

**about us**

SISMIKO is the operational task force at the Istituto Nazionale di Geofisica e Vulcanologia (INGV) aiming at the rapid deployment of temporary seismic stations in the area hit by a significant earthquake or a seismic sequence causing concerns and interest with impact on people.

Decreasing the average distance between the seismic stations improves network detection, accuracy of the earthquake locations, shakemaps and strong motion parameters.

SISMIKO coordinates all INGV groups working on seismic emergencies and involves INGV technicians and researchers from all over Italy, from Milano to Catania, grouped together by common interest technical and scientific issues (Figures 1 and 2).

**what&how: rapid deployments, integration into the monitoring system and datasets**

Since 2008, 16 temporary networks have been installed in the event of seismic emergencies (Figure 3 and in the adjacent tables). The most important were the emergencies of 2009 (Aquila, No. 15 in Figure 3), 2012 (Po Plain, No. 10) and 2016 (Central Italy, No. 6) during which more than 20 temporary stations were installed. Today, all the data acquired are transmitted and collected in real-time in the Rome INGV office. A dedicated acquisition system named "SISMIKA", has been developed (D'Alena E. et al., 2022, DOI:10.13267). SISMIKA is also used to make data readily available to the INGV seismic surveillance system in Rome and to the scientific community, the latter through the Italy node of the EIDA.



Figure 3 - Map of INGV rapid deployments since 2008. On this map and in the table, we distinguished the emergencies managed by the SISMIKO group, formally established in 2005.

References all articles, conference papers and data sets  
<http://sismi.ingv.it/publicazioni>

Emergency No.	Year	Location	Number of stations	Operator
1	2008	Emilia Romagna	10	INGV
2	2008	Emilia Romagna	10	INGV
3	2008	Emilia Romagna	10	INGV
4	2008	Emilia Romagna	10	INGV
5	2008	Emilia Romagna	10	INGV
6	2008	Emilia Romagna	10	INGV
7	2008	Emilia Romagna	10	INGV
8	2008	Emilia Romagna	10	INGV
9	2008	Emilia Romagna	10	INGV
10	2012	Po Plain	10	INGV
11	2012	Po Plain	10	INGV
12	2012	Po Plain	10	INGV
13	2012	Po Plain	10	INGV
14	2012	Po Plain	10	INGV
15	2009	Aquila	15	INGV
16	2009	Aquila	15	INGV
17	2009	Aquila	15	INGV
18	2009	Aquila	15	INGV
19	2009	Aquila	15	INGV
20	2009	Aquila	15	INGV
21	2009	Aquila	15	INGV
22	2009	Aquila	15	INGV
23	2009	Aquila	15	INGV
24	2009	Aquila	15	INGV
25	2009	Aquila	15	INGV
26	2009	Aquila	15	INGV
27	2009	Aquila	15	INGV
28	2009	Aquila	15	INGV
29	2009	Aquila	15	INGV
30	2009	Aquila	15	INGV

Figure 1 - Map of the 13 INGV offices involved in SISMIKO. Offices with few units of personnel are associated with larger ones (see Genova and Azzoza with Pisa office; (Aquila with Ancona). Currently SISMIKO has 33 stations from 4 different dataloggers: 21 ATLAS-C Lantini, 8 Retik 150, 3 Centaur Nanometrics e 1 Galis INGV. The data loggers are 6-channel equipped with a short-period velocity sensor and accelerometer. Standardized instrument post is planned (all ATLAS-C Lantini).

On-call services at the Rome office: Mobile Seismic Network and T acquisition system.



Behind the operator, the high-gain antenna support is visible for the transmission of data in real-time that flows into the INGV national monitoring system.

The data acquired by SISMIKO are available, without any constraints, to the entire scientific community through the EIDA portal Italy node (Figure 4), which assures a high level of data quality.

Datasets are archived in near real-time in the "Standard for the Exchange of Earthquake Data (SEED)" format. The data are used for monitoring, surveillance and for scientific research.

A Digital Object Identifier (DOI) is associated with each acquired dataset which guarantees the unique identification of the data.

SISMIKO is working on the recovery of datasets acquired in the past: total recovery of the acquired data, quality control and above all assignment of a network code from IV (dedicated to the INGV National Seismic Network) to one dedicated to the temporary network.



Figure 4 - Web page of the EIDA Italia Portal showing the interactive map with the temporary emergency networks installed in 2023 in the Chianti Fiorentino area (Network 29) and in the Costa Marchigiana area (Network 16).

**system preconfiguration**

A national diffusion of the preconfigured seismic stations in different headquarters and a ready acquisition system, guarantee rapid response after an earthquake and allow the immediate acquisition of the data as soon as each seismic station is installed.

An international FDSN network code is registered in advance and a five char codification for the station code is applied to request the ISC station codes (T=emergency identifier+headquarter identifier).

**Network code:** SISMIKO asks FDSN in advance for a temporary code (valid for 5 years) in order to be able to pre-configure the stations in the INGV monitoring system.  
 ----- The next network code is: 30 (2022-2027)

**Station code:** SISMIKO assigns a predefined station code associated with a defined network code. SISMIKO has codified the acronym "TKXYZ" for its stations where: T is equivalent to temporary; XX is replaced by the emergency number; YV is replaced by the site number occupied by a temporary seismic station.  
 ----- The next station code is: T18

**SEED files:** before any emergency, the response information of the instrument in SEED format is preconfigured. This allows the quick use of the acquired data.  
 ----- In the last emergency, the data acquired by the VY17 stations were available in less than 24h from the beginning of the seismic sequence

**for more information**

Moretto M., Margheriti L., D'Alena E., Piccinini D. (2023). SISMIKO: INGV operational task force for rapid deployment of seismic network during earthquake emergencies. *Front. Earth Sci.* v.11:146579. DOI: 10.3389/feart.2023.1146579.

Latorre D. et al. (2023). What we can say (or not) about the seismic sequence of the November 5th, 2022, Mw 5.5, earthquake in the Marche offshore: an analysis of the Italian Seismic Bulletin on phase interpretation, velocity models and uncertainties of earthquake locations. *ENGTS - extended abstract*. <https://www.earth-prints.org/handle/2122/16494>

**emergency in the Costa Marchigiana area**



Figure 5 - Up: Map of the SISMIKO stations installed during the emergency in the Costa Marchigiana area (orange triangles). Down: Due to the particular characteristics of the acquisition geometry with respect to the sequence position offshore (i.e., average station-source distance of the closest station ~25 km and average azimuthal gap >= 200 grad), starting conditions for earthquake hypocenter location are not very favorable. Nevertheless, the installation along the coast of the 8 temporary stations from SISMIKO has allowed us to better constrain the hypocenter solution and reduce the location errors.

The last emergency (No. 1 in Fig. 3) in 2022 was caused by an earthquake of Mw 5.5 in the Costa Marchigiana area. In this occasion, SISMIKO has installed eight stations of the VI network the same day at the mainshock (Fig. 6; DOI: 10.13127/SD/TLKBA-3046). Let's analyze some aspects of SISMIKO's contribution to the sequence. Reviewed seismicity by INGV Seismic Surveillance Room and the BSI working group.

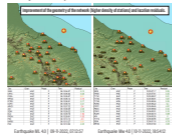
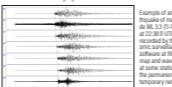


Figure 6 - Up: Earthquakes of comparable magnitude located by seismology on duty at INGV Seismic Surveillance Room, where the contribution of the SISMIKO stations is highlighted.



Example of an earthquake of magnitude ML 3.3 (11-1-2022 at 22:38:11 UTC) as recorded by the seismic surveillance software at INGV: map and waveforms at some stations of the permanent and temporary network.

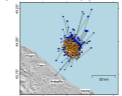


Figure 7 - To the right: Few hours after the Mw 5.5 mainshock, the Italian Seismic Bulletin (BSI, 'Bollettino Sismico Italiano') working group manually analyzed P and S phase arrival times and seismic amplitudes of earthquakes in order to better constrain hypocenter locations and magnitudes previously provided by the INGV Seismic Surveillance Room for rapid communication to the Italian Civil Protection. In the map, blue symbols are the hypocenter locations from the INGV Seismic Surveillance Room and orange symbols are the relocated events by the BSI working group. Symbols size is a function of the magnitude.

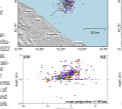


Figure 8 - Distribution of more than 500 seismic events from the INGV seismic surveillance catalog (a) and from the BSI revised catalog (b). Symbols and colors are proportional to the magnitude. Events in a range of +/- 10 km are projected on vertical cross sections (black line on the map), oriented perpendicular to the strike of the Mw 5.5 focal mechanism.

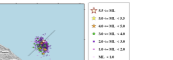


Figure 8 - Distribution of more than 500 seismic events from the INGV seismic surveillance catalog (a) and from the BSI revised catalog (b). Symbols and colors are proportional to the magnitude. Events in a range of +/- 10 km are projected on vertical cross sections (black line on the map), oriented perpendicular to the strike of the Mw 5.5 focal mechanism.