

Assembling a Global Volcano Seismometer Database

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Motivation:

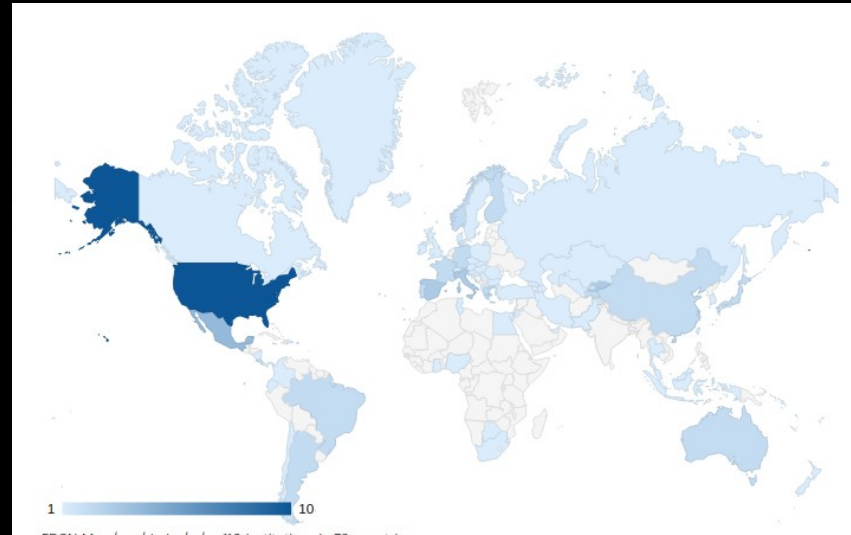
- How many volcanoes worldwide are seismically monitored?
 - Is a particular volcano seismically monitored?

Introduction: FDSN (www.fdsn.org)

- International Federation of Digital Seismograph Networks
- FDSN Web Services define standards for providing seismic and related data over the web.
- The FDSN data center registry contains a listing of data centers, which services are offered, and optionally which data sets are available from each.
- Assignment and curation of unique network codes (+ citable DOIs!)

Members:

- 110 institutions in 78 countries
- Open to all groups that operate more than one broadband station
- No charge for membership



Introduction: FDSN (www.fdsn.org)



International Federation of Digital Seismograph Networks


Home / Networks / 6D (2009-2016): Telica Seismic and Deformation Network

Sign in

6D (2009-2016): Telica Seismic and Deformation Network

FDSN Network Information

Are you the operator of this network? [Update this information.](#)

FDSN code	6D (2009-2016)	Network name	Telica Seismic and Deformation Network (TESAND)
Start year	2009	Operated by	Carnegie Institute of Washington / Science (DTM CIW) ROR::
End year	2016	Deployment region	
Description	In 2009 we deployed a temporary network of six BB seismometers and a pressure sensor around Telica Volcano, Nicaragua, to record and characterize background long period seismicity which occurs at a rate of 100sof events per day, and to compare background seismicity to pre eruptive seismicity		

Citation Information

Digital Object Identifier (DOI)	https://doi.org/10.7914/SN/6D_2009
Citation	. Roman, & DC. (2009). <i>Telica Seismic and Deformation Network</i> [Data set]. International Federation of Digital Seismograph Networks. https://doi.org/10.7914/SN/6D_2009 For more: DataCite (JSON XML BibTeX)

Data Access

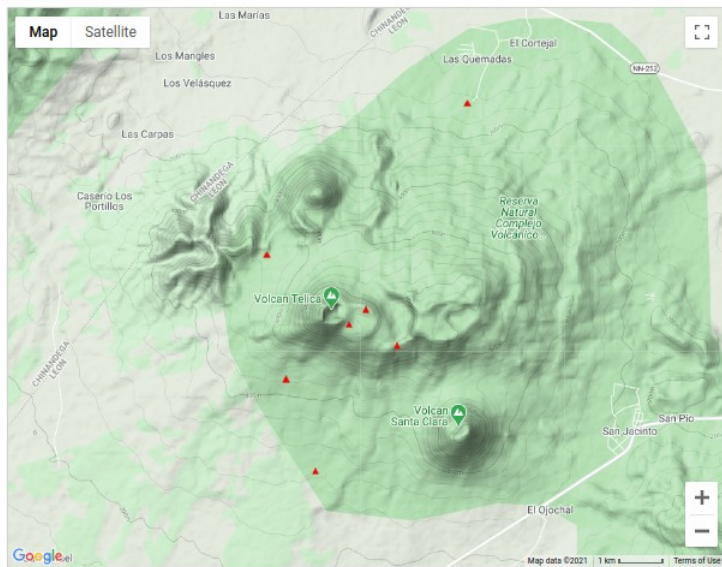
Data Availability	<p>Data available from: The IRIS Data Management Center (IRISDMC) : http://service.iris.edu/fdsnws/dataselect/1/</p> <p>FDSN Web Services provide a common data access API for seismic data.</p> <p>Availability based on irisws-fedcatalog service. Full fedcatalog information for this network</p>
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Stations in this Network

Las Marias

Introduction: FDSN (www.fdsn.org)

Stations in this Network



Station Code	Station Name	Latitude	Longitude	Data Center(s)
TBCA	TBCA	12.5725	-86.845596	IRISDMC
TBCF	TBCF	12.6031	-86.838303	IRISDMC
TBHS	TBHS	12.6177	-86.856102	IRISDMC
TBHY	TBHY	12.5988	-86.828102	IRISDMC
TBMR	TBMR	12.5918	-86.851898	IRISDMC
TBPV	TBPV	12.6493	-86.812897	IRISDMC
TBTN	TBTN	12.6064	-86.834801	IRISDMC



Introduction: FDSN

(www.fdsn.org)

- Data centers (e.g. IRIS, GEOFON, RECIF) collect and/or distribute broadband seismic data.
- Some centers distribute data directly to the user while others distribute data via other data centers.

Name	Full Name	Website
BGR	BGR Data Centre	https://www.bgr.bund.de
ETH	ETH Data Centre	https://www.ethz.ch
GEOFON	GEOFON Program	https://geofon.gfz-potsdam.de/
ICGC	ICGC Data Centre	https://www.icgc.cat/en/terratremols
IESDMC	Institute of Earth Sciences, Academia Sinica, Taiwan	http://batsws.earth.sinica.edu.tw/fdsnws/
INGV	INGV Seismology data centre - Italian EIDA node	http://www.ingv.it
IPGP	IPGP Data Center	http://datacenter.ipgp.fr
IRISDMC	IRIS Data Management Center	https://ds.iris.edu/
KOERI	KOERI Data Centre	http://www.koeri.boun.edu.tr
LMU	LMU Data Centre	https://www.uni-muenchen.de/
NCEDC	Northern California Earthquake Data Center	https://ncedc.org
NIEP	NIEP Data Centre	http://www.infp.ro/en/
NOA	National Observatory of Athens	http://bbnet.gein.noa.gr/
ODC	ORFEUS Data Centre	https://www.orfeus-eu.org/
RASPIshake	Raspberry Shake Seismic Network	http://raspberrysshake.org/
RESIF	RESIF Data Centre	https://www.resif.fr
SCEDC	Southern California Earthquake Data Center	https://scedc.caltech.edu
UIB-NORSAR	UIB-NORSAR EIDA node	http://eida.geo.uib.no

Tying the FDSN stations to the GVP Database

Recent addition to GVP External Sites to query seismic stations around a volcano (thanks to Ed Venzke, Smithsonian Institution!)

Smithsonian Institution
National Museum of Natural History
Global Volcanism Program

Weekly Report 20th Anniversary

Home Reports Database Galleries Resources Info & Contacts

Telica

Country	Nicaragua
Volcanic Region	Mexico and Central America
Primary Volcano Type	Stratovolcano(es)
Last Known Eruption	2020 CE
Latitude	12.606°N
Longitude	86.84°W
Summit Elevation	1036 m 3399 ft
Volcano Number	344040

Google Earth Placemark with Features Cite Volcano Profile

Latest Activity Reports Weekly Reports Bulletin Reports Synonyms & Subfeatures General Information

Eruptive History Deformation History Emission History Photo Gallery Map Holdings Sample Collection External Sites

Tying the FDSN stations to the GVP Database

Recent addition to GVP External Sites to query seismic stations around a volcano (thanks to Ed Venzke, Smithsonian Institution!)

[MODVOLC Thermal Alerts](#)

Using infrared satellite Moderate Resolution Imaging Spectroradiometer (MODIS) data, scientists at the Hawai'i Institute of Geophysics and Planetology, University of Hawai'i, developed an automated system called MODVOLC to map thermal hot-spots in near real time. For each MODIS image, the algorithm automatically scans each 1 km pixel within it to check for high-temperature hot-spots. When one is found the date, time, location, and intensity are recorded. MODIS looks at every square km of the Earth every 48 hours, once during the day and once during the night, and the presence of two MODIS sensors in space allows at least four hot-spot observations every two days. Each day updated global maps are compiled to display the locations of all hot spots detected in the previous 24 hours. There is a drop-down list with volcano names which allow users to 'zoom-in' and examine the distribution of hot-spots at a variety of spatial scales.

[Sentinel Hub Playground](#)

The [Sentinel Hub Playground](#) provides a quick look at any Sentinel-2 image in any combination of the bands and enhanced with image effects; Landsat 8, DEM and MODIS are also available. Sentinel Hub is an engine for processing of petabytes of satellite data. It is opening the doors for machine learning and helping hundreds of application developers worldwide. It makes Sentinel, Landsat, and other Earth observation imagery easily accessible for browsing, visualization and analysis. [Sentinel Hub](#) is operated by [Sinergise](#)

[Sentinel Hub EO Browser](#)

[IRIS seismic stations/networks](#)

[Incorporated Research Institutions for Seismology \(IRIS\)](#) Data Services map showing the location of seismic stations from all available networks (permanent or temporary) within a radius of 0.18° (about 20 km at mid-latitudes) from the given location of Telica. Users can customize a variety of filters and options in the left panel. Note that if there are no stations are known the map will default to show the entire world with a "No data matched request" error notice.

[UNAVCO GPS/IGNSS stations](#)

Geodetic Data Services map from [UNAVCO](#) showing the location of GPS/GNSS stations from all available networks (permanent or temporary) within a radius of 20 km from the given location of Telica. Users can customize the data search based on station or network names, location, and time window. Requires Adobe Flash Player.

[DECADE Data](#)

The [DECADE portal](#), still in the developmental stage, serves as an example of the proposed interoperability between The Smithsonian Institution's Global Volcanism Program, the Mapping Gas Emissions (MaGa) Database, and the EarthChem Geochemical Portal. The [Deep Earth Carbon Degassing \(DECADE\)](#) initiative seeks to use new and established technologies to determine accurate global fluxes of volcanic CO₂ to the atmosphere, but installing CO₂ monitoring networks on 20 of the world's 150 most actively degassing volcanoes. The group uses related laboratory-based studies (direct gas sampling and analysis, melt inclusions) to provide new data for direct degassing of deep earth carbon to the atmosphere.

[WQVOdat](#)

WQVOdat is a database of volcanic unrest instrumentally and visually recorded changes in seismicity around



Tying the FDSN stations to the GVP Database

Recent addition to GVP External Sites to query seismic stations around a volcano (thanks to Ed Venzke, Smithsonian Institution!)

The screenshot displays the IRIS web interface for querying seismic stations. On the left, there are search filters for Network, Station, Location, Channel, Start Time, and End Time. Below these are geographic boundary options: All Locations, Location Box, Location Radius (selected), Latitude (12.606), Longitude (-86.840), Min Radius, and Max Radius (.18). A 'Draw Boundary' button is at the bottom of the filter panel. The main area shows a map of the Chinandega region in Guatemala, with a purple circular boundary centered on a volcano. The map includes labels for various towns and roads. At the bottom, a table lists the stations within the boundary.

Network	Station	Latitude	Longitude	Start Date	End Date
6D	TBCA	12.5725	-86.845596	2010-03-16	2016-12-31
6D	TBCF	12.6031	-86.838303	2010-06-26	2016-12-31
6D	TBHS	12.6177	-86.856102	2010-03-06	2016-12-31
6D	TBHY	12.5988	-86.828102	2010-03-06	2016-12-31
6D	TBMR	12.5918	-86.851898	2010-03-06	2016-12-31
6D	TBPV	12.6493	-86.812897	2010-03-06	2010-06-22
6D	TBTN	12.6064	-86.834801	2009-11-24	2016-12-31

How many volcanoes worldwide are seismically monitored?

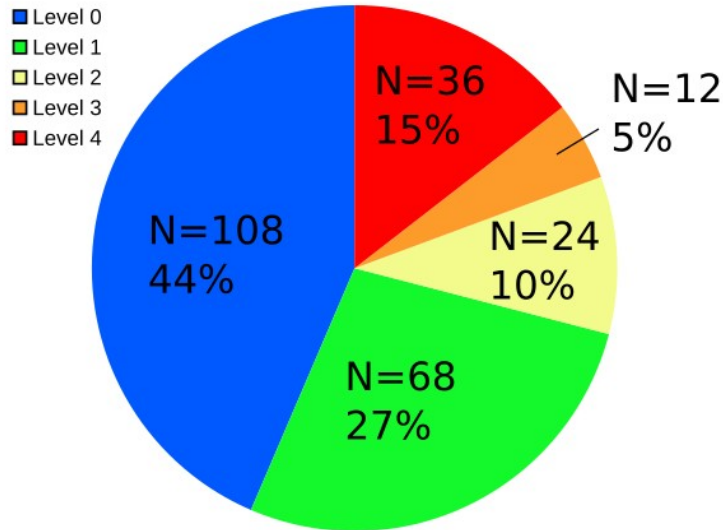
- Premise: Seismically-monitored volcanoes tend to have had recent activity or are deemed particularly hazardous (e.g., Rainier)
- From GVP Holocene database – list of volcanoes worldwide with eruptions since 1980 (**N=248**)
- Cross-referenced GVP latitudes/longitudes with FDSN Station Book (**N=108,771**, includes temporary/nodal instruments) to calculate
- all seismometer-volcano distances = **11,116** stations within 100 km of a recently active volcano

<u>Volcs with # stns within:</u>	100 km	50km	20 km	5 km
0	46	75	119	175
1	17	30	33	21
2	7	18	13	9
3	10	6	5	7
4	10	12	5	4
5	12	9	8	4
6	9	9	5	4
7	5	2	6	0
8	6	4	7	1
9	2	4	2	1
10	1	5	1	0
11+	123	74	44	22

How many volcanoes worldwide are seismically monitored?

Table 1. Instrumentation to be installed and routine baseline information to be collected at level 1-4 volcano-monitoring networks.

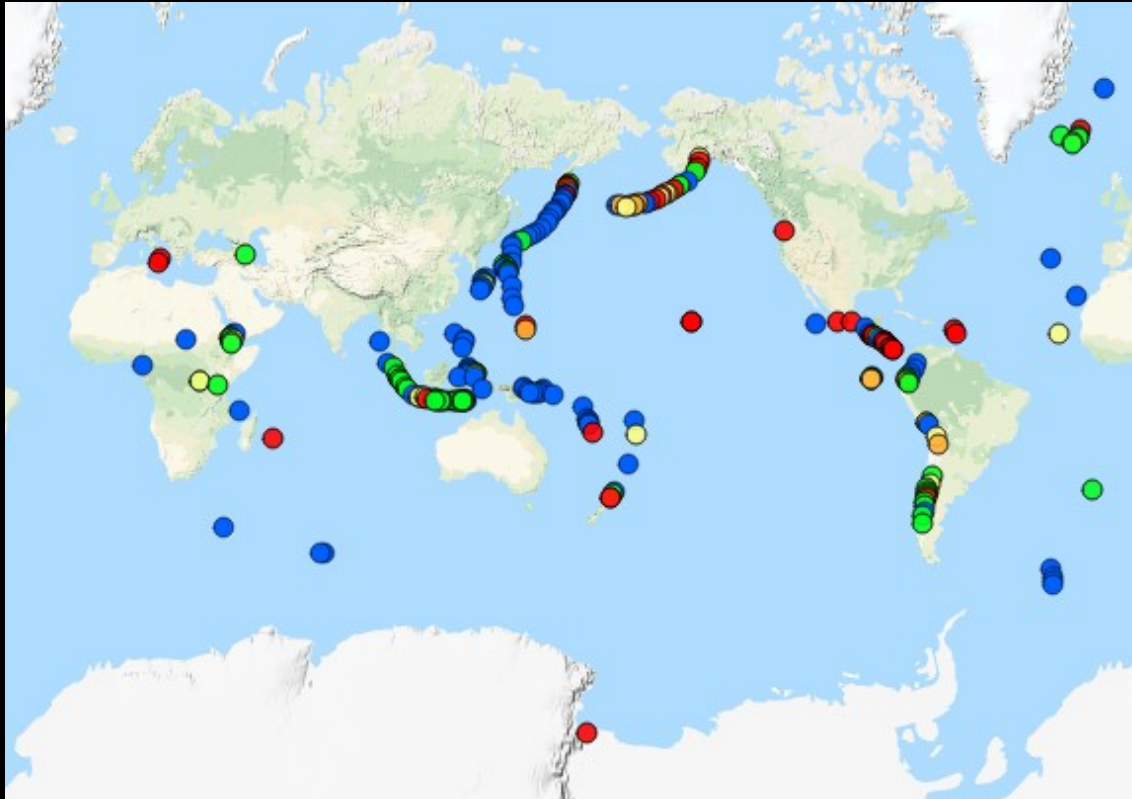
Monitoring Level:	1	2	3	4
Seismic	Five seismic stations located within 200 km, including two located within 50 km.	Five seismic stations located within 50 km, including two located within 10 km.	Six to eight seismic stations located within 20 km, including two or three located within 5 km; at least one broadband station located within 5 km.	12-20 seismic stations located within 20 km, including at least two or three located within 5 km, and at least six broadband stations (at least two located within 5 km). Collocated with these stations should be at least one strong-motion station within 5 km, and at least two infrasonic stations with two 2 sensors per station.



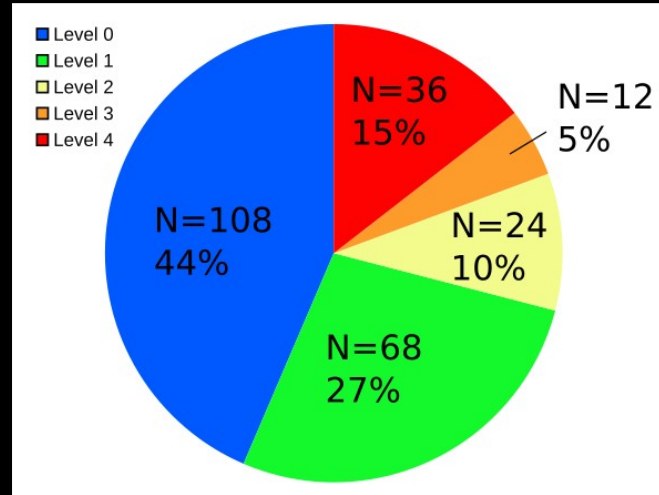
Moran, SC et al. (2008) "Instrumentation recommendations for volcano monitoring at US volcanoes under the National Volcano Early Warning System." US Geological Survey Scientific Investigations Report 5114: 47.

How many volcanoes worldwide are seismically monitored?

Seismically instrumentation levels at volcanoes worldwide



Map plot of instrumentation level highlights FDSN incompleteness/ possible regional biases in FDSN



Takeaway Points

- Developing a global database of seismometers on volcanoes is challenging (!)
- FDSN is a logical/robust platform, though currently incomplete and no mechanism for listing stations manually
- Provides a good model for other instrument databases (DOIs, network codes, metadata standards and standardized tools)
- Critical to support observatories to maintain network information in FDSN, and to access related tools
- Spreadsheets/databases underlying this effort available on request (please email me – droman@carnegiescience.edu)

Why register your network with FDSN?

- Discoverability → Collaboration opportunities!
- Credit – Citations for your network!

Why send your continuous data to an FDSN Data Center?

- Professional/managed archiving → Data preservation
- Access through FDSN web services/many other useful tools

Thank you!