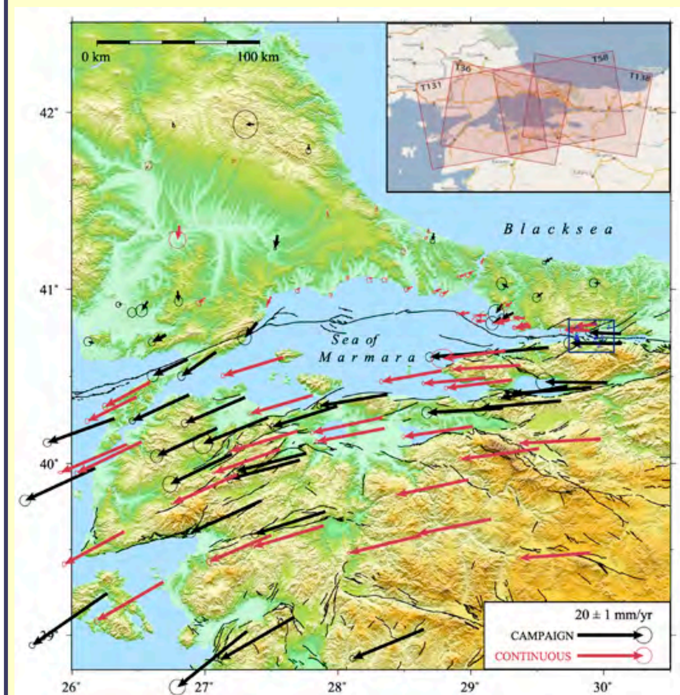
PS-InSAR velocities estimated from different sensors







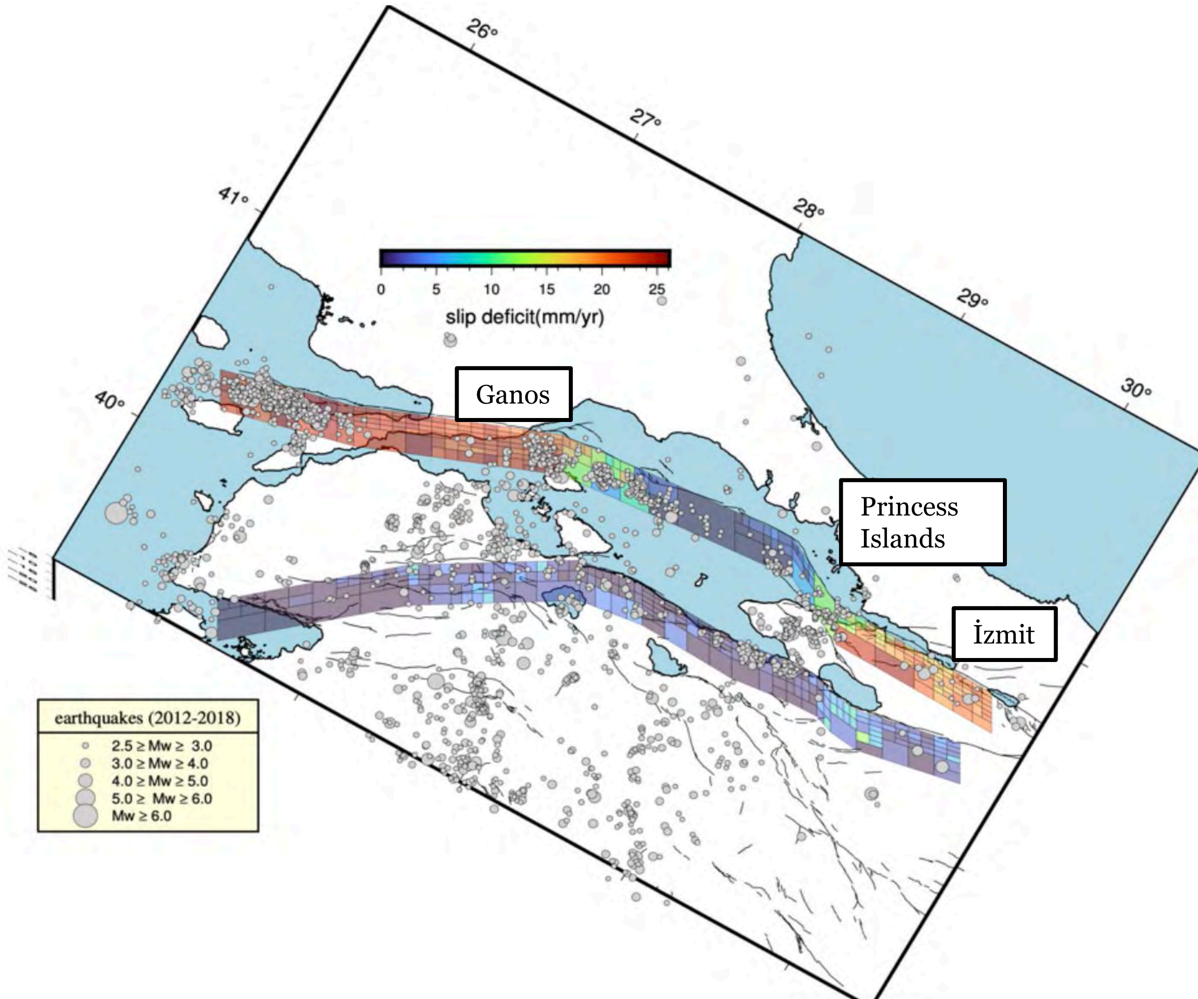




GNSS velocity vectors. Inset shows the frames of Sentinel data, used in the modeling

Preliminary results of the realistic mapping of slip deficit along main Marmara fault (2/2)

This deformation pattern, adjacent to each of the major fault branches, indicates that those branches that have generated M> 7 earthquakes, are accumulating strain and are the most likely branches to generate future earthquakes (from east to west: Izmit, the Princess Island segment, and Ganos segments.



Supersite benefits

Increased access to X-,C- and L-band SAR data

Increased international collaboration (e.g modeling software developed by GFZ, Germany as a part of DFG project)

Developing innovative methods for earthquake hazard assessment and improvement of our knowledge: *Our results have the fundamental importance for probabilistic seismic hazard analysis. All hazard models should be modified based on the* ***SAR results, which controls the wide area with high sampling rate in space and time.***

Sharing the results with Istanbul Municipality to help their risk plans

No funding resources officially available: We have limited resources from the local projects, only.

Geohazard Supersites and Natural Laboratories

The New Zealand Volcano Supersite

Ian Hamling
GNS Science

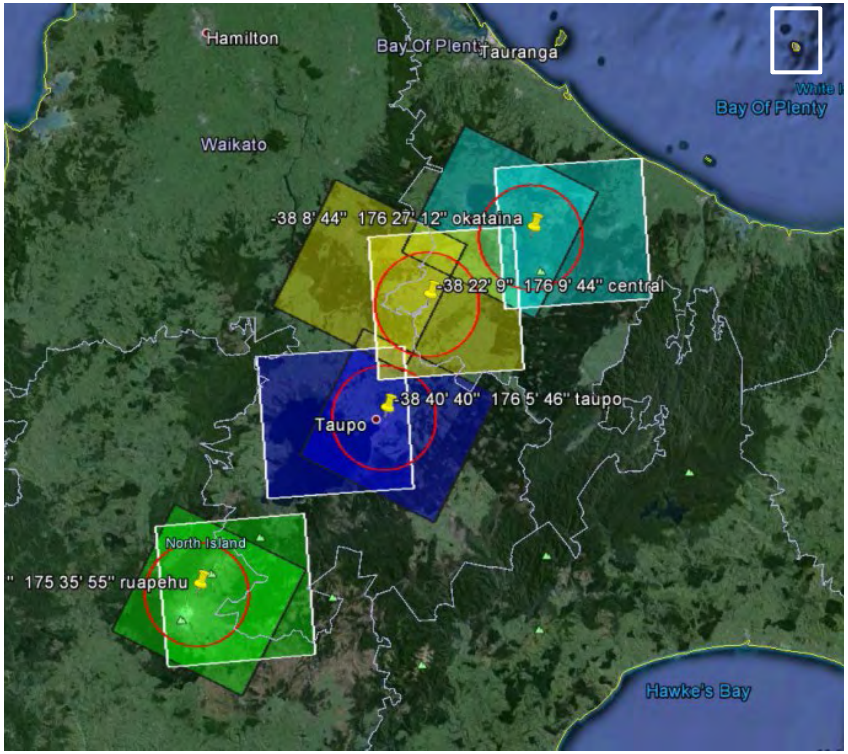
Supersite description

Principle coordinator: Ian Hamling

Launched in 2015 with a focus on both cone (Ruapehu, Tongariro, Ngauruhoe, Whakaari/White Island) and caldera (Taupo, Rotorua, Okataina) volcanoes.

Hi-resolution radar data from Cosmo-SkyMed and TSX missions has been a key resource for ongoing research programs and monitoring efforts.

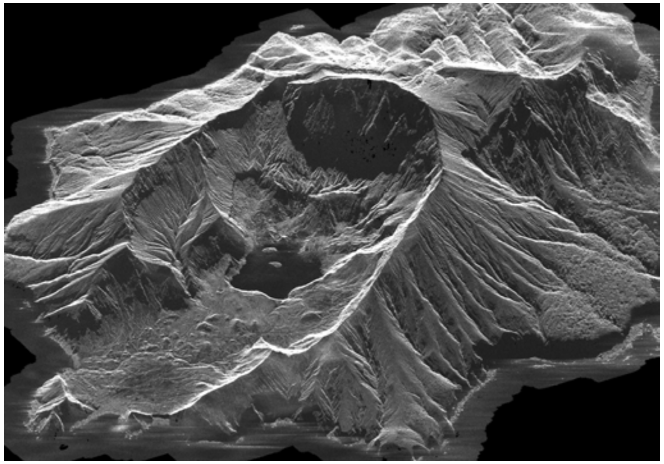
Recent phreatomagmatic eruptions have been associated with localised vent scale deformation hard to track without the radar data



Outline of CSK frames over Taupo Volcanic Zone (TVZ) and offshore White Island (TSX)

Supersite data

Supersite has focussed on data provided by ASI (CosMo) and DLR (TerraSAR) but also has allocation of Radarsat (not currently exploited fully due to capacity)



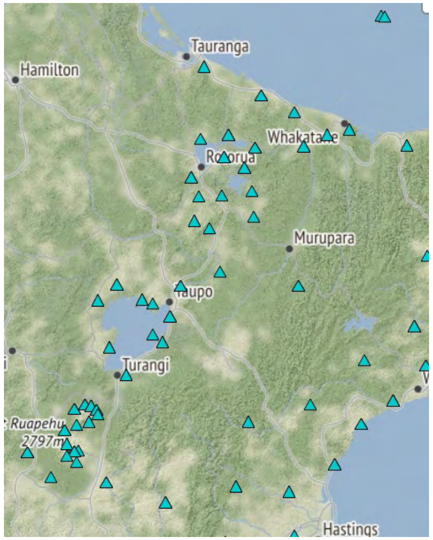
In Situ data is provided through GeoNet program and includes:

GNSS

Visual

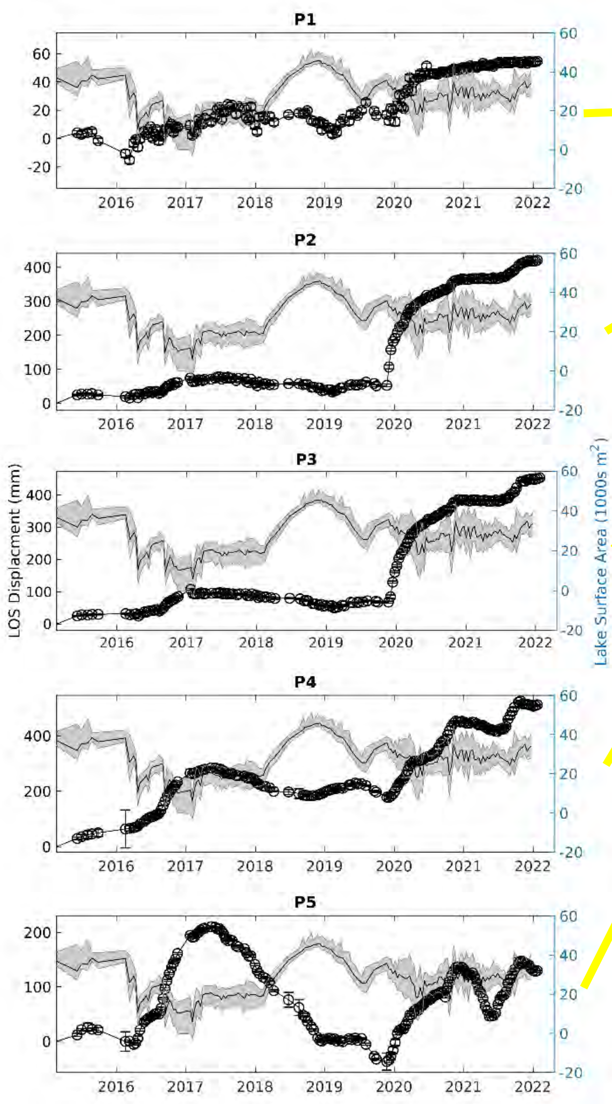
Seismic

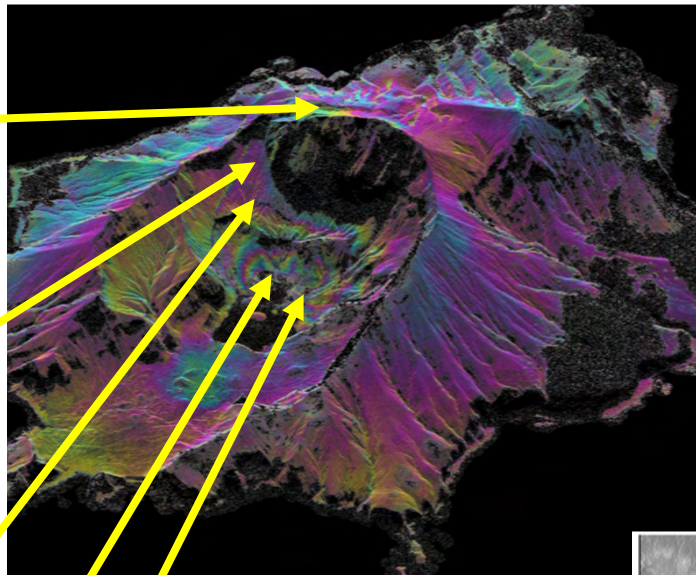
Gas



All data is publicly available and downloadable from www.geonet.org.nz

Supersite science

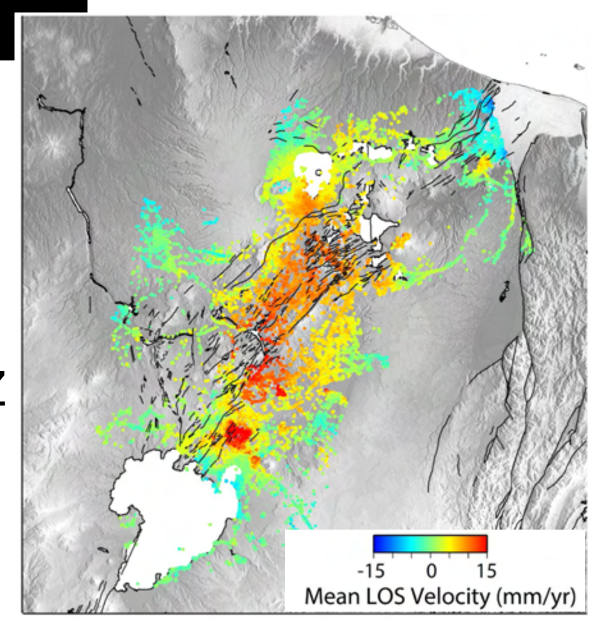




Deformation at White Island is dominated by shallow hydrothermal activity within crater floor and creep of SW crater wall.

High resolution SAR observations have been pivotal in monitoring of the main crater floor and will continue to be so with more restricted access in the future.

CSK data reveals widespread subsidence across much of the TVZ inferred to be the result of cooling and contraction at depth.



Supersite science

Publication highlights:

- Benson, T.W., Illsley-Kemp, F., Elms, H.C., Hamling, I.J., Savage, M.K. and Wilson, C.J., 2021. N, Mestel ERH and Barker SJ (2021) Earthquake Analysis Suggests Dyke Intrusion in 2019 Near Tarawera Volcano, New Zealand. Front. Earth Sci, 8, p.60699
- Hamling, I.J. and Kilgour, G., 2021. Comment on the paper titled “Harvey, M., 2021. Sentinel-1 InSAR captures 2019 catastrophic White Island eruption. Journal of Volcanology and Geothermal Research. 411, https://doi. org/10.1016/j. jvolgeores. 2020.107124”. Journal of Volcanology and Geothermal Research, p.107234.
- Caudron, C., Girona, T., Jolly, A., Christenson, B., Savage, M.K., Carniel, R., Lecocq, T., Kennedy, B., Lokmer, I., Yates, A. and Hamling, I., 2021. A quest for unrest in multiparameter observations at Whakaari/White Island volcano, New Zealand 2007–2018. Earth, Planets and Space, 73(1), pp.1-21.
- Illsley-Kemp, F., Barker, S. J., Wilson, C. J. N., Chamberlain, C. J., Hreinsdóttir, S., Ellis, S., et al. (2021). Volcanic unrest at Taupō volcano in 2019: Causes, mechanisms and implications. Geochemistry, Geophysics, Geosystems, 22, e2021GC009803. https://doi.org/10.1029/2021GC009803
- Ian J. Hamling (2020): InSAR observations over the Taupō Volcanic Zone’s cone volcanoes: insights and challenges from the New Zealand volcano supersite, New Zealand Journal of Geology and Geophysics, DOI: 10.1080/00288306.2020.1721545
- Yates, A.S., Savage, M.K., Jolly, A.D., Caudron, C. and Hamling, I.J., 2019. Volcanic, coseismic, and seasonal changes detected at White Island (Whakaari) Volcano, New Zealand, using seismic ambient noise. Geophysical Research Letters, 46(1), pp.99-108.
- Miller, C.A., Currenti, G., Hamling, I. and Williams-Jones, G., 2018. Mass transfer processes in a post eruption hydrothermal system: parameterisation of microgravity changes at Te Maari craters, New Zealand. Journal of Volcanology and Geothermal Research, 357, pp.39-55.
- Hamling, I.J., 2017. Crater lake controls on volcano stability: insights from White Island, New Zealand. Geophysical Research Letters, 44(22), pp.11-311.
- Hamling, I.J., Hreinsdóttir, S., Bannister, S. and Palmer, N., 2016. Off-axis magmatism along a subaerial back-arc rift: Observations from the Taupo Volcanic Zone, New Zealand. Science Advances, 2(6), p.e1600288.
- Hamling, I.J., Williams, C.A. and Hreinsdóttir, S., 2016. Depressurization of a hydrothermal system following the August and November 2012 Te Maari eruptions of Tongariro, New Zealand. Geophysical Research Letters, 43(1), pp.168-175.

Supersite benefits

Data access through the supersite initiative has become a vital tool for our ongoing monitoring efforts of White Island. Ground based data is limited, and the resolution provided by other SAR satellites is not sufficient to capture the deformation around the crater floor. However, high resolution InSAR monitoring with TerraSAR X images granted through the Supersite have provided, and continue to provide, unprecedented levels of detail about the deformation around the island.

Access to supersite data continues to help supplement our monitoring capabilities across the TVZ. While we may be in a period of mostly non-eruptive behaviour, the data provide an exceptional source of information to understand periodic episodes of unrest and is helping us build a better picture of the subsurface magmatic system through GNS's government funded research programs.

The timely acquisitions and data continuity provided by the supersite initiative will be invaluable when an eruption starts in the future…….

Geohazard Supersites and Natural Laboratories

The Ecuadorian volcanoes Supersite

Coordinator: Patricia A. Mothes
pmothes@igepn.edu.ec; (+593) 991 374 911

Instituto Geofísico, Escuela Politécnica Nacional (EPN)
Quito Ecuador
www.igepn.edu.ec

Supersite description

The Instituto Geofisico of the EPN was formed in 1983. It is encharged by the Ecuadorian government to monitor and provide diagnosis of volcanic and tectonic activity within Ecuador.

The IGEPN operates a nationwide network of 500 telemetered instruments: BB seismic, infrasound, cGPS, tiltmeters, DOAS, accelographs, visual and thermal cameras, lahar detectors, rain gauges, etc. There are 45 potentially active volcanoes.

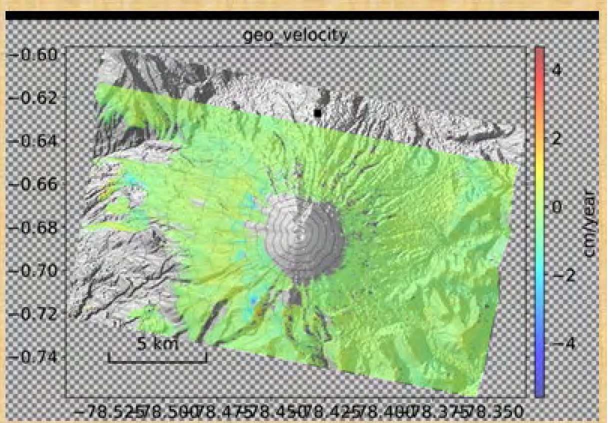
Under the Supersite umbrella, 8 volcanoes on the continent and 4 in the Galapagos islands are monitored with InSAR (Sentinel 1; TerraSar-X; CSK) imagery. InSAR results are combined with seismic, gas. visual
and thermal data to make a daily and/or weekly evaluation of the volcano´s status (quiet, reactivating or erupting).
5 technical people process, evaluate and present the weekly data all year round.

The accesibility of imagery and processing capacity is invaluable for enabling frequent and correct assessments of a volcano´s status to local authorities, civil defense agencies and the public in general. Daily reports are given ….
06 March, 2022_Quito_pmothes

Supersite science

Cotopaxi Volcano_Results– no changes detected.

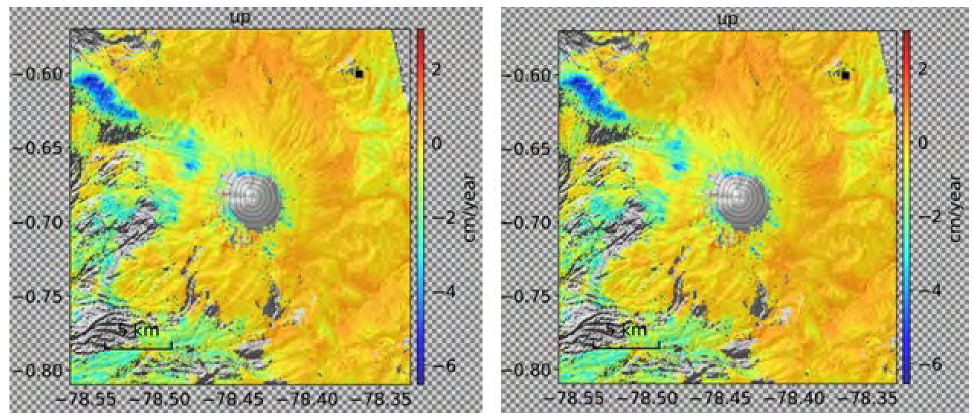
InSAR- Volcán Cotopaxi, Track Descendente, Terras-SAR: con datos hasta 01 Nov., 2021_Mapa de Velocidades



Tracks combinados_ Componente Vertical, 10 Dic y 22 Dic 2021, Sentinel-1, Volcán Cotopaxi

10 de Dic, 2021

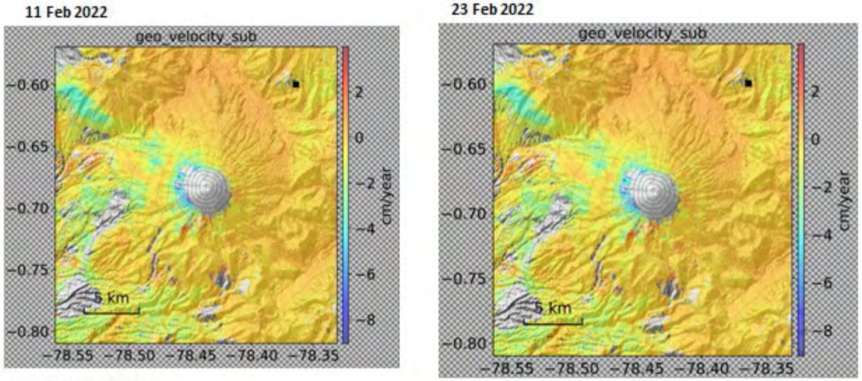
22 de Dic 2021



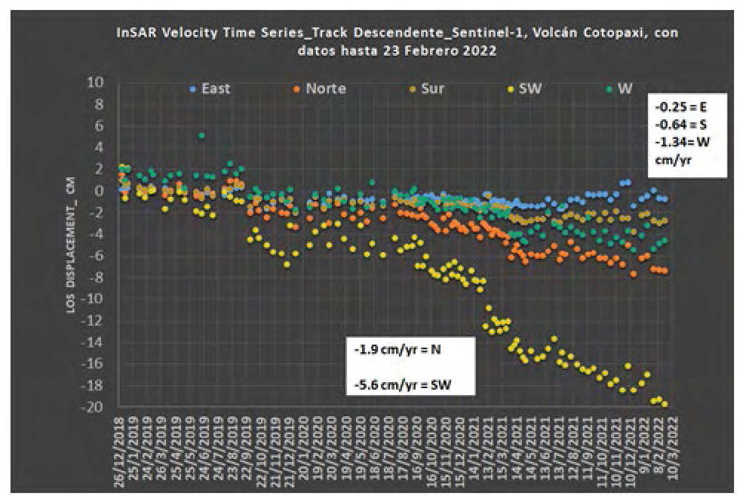
Track Descendente, 23 Febrero 2022, Sentinel-1, Volcán Cotopaxi

11 Feb 2022

23 Feb 2022



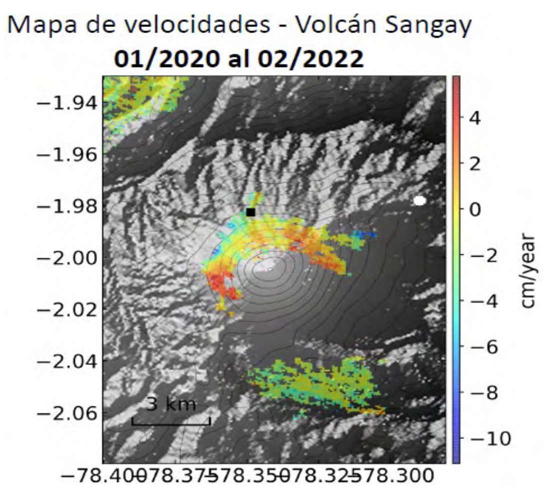
Pm_03 Marzo 2022

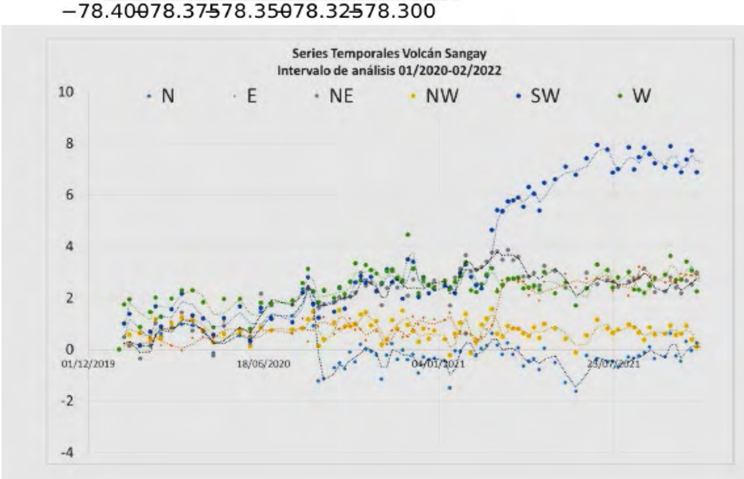


P. Mothes

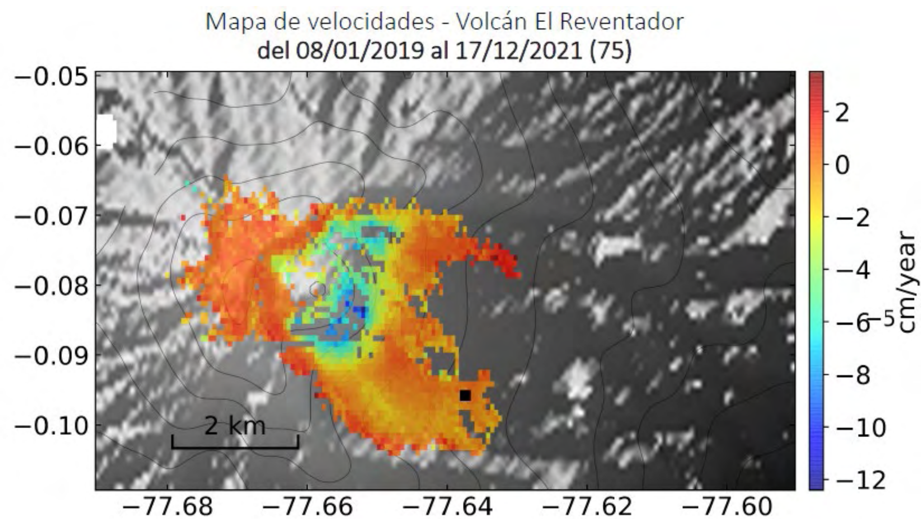
Supersite science

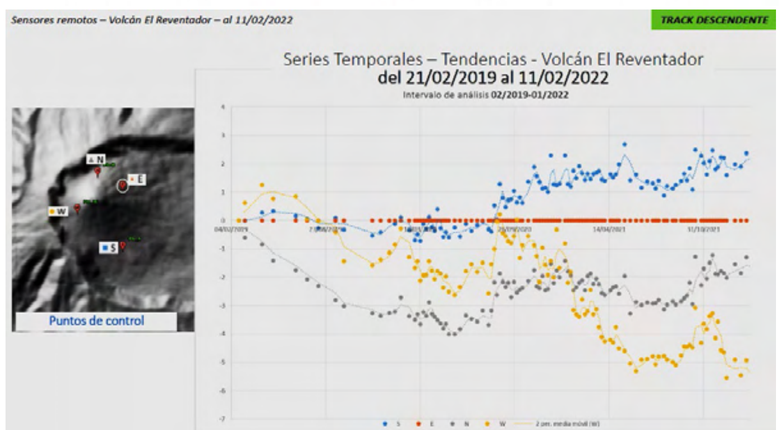
Sangay & Reventador Volcanoes, both erupting





M. Cordova

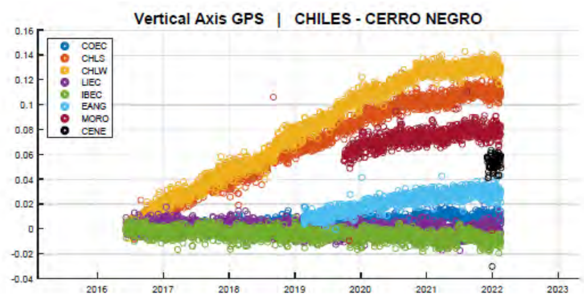


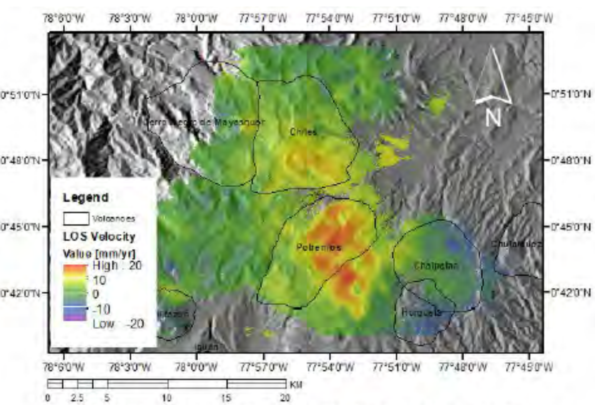


M.F. Naranjo

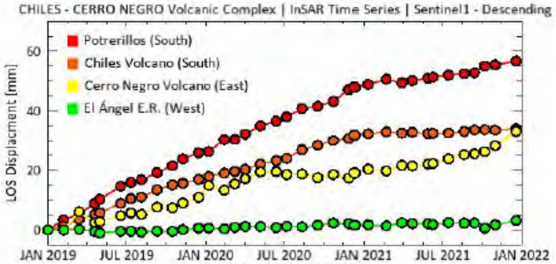
Supersite science

Chiles & Cayambe_ Combining cGPS and InSAR

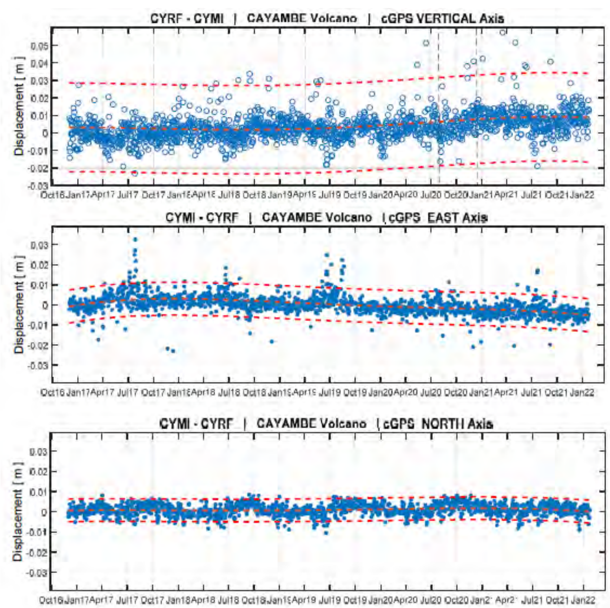


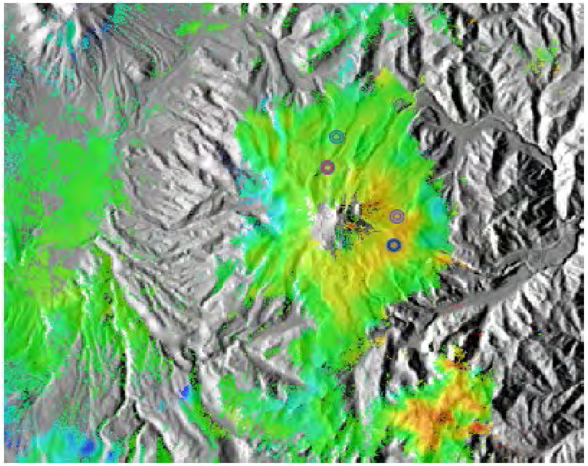


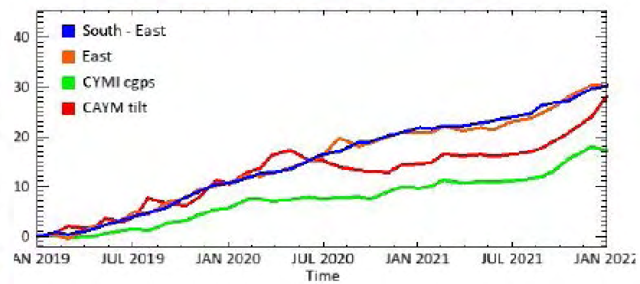
CHILES - CERRO NEGRO Volcanic Complex | InSAR Time Series | Sentinel1 - Descending



Cayambe, Sentinel-1 Descending & cGPS



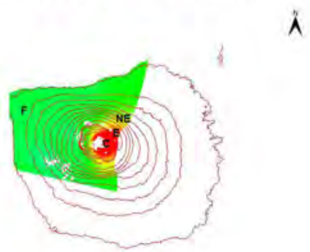


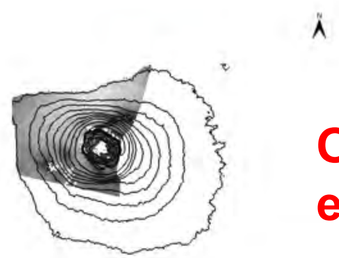


M. Yepez

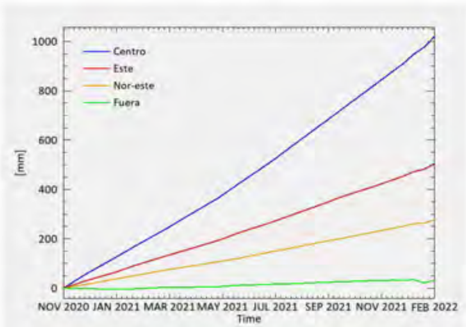
Supersite science

FERNANDINA DESCENDENTE
NOV 2020 - FEBRERO 2022

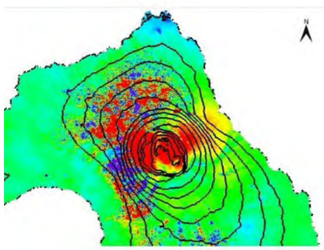




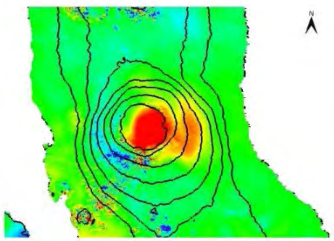
On the verge of eruption!



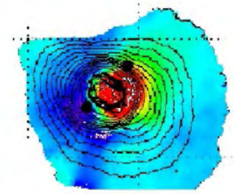
Volcán Wolf
Mayo 2020 - Oct 2021

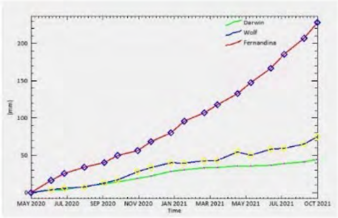


Volcán Darwin
Mayo 2020 - Oct 2021



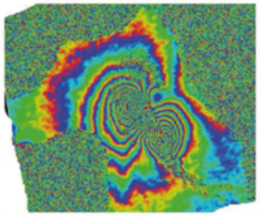
Volcán Fernandina
Mayo 2020 - Oct 2021

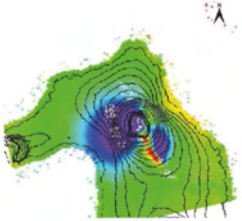




Erupting!

WOLF
5 - 29 enero 2022
Ascendente





S. Aguaiza

Supersite benefits

Supersite imagery and processing infrastructure are invaluable inputs to strengthen the monitoring capabilities of the IGEPN, in its mission to provide early warnings of impending eruption.

At the moment 12 volcanoes are monitored on a weekly-biweeky schedule with Sentinel-1 or TerraSar-X imagery processing.

5 IGEPN technicians are responsabile for the weekly processing and reporting of the results.

InSAR results are combined with other data: seismic, gas, GPS & tilt and termal images, to arrive at a composite picture of each volcano´s level of activity, and are reviewed in the IGEPN´s weekly “Volcano Meeting”.

Weak points: CSK images are noisy and therefore are not being processed often; Little space in the SarScape server.

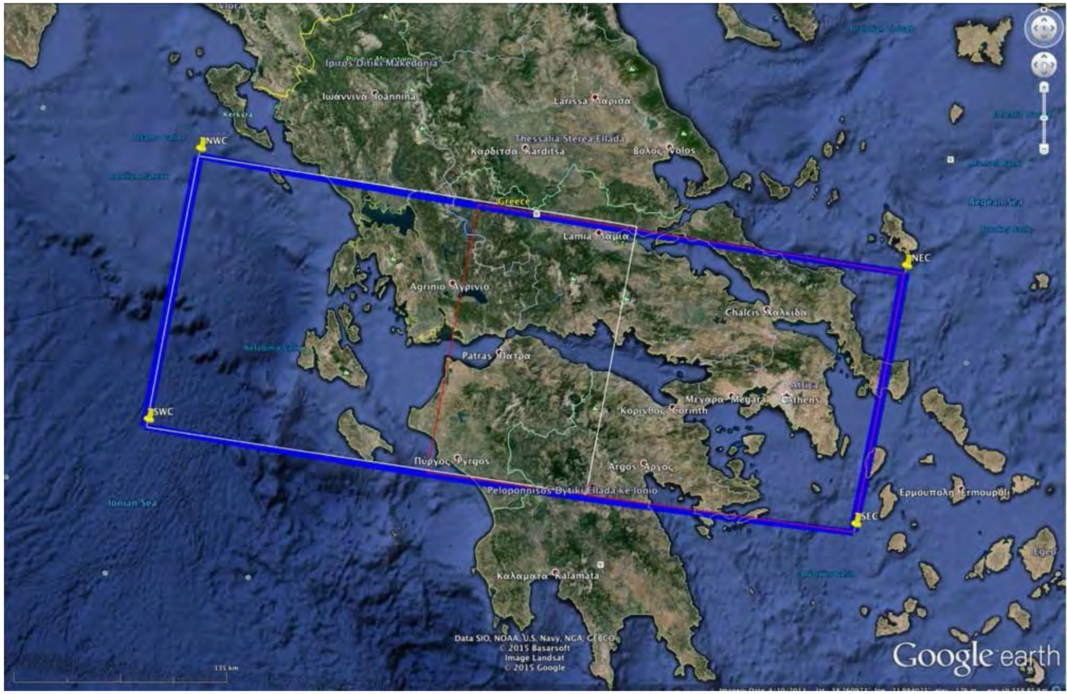
Geohazard Supersites and Natural Laboratories

The Enceladus Hellenic Supersite

Spyros Lalechos, Ph.D. Geophysicist - Head of Department of Seismotectonics
Earthquake Planning & Protection Organisation (EPPO)
Xanthou 32, Neo Psykhiko 15451, Athens, Greece

Thomas Salonikios, Ph.D. Structural Engineer – Senior Researcher
EPPO - Research Unit (ITSAK), Structural Division
Dasiliou Street, Pylaia 55535, Thessaloniki

Earthquake Planning and Protection Organisation of Greece (EPPO), established in 1983 as a Legal Entity of Public Law, operates under the supervision of the new Ministry of Climate Crisis & Civil Protection.
EPPO is responsible for the design and implementation of the earthquake national policy during the pre-seismic (ex ante), seismic (on going) & post-seismic (ex post) phases.
Recently, EPPO also undertook the coordination of the volcanic risk assessment throughout the Aegean Volcanic Arc.



Enceladus Hellenic Supersite
800 km long – 300 km width, 3 deformation zones (Ionian Islands, Corinth & Evoikos rift)
High societal impact: More than 50% of the population, 40% of the industrial production, millions of visitors per year, cultural heritage
Highest observed seismicity in Europe
Last 15 years: 23 earthquakes between **M 5.0-6.5** with damages to the building stock
Highest strong ground motion recorded: **0.77g** at 7 km from a M6.0 earthquake in Kefalonia Island on February 3, 2014.
Intense ground deformation
Cephalonia Island: Uplift **> 4 mm/yr** in the western part for the period of 2003 to 2010
Corinth Rift: N-S extension at **<5mm/yr** in the east and **>15mm/yr** in the west

Supersite data

(https://greeksupersite.eu/ & http://apollo.geosystems-hellas.gr/greeksupersite/)

Satellite data

- 81 DLR TerraSAR-X stripmap archive images in Kefalonia area (Ionian Islands) to be processed by the Laboratory of Engineering Geology, University of Patras (contact person Prof. K. Nikolakopoulos), to study the surface deformation.

In situ data

- GIS Hellenic Accelerograms Database (GHEAD) portal allows users to query earthquake, station information and ground motion parameters, as well as to select and download processed and unprocessed accelerometric waveforms and response spectra (also available at http://ghead.itsak.gr/).
- Online seismicity of the Greek territory, from Seismological Laboratory, University of Athens
- The Digital Terrain Model of the seafloor of the Greek Supersite with a grid resolution of 1/16 x 1/16 arc minutes, produced by HCMR in the framework of EMODnet Bathymetry project.

Supersite science

On-going projects

- Study of surface deformation in Kefalonia area (Ionian Islands) by Prof K. Nikolakopoulos
- Development of a Support System for Improved Resilience and Sustainable Urban areas to cope with Climate Change and Extreme Events (EU Horizon 2020: H2020-LC-CLA-2018-2019-2020). From 01/06/2021 until 01/02/2025 (https://harmonia-project.eu/)
- Establishment of an on-line plattform of continuous processing of GNSS stations in the Enceladus Supersite area - Surface deformation assessment from GNSS data in the Corinth rift. Laboratory of Higher Geodesy and Dionysos Satellite Observatory of National Technical University of Athens (Prof. M. Tsakiri). From August 2021 – July 2022. Project funded by EPPO.
- Surface deformation assessment in the wider region of the Corinth rift through Persistant Scatterers (P.S.). Dep. of Geography, Harokopio University of Athens (Prof. I. Parcharidis). From October 2021 – September 2022. Project funded by EPPO.

Supersite benefits

Expected outcomes from the work in progress

- Surface deformation magnitude just after a strong earthquake, valuable information with the recorded strong ground motion to assess potential damages in the epicentral area.
- Delimitation of tectonic blocks in Corinth rift area where faster deformation is recorded and thus presenting a greater seismic risk.
- Continuous monitoring of the above blocks through DInSAR techniques
- Continuous monitoring from GNSS permanent stations of surface deformation in Supersite area.
- All the above data will be available to the scientific community and the Civil Protection through Supersite web site https://greeksupersite.eu/.

Supersite main issues

- The Enceladus Supersite still lacks manpower and systematic funding.
- The Supersite planning and workflow were deeply affected by the two lockdowns in Greece and the covid-19 restrictions in general.

Geohazard Supersites and Natural Laboratories

The San Andreas Fault Natural Laboratory (SAFNL) Supersite

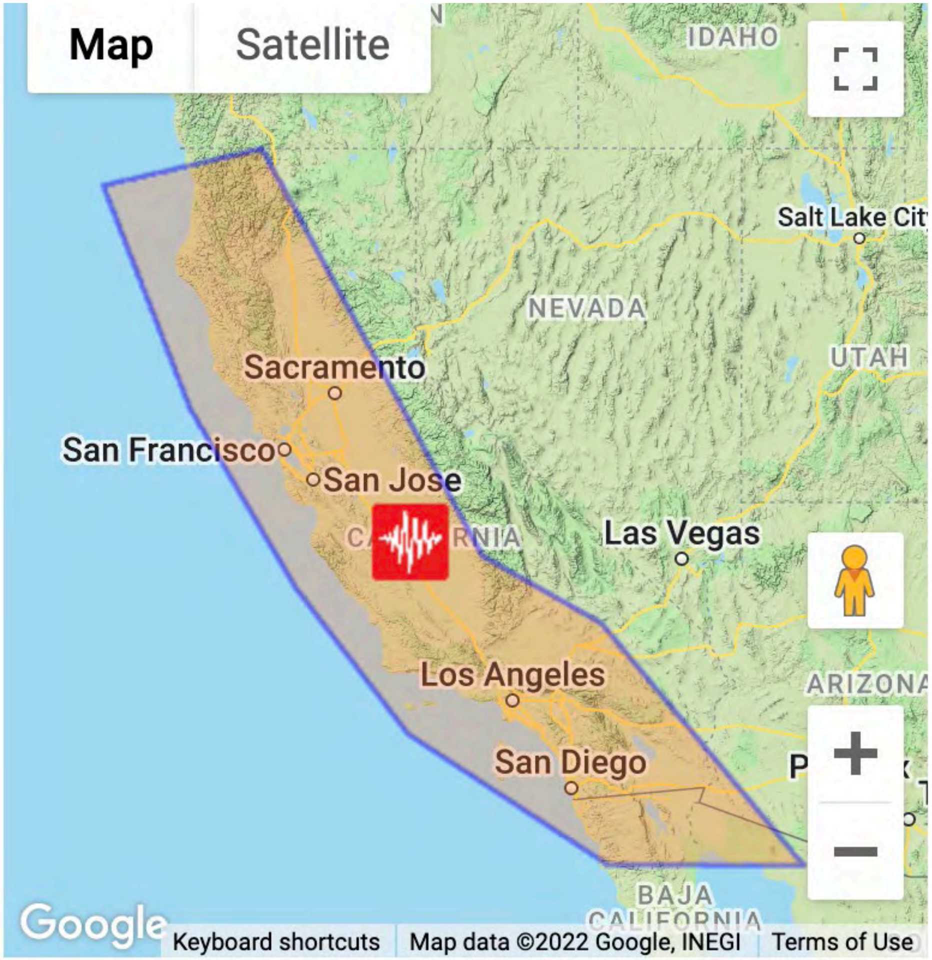
William Barnhart (USGS Earthquake Hazards Program)
Kathryn Materna (USGS Earthquake Science Center)
Kang Wang (UC Berkeley)

Supersite description

Coordinators: Barnhart, Materna, and Wang (new coordinators effective 2022)

Kudos to former coordinator Chuck Wicks (USGS)!

Goal: Support basic and operational research along a high risk, major continental transform system

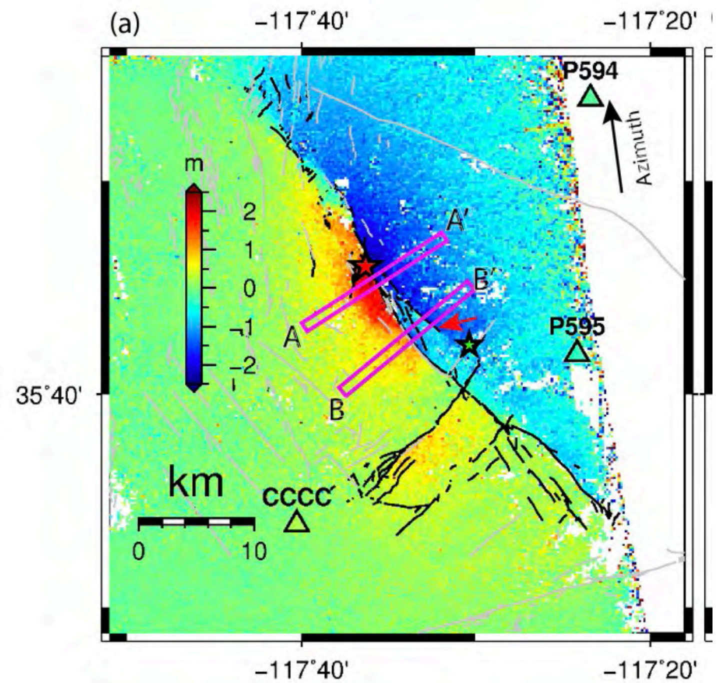


Supersite data

Current open access satellite imagery hosted:

TerraSAR-X

COSMO-SkyMed



Wang & Bürgmann, 2020

In-situ data:

- GPS (Archived and served via UNAVCO)

- Seismic waveforms (IRIS, Southern California Earthquake Data Center, Northern California Earthquake Data Center)

- Strainmeters (UNAVCO)

- High-resolution topography (OpenTopography)

Supersite science

- Interseismic slip and strain rates
- Post-seismic deformation
- Earthquake characterization and response
- Hydrologic deformation and impacts on seismotectonics
- Geodetic tool and algorithm development

Supersite benefits

The SAFNL primarily facilitates access to high-resolution, SAR imagery (TerraSAR-X, COSMO-SkyMed) that support detailed studies of earthquake cycle processes on and around the San Andreas Fault system, and particularly provide the ability to conduct high-resolution deformation studies in high-risk urban environments. The SAFNL additionally provides access to imagery assets for near-real-time earthquake response.

Under new leadership, we hope to expand the user-base of the SAFNL for both SAR and optical assets.

Geohazard Supersites and Natural Laboratories

The SOUTHERN ANDES Supersite

Luis E. Lara, SERNAGEOMIN and CIGIDEN
Supersite coordinator

M. Loreto Córdova, SERNAGEOMIN
Supersite co-coordinator

Supersite description

Main goal: To understand coupled geohazards in an arc segment at Southern Andes: Copahue-Lanín arc volcanoes and adjacent crustal faults

- 9 active stratovolcanoes + 2 distributed fields
- 80 eruptions since 20th century
- An active intraarc fault system (LOFS)

Supersite coordinator: Luis E. Lara
Supersite co-coordinator: M Loreto Córdova

Supersite data

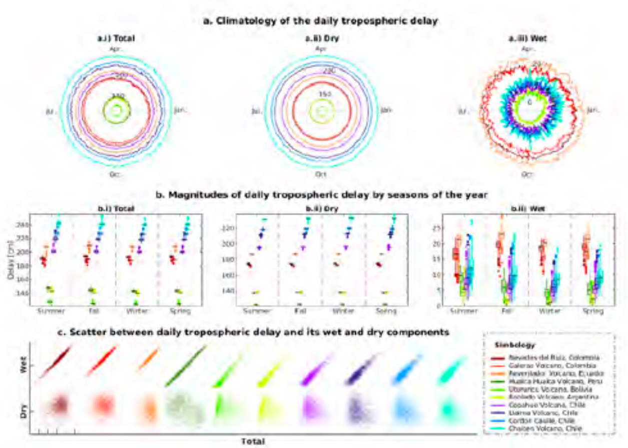
TerraSAR X, COSMO Skymed SKM, Radarsat, Pleiades

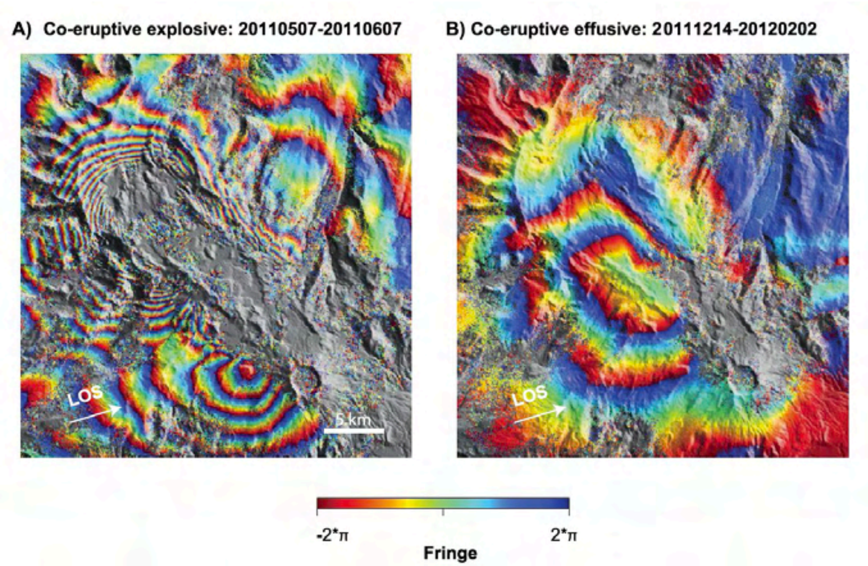
Ground monitoring data retrieved by Sernageomin through the OVDAS volcano observatory is accesible under request

Supersite science (results)

Left, The regional pattern of tropospheric component on InSAR signal analyzed (López et al., submitted)

Right, The role of intraarc fault systems assessed trough InSAR modeling of magmatic systems (Novoa et al., 2022)





Supersite science (articles*)

López, F.; Abarca del Río, R.; Lara, L.E.; Tassara, A. (submitted). Climatology of tropospheric delay in InSAR data 1 applied as tropospheric correction to volcanoes in the Andes

Novoa, C., et al. 2022. The 2011 Cordón Caulle eruption triggered by slip on the Liquiñe-Ofqui fault system. Earth and Planetary Science Letters 583 (2022): 117386.

* With co-autorship of research scientists involved in the Southern Andes Supersite, although not always based on images obtained by this project

Supersite benefits

Increased data access for volcano monitorig by OVDAS (Sernageomin volcano observatory)

Increased international collaboration in some specific case-studies

Geohazard Supersites and Natural Laboratories

The Virunga Supersite

Charles Balagizi, Goma Volcano Observatory

Supersite description

- Coordinator: Charles Balagizi (GVO)
- The scientific challenges (specific objectives):

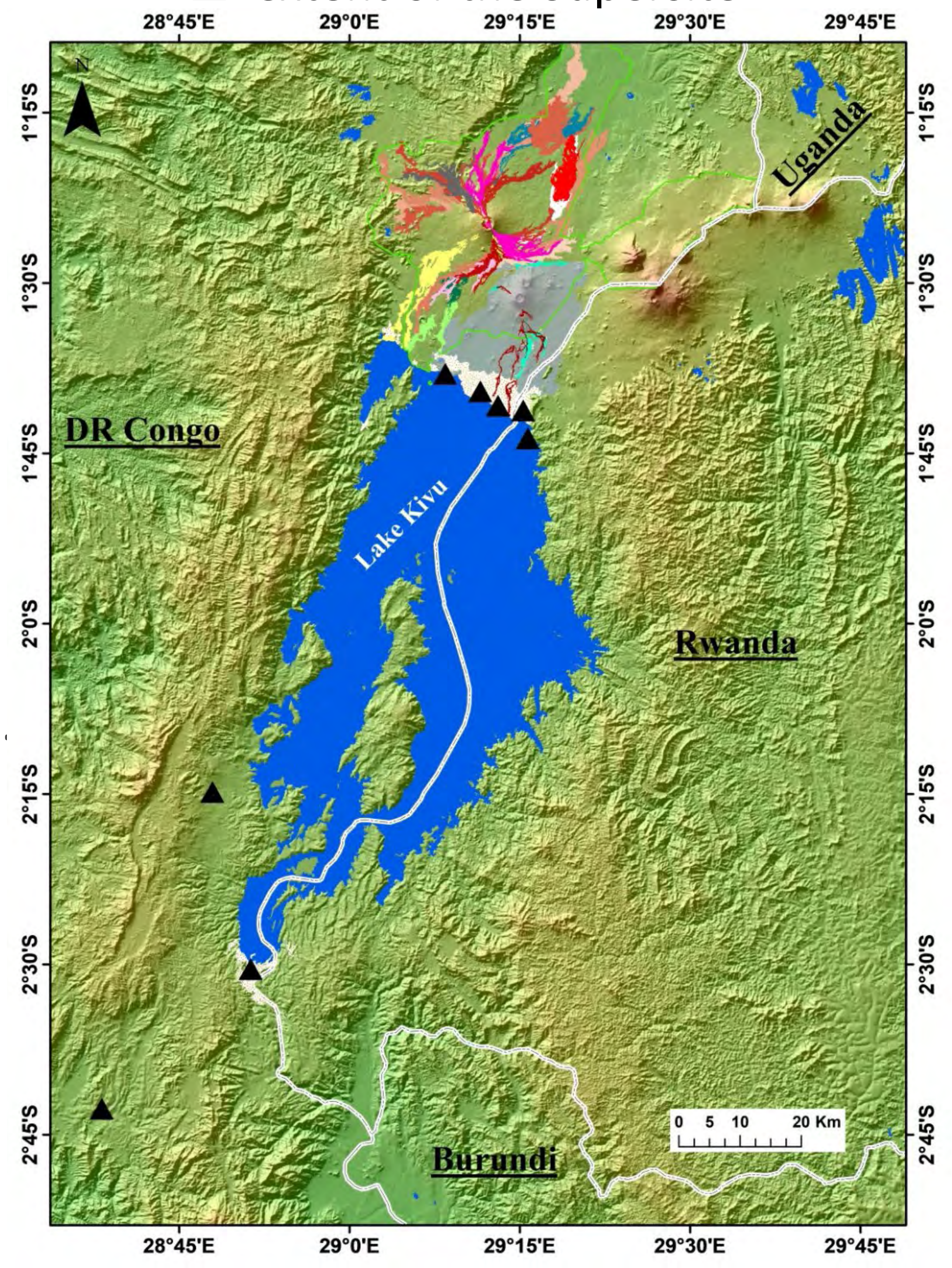
1.capacity building of local scientists,

2.increase, on a fair basis, international collaboration for the monitoring of the Virunga active volcanoes and the Lake Kivu with the aim of preventing the related risks,

3.access Earth Observation satellite data, for the monitoring and understanding of the volcano processes,

4.identify possible funding sources and obtain resources to develop GVO monitoring and scientific capacities.

- extent of the Supersite



Supersite data

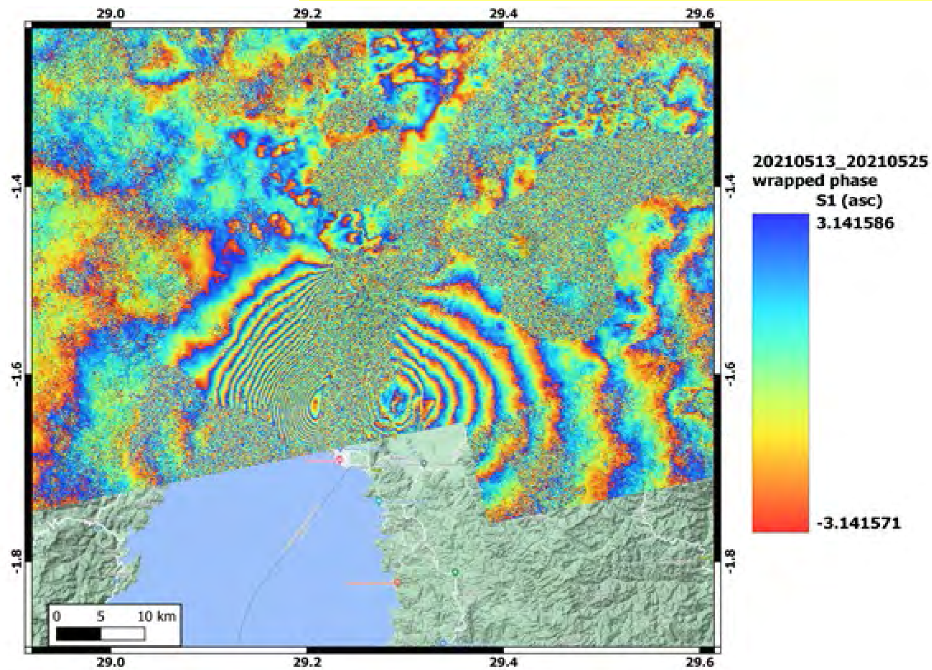
- Data provided open access by the CEOS:

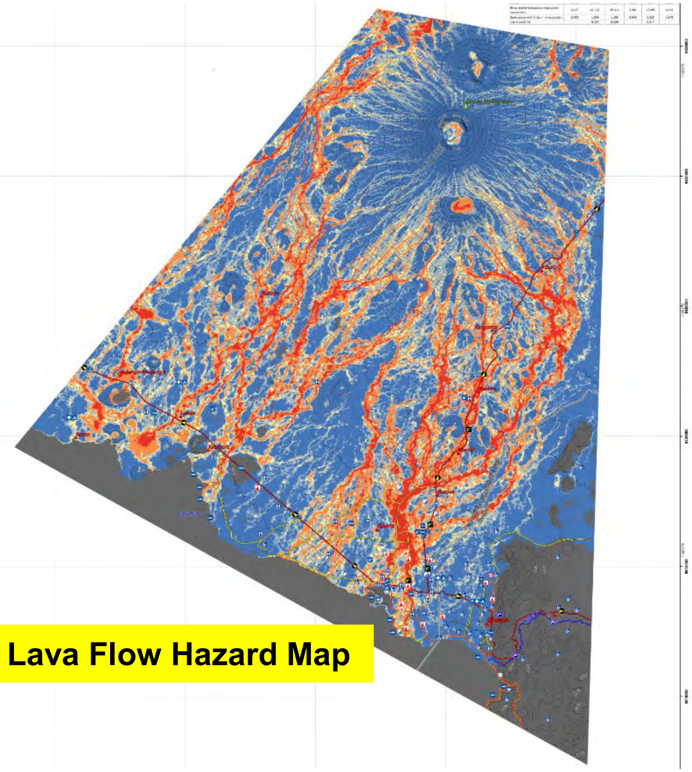
1. TerraSAR X satellite data can be accessed from the DLR Supersite Data Portal (registration needed)
2. COMO-SkyMed SAR data can be accessed from the ESA Geohazard Exploitation Platform.
3. Pleiadés data: Accessible on demand from the Coordinator and soon at the the FTP site

- In situ data which are provided open access: None up to now (discussions are ongoing, the Virunga Supersite Data Policy has been adopted.

Supersite science: Main scientific results

Ascending syn-eruptive wrapped interferogram

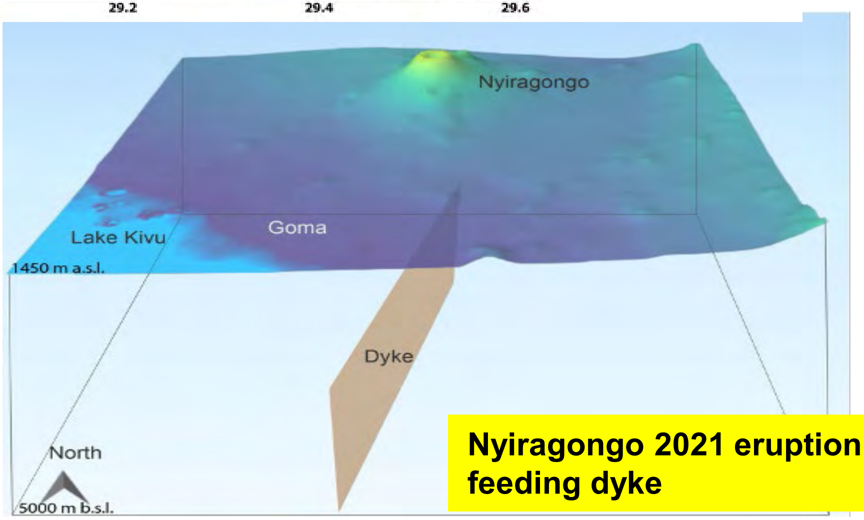




Lava Flow Hazard Map

Main scientific results

(1) Volcanic hazard assessment
(2) Volcano monitoring
(3) Supported the response to the Nyiragongo 2021 volcanic crisis
(4) Capacity building of local scientists through trainings



Nyiragongo 2021 eruption feeding dyke

List of publications (main):

(1) Lowenstern JB et al., 2022. Guidelines for volcano-observatory operations during crises: recommendations from the 2019 volcano observatory best practices meeting. J Appl. Volcanol. 11, 3 (2022). https://doi.org/10.1186/s13617-021-00112-9

(2) Plisnier P-D et al., 2022. Need for a long-term multi-lake harmonized monitoring of African Great Lakes. Accepted for publication in the Journal of Great Lakes Research. https://doi.org/10.1016/j.jglr.2022.01.016

(3) Kasereka MM et al. 2021. Baseline for rainwater chemistry and quality as influenced by Nyiragongo volcano permanent plume, East Africa. Chemosphere. 2021 Nov; 283: 130859. https://doi.org/10.1016/j.chemosphere.2021.130859

(4) Burgi P-Y et al., 2021. Unconventional filling dynamics of a pit crater, EPSL, https://doi.org/10.1016/j.epsl.2021.117230

(5) Tuluka, G.M., Lukindula, J. & Durrheim., R. (2019). Seismic Hazard Assessment of the Democratic Republic of Congo and Environs Based on the GEM-SSA Catalogue and a New Seismic Source Model. Journal of Pure and Applied Geophysics. https://doi.org/10.1007/s00024-018-2084-6

(6) Balagizi, C., Kies, A., Kasereka, M., Tedesco, D., Yalire, M., McCausland, W. A. (2018). Natural hazards in Goma and the surrounding villages, East African Rift System. J. of Natural Hazards, https://doi.org/10.1007/s11069-018-3288-x

(7) Balagizi, et al., 2018 . Influence of moisture source dynamics and weather patterns on stable isotopes ratios of precipitation in Central-Eastern Africa. Science of the Total Environment Journal, https://doi.org/10.1016/j.scitotenv.2018.01.284

(8) Kasereka et al., 2017. Risks Associated with Mazuku in the Goma area, Democratic Republic of the Congo (East African Rift). J. Wat. Env. Sci. Vol. 1, 164-174.

(9) Balagizi, 2017. Rain-plume interactions at Nyiragongo and Nyamulagira volcanoes and associated rainwater hazards, East Africa, http://dx.doi.org/10.1016/j.apgeochem.2017.03.018

Supersite benefits

- **Increased data access**: the supersite has allowed to access, free of charge, a variety of EO data (COMO-SkyMed SAR, TerraSAR X and Pleiadés data

- **Improved scientific support to local users**: the Virunga Superstite Scientific team supports in the ordering of EO data and their processing and interpretation

- **Increased international collaboration**: this collaboration has allowed:
  - Short trainings of local scientifs in volcano monitoring based technics, and volcanic hazards assement and risk prevention
  - Long training (masters level or equivalent) in volcanology and seismology
  - Donation of equipment for ground based data collaction, and seismic data processing

- **Access to funding:** a project has been drafted in collaboration with the Virunga Scientific team but has not been funded yet.

Geohazard Supersites and Natural Laboratories

The Kamchatka/Kuriles Volcano Supersite

Alina Shevchenko
German research center for Geosciences GFZ
Institute of volcanology and seismology FEB RAS

Supersite description

Coordinator: Alina Shevchenko, postdoc in GFZ, senior researcher of IVS

Scientific challenges:

1. To collect and process space-borne data for Kamchatka and Kuriles volcanoes
2. To develop a strategy for deformation monitoring based on radar and optical data processing
3. To improve the capability to track effusion/emission rates based on the space-borne and aerial image products

Supersite data

Satellite data, which are provided open access by the CEOS:

Pleiades – 65 new datasets

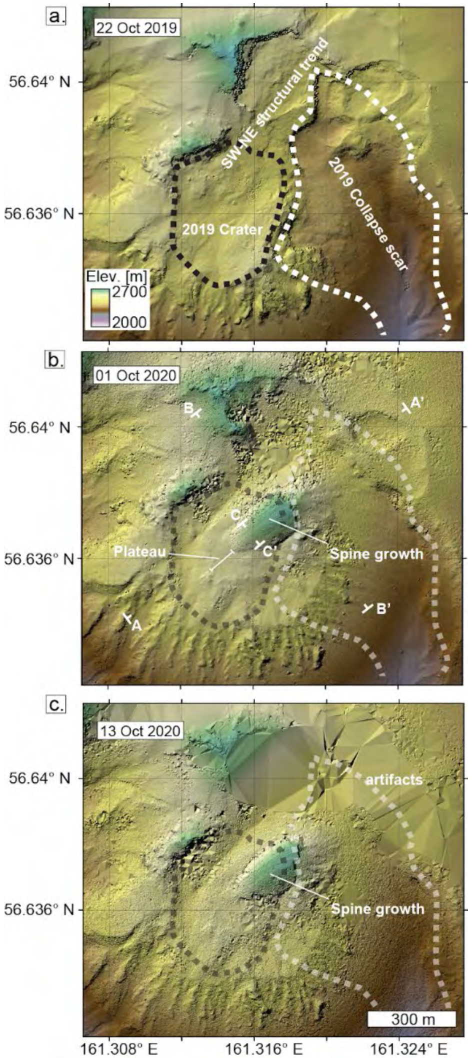
TerraSAR-X – 43 archive; 5 new datasets

COSMO-SkyMed – 197 archive; 24 new datasets

In situ data which are provided open access by the Coordinating institute and by the scientific community:

Aerial images and aerial digital elevation models – about 15 datasets

Supersite science: Spine growth monitoring at Shiveluch volcano



DEMs produced from stereo imagery: a. Aerial DEM on October 22, 2019, before the spine growth reveals the presence of summit craters roughly aligned along the SW-NE. Note the deep collapse scar that formed in 2019 on the eastern part of the edifice. b. Pleiades satellite DEM on October 01, 2020, shows the presence of a spine extrusion, partly overflowing the 2019 collapse scar. c. Pleiades satellite DEM on October 13, 2020, shows continuous spine growth, yet cloud artifacts in the northeast. Map created using ArcMap vs. 10.8.1.

Publication: Walter T.R., Zon E.U., Harnett C.E., Shevchenko A.V., Vassileva M.S. (2022) Tracking magma spine extrusion from space: Implications for conduit and topography complexity at Shiveluch volcano. Commun. Earth Environ. In review.

Supersite benefits

1. Access to high-resolution satellite data → Possibility to study the morphology of remote and hazardous volcanoes of Kamchatka and Kuriles in detail.
2. Increased international collaboration between IVS and GFZ.
3. Increased scientific interest in Kamchatkan and Kuriles volcanoes.

GROUP ON EARTH OBSERVATIONS

Geohazard Supersites and Natural Laboratories

The China Earthquake Supersite

Yun Shao
7 March 2022

Supersite coordinator:

Prof. Yun Shao
Aerospace Information Research Institute, Chinese Academy of Sciences

China Supersite description

◆Scientific challenges

(1) Postseismic deformation along the Longmenshan fault zone;

(2) Interseismic deformation along the Haiyuan fault;

(3) Interseismic deformation along the Xianshuihe fault.

◆Extent of the Supersite

As shown in Fig.1

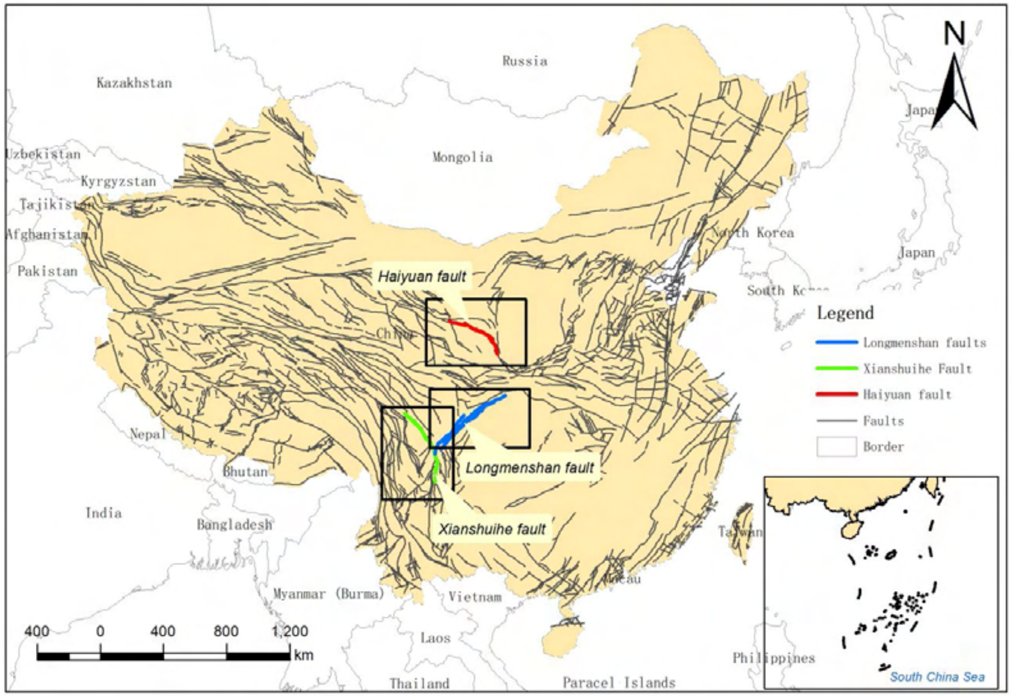


Fig.1 Longmenshan fault, Haiyuan fault, Xiaoshuihe fault

Supersite data


Fig.2 CSK images

◆ Satellite data from the CEOS:

➢ 76 Cosmo-Skymed satellite images (Fig.2).

➢ CSK data available from ESA's Geohazards Exploitation Platform

◆ In situ data from the Coordinating institute:

✓ Open access of the GNSS (Fig.3) and seismic network (Fig.4) from China Earthquake Administration (CEA) through **reasonable requests**;

✓ Facilitate open access to all Chinese GNSS and seismic data and products following the GEO data sharing principles.

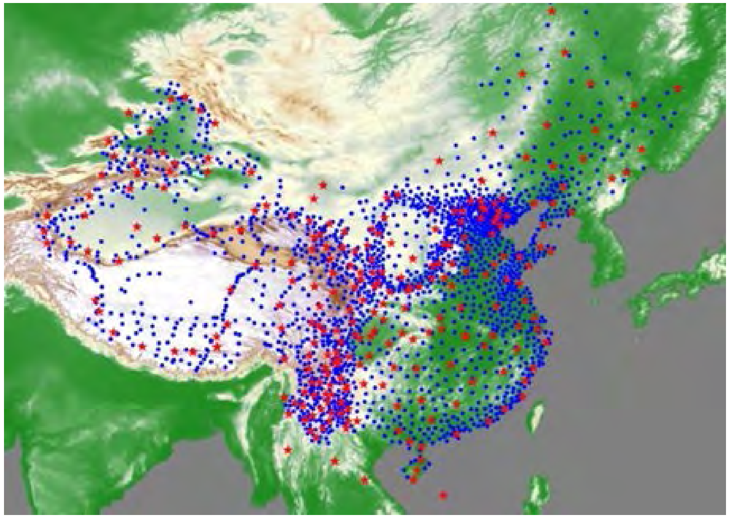


Fig.3 GNSS network of China

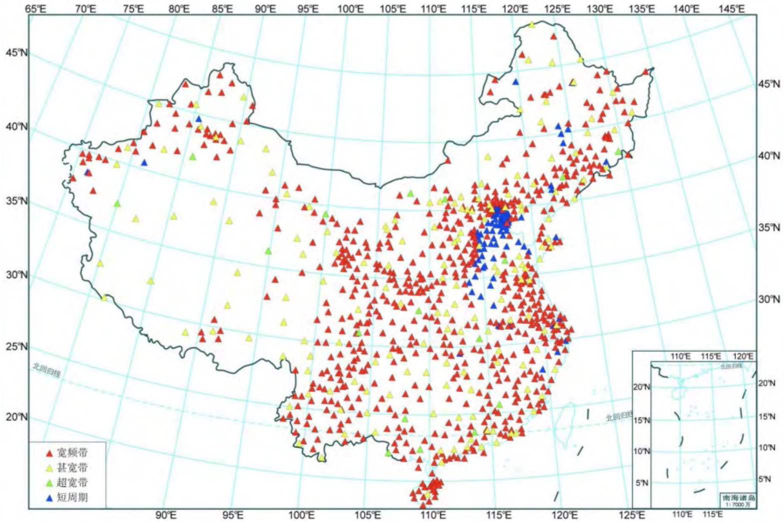


Fig.4 Seismic network of China

Supersite science

1. The efficient process of InSAR data using XSEDE's Stampede2 at the Texas Advanced Computing Center
2. Deformation velocity of Tibet during 2014.10 – 2021.7

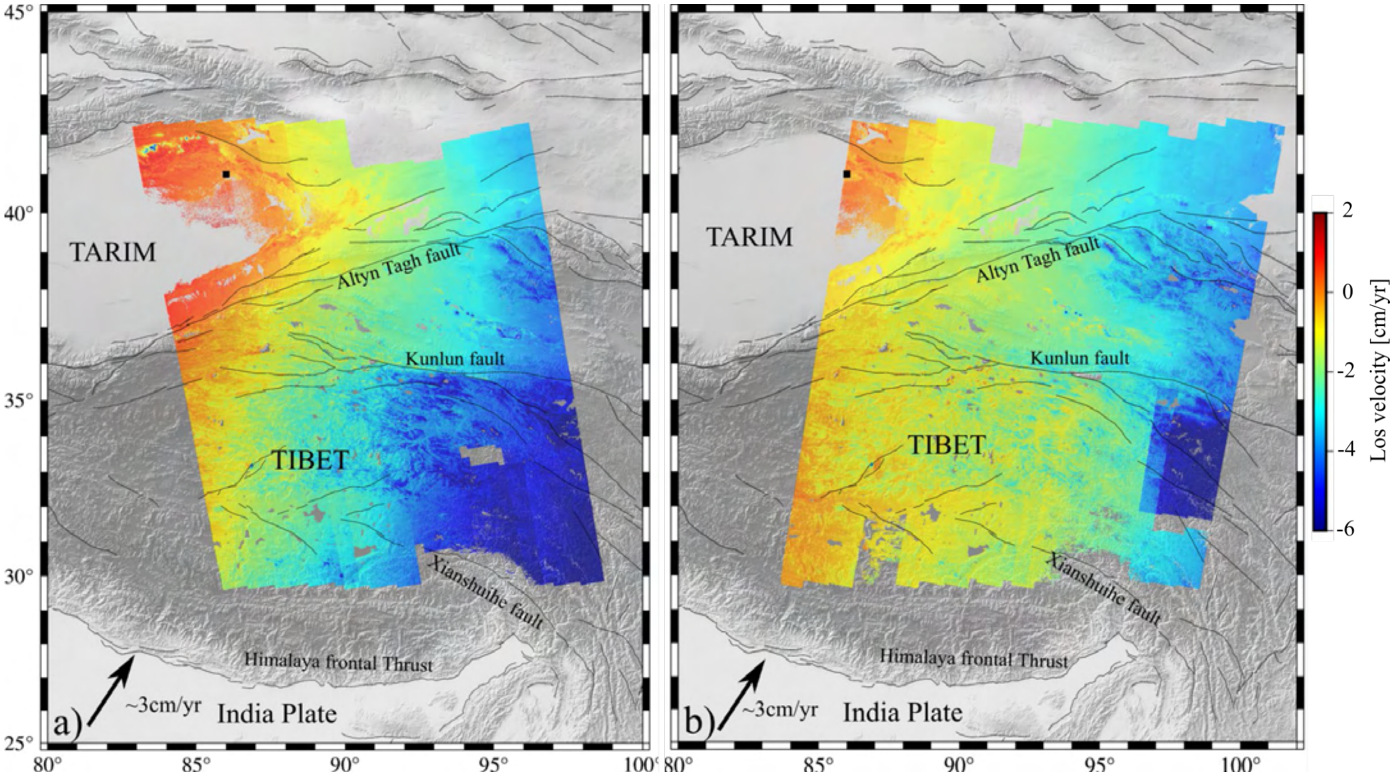


Fig.4 Deformation velocity of Tibet

Supersite benefits

China is one of the countries with the highest earthquake hazard and risk in the world. Satellite-derived earthquake deformation data will aid emergency management department to quick and better response to earthquake disaster and mitigate the damage.

◆Benefit for emergency management. The study results about inter-seismic (e.g. Haiyuan fault, Xianshuihe fault), co-seismic and post-seismic (e.g. Wenchuan earthquake) deformation will be provided to the emergency management department.

◆Support the research at the China Seismic Experimental Site (CSES).

◆Access to in situ data. It is conducive to obtain GNSS and seismic wave data in China ,and to increase international collaboration.

◆ The long-term plan is to move the responsibility of Supersite coordination to the Chinese Earthquake Administration.

GROUP ON EARTH OBSERVATIONS

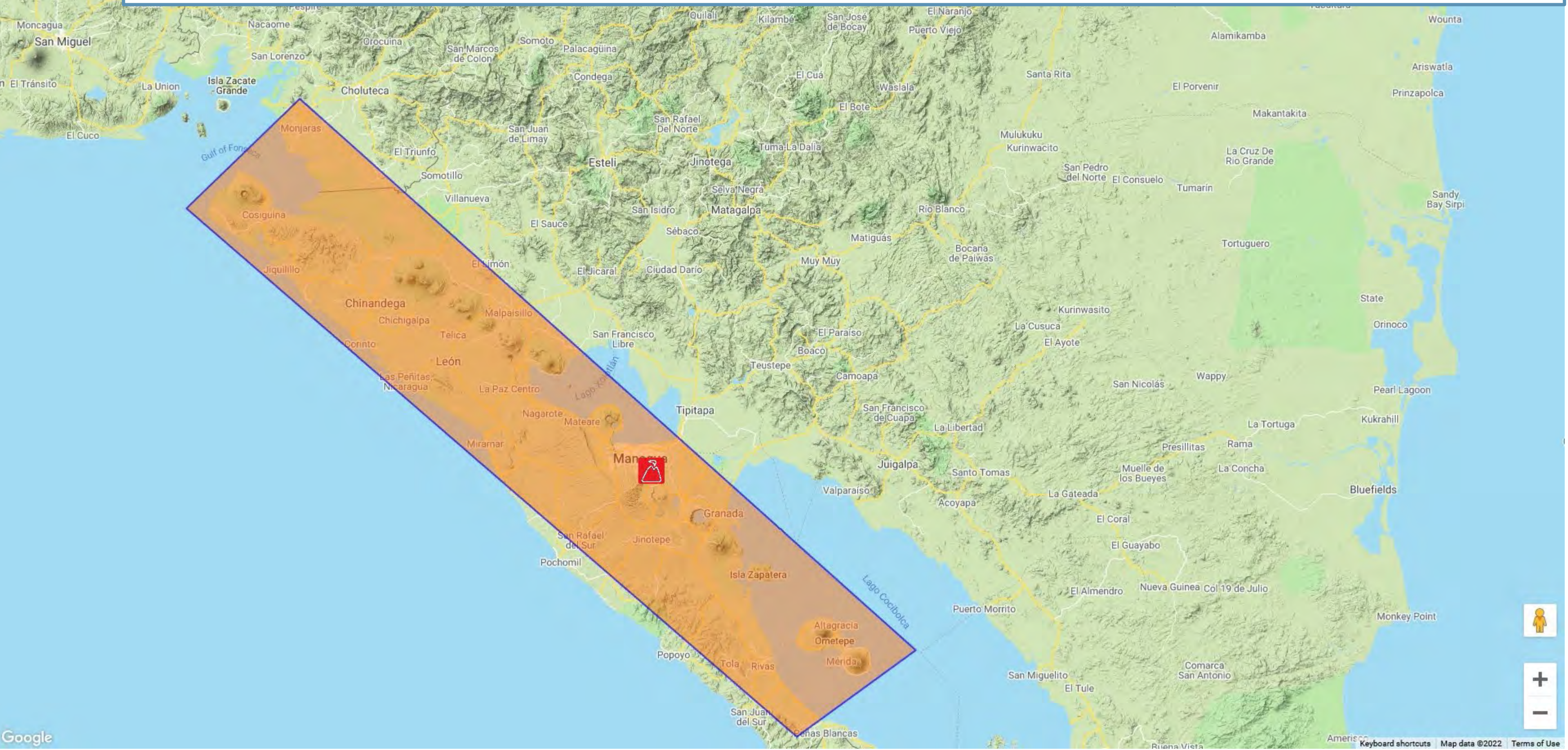
Geohazard Supersites and Natural Laboratories

The Nicaragua Supersite

Iris Cruz
Instituto Nicaragüense de Estudios Territoriales (INETER)
https://geo-gsnl.org/supersites/permanent-supersites/nicaragua-supersite/

Supersite description

The primary objective of the Nicaragua Supersite is to provide insights into the volcano-tectonic Geohazard Interaction within the Nicaraguan Depression, where ~70% of the total Nicaraguan population resides



Supersite data

The satellite data which are provided open access by the CEOS are:

- COSMO-Skymed (Agenzia Spaziale Italiana (ASI))
- Pleiades: 4000 km^2 per year (Centre National d'Etudes Spatiales (CNES)
- TerraSAR-X (Deutsches Zentrum für Luft- und Raumfahrt (DLR))

The in situ data which are provided open access by the Coordinating institute and by the scientific community are:

- Data from the main seismic stations
- SO2 data from the volcanoes Masaya, San Cristóbal, Telica, Momotombo, Concepción
- Multigas data from the Masaya volcano station while it was in operation
- Data from the main GPS stations
- Webcam data

Supersite science

The Nicaragua Supersite has just been established and scientific results are not yet available.

In the near future we will share scientific results with the scientific communities and decision makers

Supersite benefits

We are going to have several important benefits from the Supersite, like the following ones:

- We are going to develope new skills to work with the data provided by the Supersite
- We are going to add a new data type different from what we already have, so expanding the diversitty of our data availability, which in turns will provide to us an independent source of information to our Geohazard research program
- We are going to improve the scientific support to local users
- The Supersite data will foster our collaboration with national and international research institutions, which will enhance our access to research funding in many different ways