Description of dataset “Villarrica Tomography (VITO)”

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Abstract
The Villarrica Volcano is one of the most active volcanoes in South America and is located in a major tourism region. A dense temporal seismological network was installed to investigate the volcanic seismicity and the seismic structure of the edifice with seismic traveltime tomography at high spatial resolution. The network was in operation for 2 weeks from 01.03.2012 to 14.03.2012. It consisted of 30 three-component and 45 one-component short period seismographs covering an area of about 2000 km$^{2.}$ The covered area has a diameter of 45 km and includes the volcanic building.

Coordinates: 39.42°S, 71.73°W
Keywords: Volcano seismology, seismic tomography, seismotectonics

1. Introduction

The Villarrica volcano is one of the most active volcanoes in South America. It is located in a major tourism region. A lava lake can be seen in the crater and the magma level is changing all the time. Continuous gas emission is observed from the crater, showing the unrest of the volcano.

The main objective of the seismic measurements was to provide a database for studying volcanic seismicity and the seismic structure of the volcanic edifice:

- Investigation of the type, frequency content and temporal change of volcanic seismicity,
- Investigation of the relation between seismic emission and gas emissions.
- Determination of the source location of volcano-seismic emissions, and
- Determination of the seismic structure of the edifice by seismic traveltime tomography.

Based on this data set Lehr et al. (2019) provide an analysis of the low-frequency seismicity of Villarrica volcano and depth functions of shear wave velocity. Tomographic images of the interior of the volcanic edifice can be found in Mora Stock (2015).

2. Data Acquisition

2.1 Experiment design & schedule

The temporary seismic network consisted of 75 mobile seismic stations. 45 seismic stations were placed directly in the area of the volcano, and the others in the surrounding of the volcano (see Figure 1). There are also 3 little subarrays (AVW, ACV and ALN) placed west, north and east of the crater. Each subarray consisted of 5 seismic stations.

Deployment of the seismic stations was done between 29.02. and 05.03.2012 and the deinstallation lasted from 11.05. to 15.03.2012. Most stations on the volcanic body were recording between 03.03. and 12.03.2012 (see Figure 2).

2.2 Geometry/Location

A general map of the location of all stations of the VITO temporal network is shown in Figure 1 (top). The middle and bottom panels of Figure 1 show detail maps for subarrays and the crater area. The subarrays were set up to enable local beamforming. Table 1 provides the station coordinates, recorder number and number of components. Figure 2 shows the recording time periods period for all stations.

2.3 Instrumentation

The deployed seismic sensors were one-component and three-component (PE-6/B) geophones with a natural frequency of 4.5 Hz, manufactured by SENSOR Nederland. They are coupled to the ground by steel spikes.

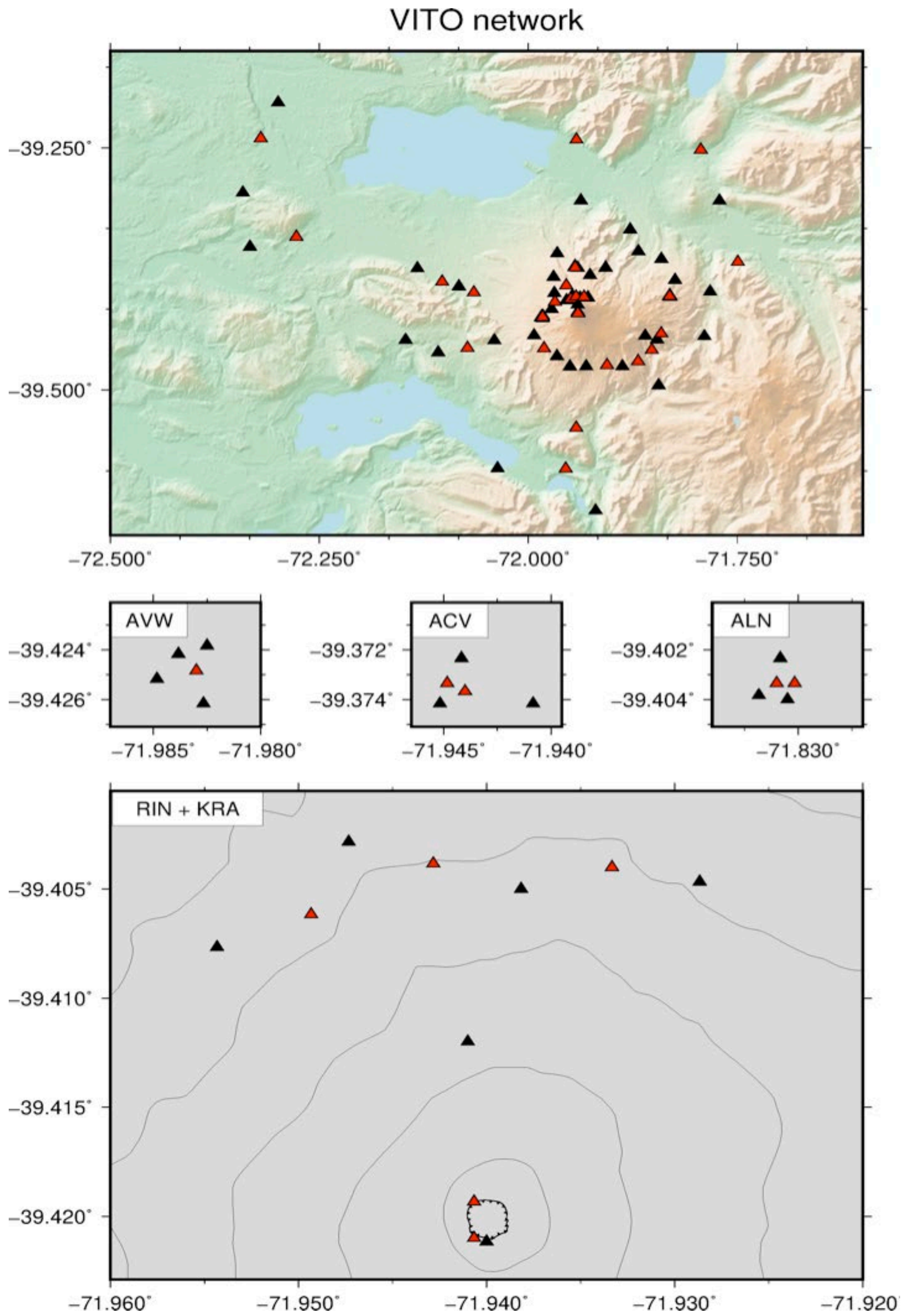

Figure 1: Location map of the VITO temporary seismic network at Villarrica volcano. Top: whole station network; middle: detail maps of subarray with short sensor spacing; bottom: detail map of stations near the crater.

The data loggers were one-component DSS-CUBE (manufactured by Omnirecs) and three-component DATA-CUBE (manufactured by DIGOS/Omnirecs; www.digos.eu). Most of the recorders were powered by 2 mono-cells (Type D) in the internal battery bay. The stations above the snow level were powered by 8 mono-cells (Type D) in an external battery bay.

2.4 Acquisition parameters

All stations were configured in a similar way, only the gains between 1-C and 3-C recorders differ:

- Sampling rate: 100 Hz,
- Gain 10 for 1-component DSS CUBES, and gain 16 for 3-component DATA-CUBE

3. Data Processing

Raw data were converted from the CUBE-internal format to MSEED (FDSN, 2012) including time correction.

4. Data Description

4.1 File format (s)

The data provided are in original cube format and (converted) MSEED format.

4.2 Data content and structure:

Raw data: Each station has its own subfolder in folder */raw n*amed after the number/ID of the datalogger.
MSEED data: The MSEED data of all stations is stored in one-hour files (all stations; one file per hour) in folder */mseed*. The MSEED header contains the station code (see Table 1). Channel codes are BH?.

Table 1: Station list showing the name, recorder number (#(cube)), WGS84 coordinates and number of recorded sensor components (#(comp)) for each station.

Station name	#(Cube)	Longitude (°)	Latitude (°)	Elevation (m)	#(comp)
ACV1	c0004	-71.945167	-39.374167	1111	1
ACV2	c0005	-71.940833	-39.374167	1138	1
ACV3	c0726	-71.944833	-39.373333	1103	3
ACV4	c0727	-71.944000	-39.373667	1115	3
ACV5	c0001	-71.944167	-39.372333	1098	1
ALN1	c0015	-71.830833	-39.402333	1385	1
ALN2	c0725	-71.830167	-39.403333	1419	3
ALN3	c0735	-71.831000	-39.403333	1414	3
ALN4	c0031	-71.831833	-39.403833	1417	1
ALN5	c0012	-71.830500	-39.404000	1428	1
AVW1	c0023	-71.982500	-39.423833	1409	1
AVW2	c0022	-71.983833	-39.424167	1391	1
AVW3	c0738	-71.983000	-39.424833	1399	3
AVW4	c0026	-71.984833	-39.425167	1372	1
AVW5	c0018	-71.982667	-39.426167	1398	1
CIR1	c0034	-71.937167	-39.304667	309	1
CIR2	c0750	-71.942500	-39.241667	350	3
CIR3	c0745	-71.793667	-39.252000	412	3
CIR4	c0017	-71.771333	-39.304833	451	1
CIR5	c0743	-71.749333	-39.368000	563	3
CIR6	c0041	-71.782500	-39.398667	701	1
CIR7	c0033	-71.789333	-39.444833	869	1
CIR8	c0038	-71.844167	-39.495333	1047	1
KRA1	c0734	-71.940667	-39.419333	2792	3
KRA2	c0733	-71.940667	-39.421000	2828	3
KRA3	c0020	-71.940000	-39.421167	2836	1
KRA4	c0025	-71.941000	-39.412000	2375	1
PRN1	c0021	-72.132667	-39.374667	392	1
PRN2	c0730	-72.103167	-39.388333	469	3
PRN3	c0029	-72.083000	-39.393333	557	1
PRN4	c0731	-72.065167	-39.399500	635	3
PRS1	c0019	-72.146833	-39.448667	420	1
PRS2	c0028	-72.107833	-39.461500	414	1
PRS3	c0732	-72.072833	-39.456833	590	3

Station name	#(Cube)	Longitude (°)	Latitude (°)	Elevation (m)	#(comp)
PRS4	c0024	-72.040667	-39.449167	791	1
RIN1	c0008	-71.954333	-39.407667	1850	1
RIN2	c0729	-71.949333	-39.406167	1938	3
RIN3	c0009	-71.947333	-39.402833	1856	1
RIN4	c0740	-71.942833	-39.403833	1944	3
RIN5	c0007	-71.938167	-39.405000	2047	1
RIN6	c0739	-71.933333	-39.404000	1996	3
RIN7	c0002	-71.928667	-39.404667	1894	1
SUR1	c0728	-71.942667	-39.539000	616	3
SUR2	c0747	-71.955333	-39.581167	276	3
SUR3	c0045	-72.036833	-39.580833	204	1
SUR4	c0047	-71.919500	-39.624333	486	1
VS01	c0030	-71.968833	-39.400167	1403	1
VS02	c0737	-71.968167	-39.409167	1556	3
VS03	c0027	-71.972167	-39.416667	1571	1
VS04	c0043	-71.993167	-39.443833	1256	1
VS05	c0742	-71.981167	-39.457167	1391	3
VS06	c0046	-71.965667	-39.465333	1488	1
VS07	c0752	-71.950167	-39.476000	1432	1
VS08	c0014	-71.930833	-39.475833	1494	1
VS09	c0751	-71.905833	-39.474500	1514	3
VS10	c0042	-71.887500	-39.475833	1481	1
VS11	c0753	-71.868667	-39.470500	1505	3
VS12	c0749	-71.852333	-39.459000	1316	3
VS13	c0040	-71.860167	-39.444333	1564	1
VS14	c0036	-71.846000	-39.448167	1504	1
VS15	c0741	-71.841000	-39.441833	1483	3
VS16	c0013	-71.824500	-39.386667	1146	1
VS17	c0744	-71.840833	-39.365000	828	1
VS18	c0035	-71.868333	-39.357000	662	1
VS19	c0039	-71.907500	-39.374000	979	1
VS20	c0044	-71.926167	-39.381667	1348	1
VS21	c0736	-71.954667	-39.392167	1470	3
VS22	c0032	-71.969833	-39.383500	1259	1
VS23	c0006	-71.965500	-39.359167	857	1
VS24	c0754	-71.878167	-39.334500	509	1
WES1	c0016	-72.299333	-39.203333	238	1
WES2	c0746	-72.320000	-39.240167	264	3
WES3	c0037	-72.341500	-39.296500	314	1
WES4	c0748	-72.277500	-39.342000	336	3
WES5	c0010	-72.333000	-39.352500	300	1

5. Data Quality/Accuracy

The GPS clock was checked and adjusted every 30 min. The raw data itself may have a temporal drift, which was corrected during the conversion to MSEED. Horizontal orientation of the 3-C geophones is unknown.

The data of the stations on the volcano edifice are dominated by a permanent ground-roll consisting of emergent low-frequency (LF) events originating near the crater (Lehr et al., 2019). This LF sesimicity is variable in amplitude over time and shows occasional bursts. From this volcanic background volcano-tectonic (VT) events stick out, several of them recorded with a good signal-to-noise-ratio allowing to pick accurate arrival times.

Some regional seismic events were recorded originating at epicentral distances of up to 300 km. In general, their P-wave onsets are weak due to the radiation patterns of the earthquakes. A deep M6.2 earthquake was recorded that took place in North Argentina on 05 March 2012 at 07:46 in a depth of about 550 km (International Seismological Centre, 2019). The waveform of this event is the largest amplitude signal observed during the recording period.

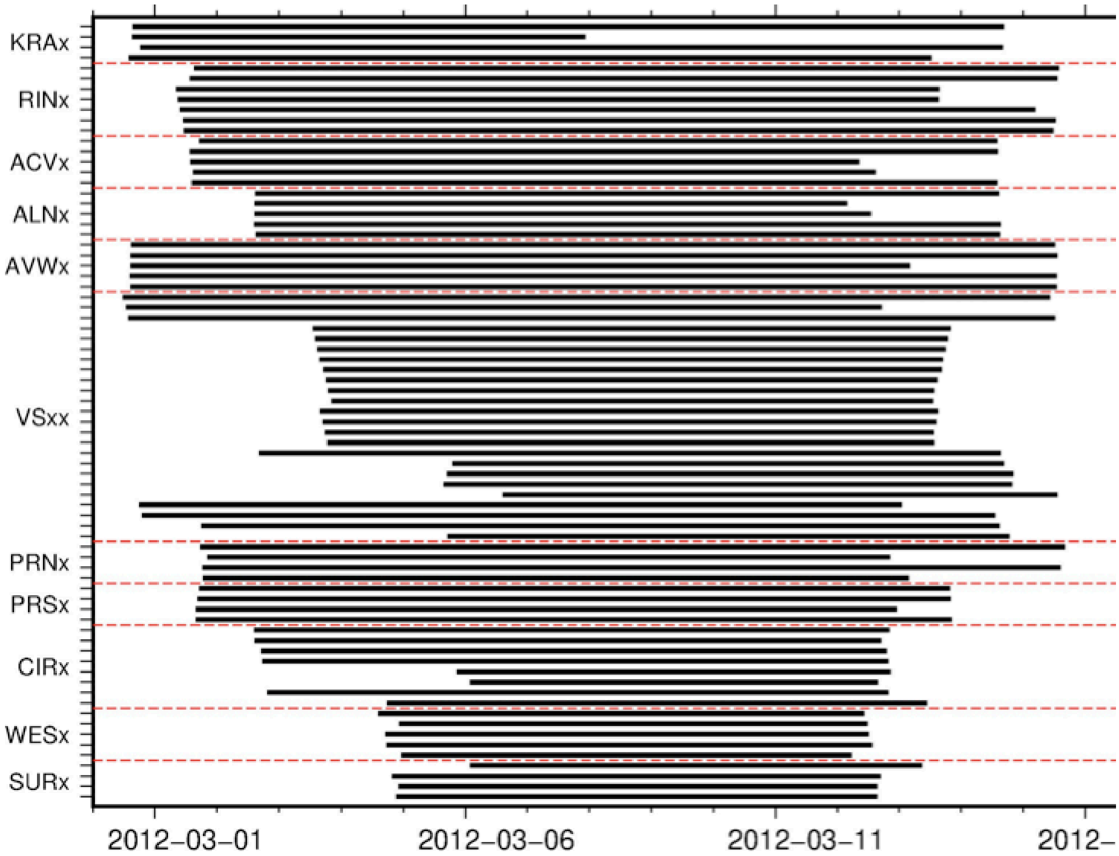

Figure 2: Recording time periods of the stations of the VITO temporary seismic network at Villarrica volcano.

6. DataAvailability/Access

The data recorded by the VITO network is archived in the GIPP Experiment and Data Archive (https://gipp.gfz-potsdam.de; see also Haberland and Ritter, 2016) where it is freely available for further use after 03.2012 under a CC-BY 4.0 license. When using the data, please give reference to this data publication. Recommended citation for this publication is:

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