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Rome, 25th May 2023



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Editors: Giuseppe Di Stefano and Maria Grazia Ciaccio*

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Preface

On 25 May 2023, the Roma 1 Section of INGV organized the "Roma 1 Daily Poster Exhibition", an 'internal' meeting that had the aim of encouraging and facilitating the exchange of information, the mutual learning of the main scientific results, the multidisciplinary, or exchange of the ideas on which each of us is working, stimulate opportunities for collaboration between colleagues, between sections, getting to know each other, "being together".

A day dedicated to a scientific discussion between colleagues is an important event and should be considered a usual event within a research institution. We also believe that the "Roma 1 Daily Poster Exhibition" has taken on extraordinary value, especially in a slow recovery of ordinary working life following the closure of workplaces imposed by the lockdown.

In fact, during the pandemic, research certainly did not stop. The work of researchers and technologists has had, in this complex moment, an advantage: being traditionally based on the principle of autonomy, flexibility and on a form of subjective self-organization that has objectively trained them to experiment and implement with a certain elasticity, new ways of operating with a capacity for adaptation compared (in this specific phase) to such a drastic change in the working context.

Research has thus adapted, transformed and restructured. We must grasp the positive aspects of all this. Some communication and sharing technologies have become a fundamental work tool: meetings have become 'meets', virtual rooms have emerged, all while respecting rigorous physical distancing. But, although the benefits of conferences which have become standard practice in mixed mode are now also recognized, i.e., exploiting technology for science experienced in person and remotely, we wanted to try, for such a local event, to come back to meet again, to tell our experience, to enjoy direct dialogue, to recover, in a certain sense, human contact.

The Rome 1 Section presented an excellent response to the call, and 50 works were presented and divided into nine sessions (see the Program):

- Environmental Science, Georesources and Geochemistry.
- Databases and Infrastructures.
- Magnetism, Palaeomagnetism, Rock Physics and Geomaterials.
- Natural Hazards.
- Psychosocial Research and Risk Communication.
- Site Effects.
- Engineering Seismology and Seismology.
- Tectonics and Structural Geology.
- Scientific Outreach.

We present here 21 abstract representatives of the different sessions.

The day was worthwhile and achieved the objective of sharing activities and themes with a multidisciplinary and transversal approach: presenting the work of many people, making it known, creating collaborations and enhancing it, leaving our "rooms".

To conclude, we link here to a short video demonstrating how productive this day was and how beautiful it was.



Roma 1 Meeting 25 May 2023

Keywords Roma 1 - INGV; Daily Poster Exhibition; Geoscience Research; Databases and Infrastructures

Fault reactivation by fluid injection: insights from laboratory friction experiments with multiple reactivation sequences

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Several human activities involve the underground injection of fluids under pressure: disposal of wastewater, CO₂ storage, and production of geothermal energy. However, fluid injection and increase of pore pressure at depth can perturb the stress state, create new fractures, and reactivate nearby faults. When reactivated, faults might produce induced or triggered earthquakes eventually damaging and making the human use of georesources unsustainable. The increase of pore fluid pressure is known to promote fault reactivation by reducing the effective stress on the fault. However, the style of reactivation, whether seismic or aseismic, is not clearly constrained. By combining laboratory experiments and numerical simulations, the pore pressure increase was shown to produce aseismic slip at the fluid injection point. However, the stress changes related to pore pressure increase triggered seismic slip nearby [Cappa et al., 2019]. The ERC-SYG FEAR project aims at studying the physical processes underlying induced earthquakes by combining fluid stimulation in the Bedretto Underground Laboratory for Geosciences and Geoenergy (BULGG), numerical models and laboratory experiments.

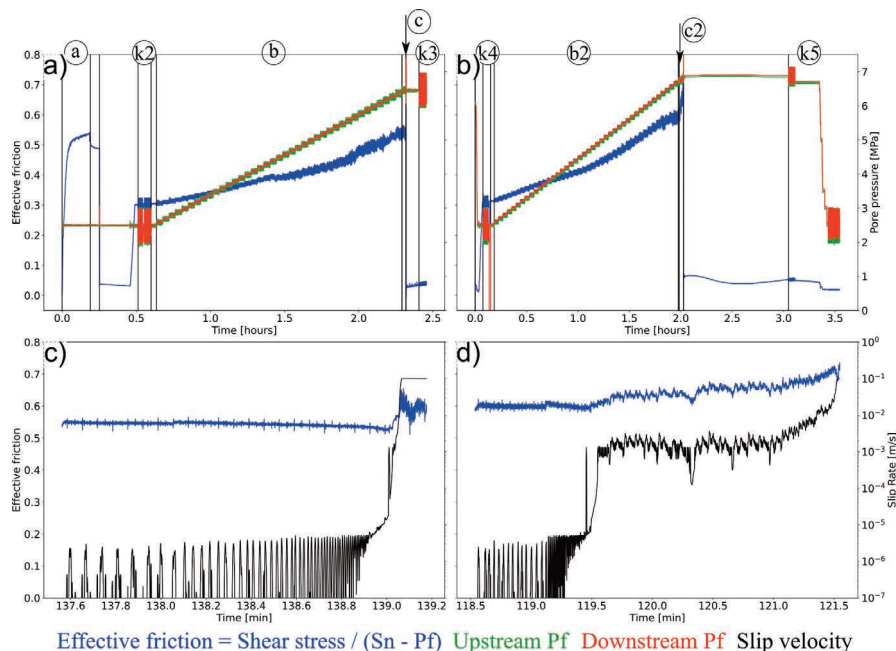


Figure 1 Experimental protocol of the fault reactivation by pore pressure increase. a) First and b) second reactivation cycles. (a) is a low velocity slip, (b) and (b2) are the fluid injection stages leading to fault reactivation (c) and (c2), intertwined with several measures of permeability by the pore fluid pressure oscillation method (k2), (k3), (k4), and (k5). Reactivation stage: starting from the last or second-to-last pore pressure increase step, the fault either evolves into: c) a dynamic instability (Pf=6.5 MPa), or d) into a slip oscillation stage (Pf=6.8 MPa) which is forced into a dynamic instability by one further step increase in pore pressure (Pf=6.9 MPa).

We run experiments under fluid pressurized conditions in a true triaxial machine [Collettini et al., 2014] and in a rotary shear machine [Di Toro et al., 2010] on a fault gouge sampled directly from the fault targeted for fluid stimulation in BULGG. We show that the fault gouge is a strong, velocity strengthening and therefore inherently stable material that can be effectively reactivated and de-stabilized by the action of pore fluid pressure increase [Volpe et al., 2023]. Moreover, we imposed two subsequent fluid stimulation and reactivation sequences on the same fault gouge using the rotary shear apparatus employing a novel experimental setup [Aretusini et al., 2021] (Figure 1). In the first reactivation slip accelerated up to a velocity $V=0.1$ m/s, whereas in the second slip accelerated and decelerated cyclically ($0.1 < V < 1$ mm/s) before accelerating up to $V=0.1$ m/s. The second reactivation occurred for a higher pore pressure (6.8-6.9 MPa) than the first reactivation (6.5 MPa), indicating an increase in fault strength. Meanwhile, fault-normal permeability decreased from ca. 10^{-16} m² to $3 \cdot 10^{-17}$ m² after one reactivation and then remained constant at $3 \cdot 10^{-17}$ m² before and after the second reactivation.

These results provide a first step toward the further understanding of the physical process controlling seismic fault reactivation by pore pressure increase. Here we suggest that complex slip histories during fault reactivation cycles induced by pore pressure increase result in an increase of frictional strength, fault dilatancy and frictional instability.

Keywords

Earthquake; Induced seismicity; Laboratory experiments; Pore pressure; Fault reactivation

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EPOS: a FAIR Research Infrastructure for data, data products, software and service integration in the solid Earth domain

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EPOS, a European-wide research infrastructure, allows users to access and use data, datasets, software, and services (DDSS) in the solid Earth domain provided by various Research Infrastructures across Europe. These facilities and services are offered in a FAIR (Findable, Accessible, Interoperable, and Reusable) manner, underscoring the endeavour to comply to European standards, principles and practices. The platform's architecture includes Thematic Core Services (TCS), which serve as international nodes integrating domain-specific DDSS from National Research Infrastructures. At its core is the Central Hub (ICS-C), a system designed for resource orchestration and metadata catalog management. The ICS-C operates on a microservices architecture, capable of distributed operation, technological flexibility, scalability, and enhanced reliability, supported further by Docker environments. A primary tool for data communication from Thematic Services to the Integrated Services are the WEB APIs, which employ RESTful services, making EPOS TCS machine-readable and actionable. The Metadata Catalogue, using the CERIF data model, is the key in managing and orchestrating all essential resources. On the periphery, the Distributed Services (ICS-D) are designed to add a virtual extension, encompassing additional computing facilities for diverse functionalities such as processing or visualization. The system acknowledges the heterogeneity of data types and sources, and hence significant efforts have been spent towards harmonizing data and metadata. The ultimate vision for EPOS is to be a one-stop, FAIR-compliant platform for diverse user types, demonstrated via its intuitive Graphical User Interface (GUI) available at the EPOS Data Portal (<https://www.ics-c.epos-eu.org/>).

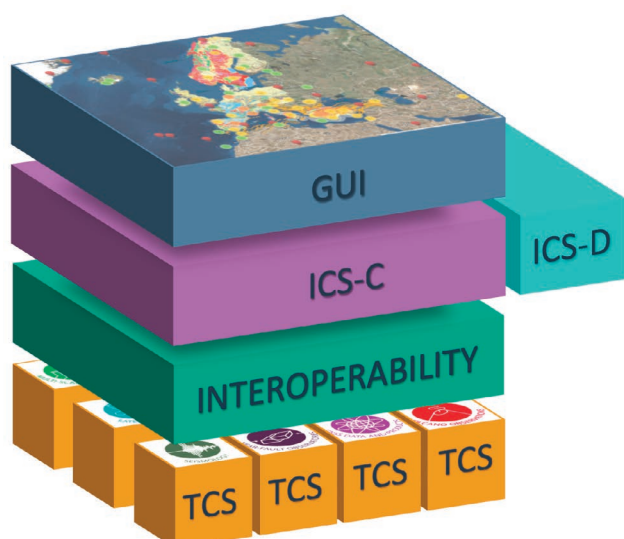


Figure 1 The EPOS technical architecture consists of four tiers, Thematic Core Services (TCS), Interoperability, Integrated Core Services (Central Hub and Distributed), Graphic User Interface (GUI).

Keywords

EPOS; Solid Earth Domain; FAIR; Research Infrastructure; Data Integration; Metadata Catalogue; Microservices; Thematic Core Services

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ST-Predict: Seismic response in downtown Rome from new strong motion observations and 1D to 3D seismic wave propagation modelling

Paola Bordoni¹, Fabrizio Cara¹, Rocco Cogliano¹, Giovanna Cultrera¹, Vera D'Amico¹, Giuseppe Di Giulio¹, Federica Di Michele¹, Daniela Famiani¹, Salomon Hailemichael¹, John Haines², Ilaria Leschiutta¹, Ivan Mammone³, Fabrizio Marra¹, Carlo Meletti¹, Alessia Mercuri¹, Giuliano Milana¹, Stefania Pucillo¹, Gaetano Riccio¹, Eliano Romani³, Carlo Rosa⁴, Matteo Ruggeri⁵, Riccardo Salvini⁶, Tiziana Sgroi¹, Daniele Silvestri⁶, Andrea Tertulliani¹, Maurizio Vassallo¹, Francesco Visini¹

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At the Roma 1 Daily Poster Exhibition held on the 25 May 2023 at the Via di Vigna Murata INGV Roma headquarter, we presented the ongoing activity of the Pianeta Dinamico 2023-2025 ST-Predict project entitled “Seismic response in downtown Rome from new strong motion observations and 1D to 3D seismic wave propagation modeling” proposed by Paola Bordoni and colleagues.

Figure 1 shows the study area, which includes some of the most famous archaeological sites in the world, Colosseum, Circus Maximo and Caracalla Bath, with an invaluable cultural heritage. In the same area, there is the T3 trace of the new metro line and a structural health monitoring network (SHM [Moretti et al., 2019]), managed by the engineering company Metro C S.p.A., which is excavating the new metro line. This seismic network recorded the main events of the 2016-2017 seismic sequence.

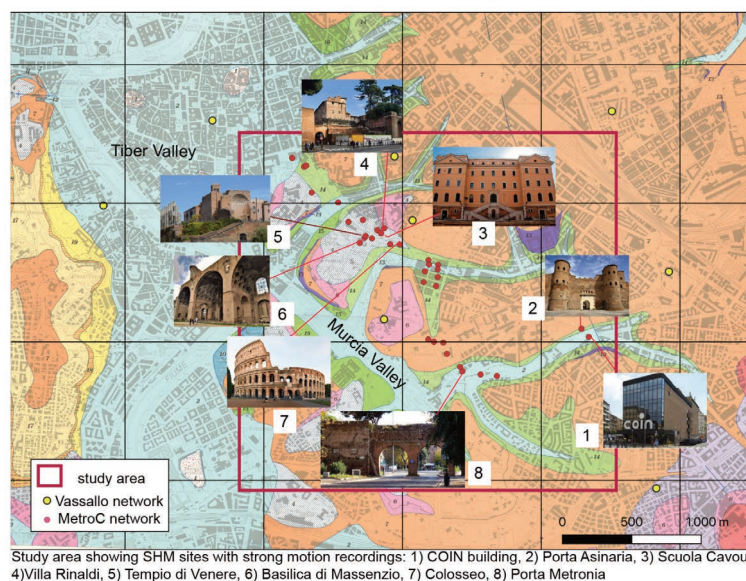


Figure 1 Study area showing the locations of the MetroC Structure Health Monitoring (SHM) network underlain by the geological map [Marra et al., 1995].

The idea is to constrain a 3D subsurface model using the geological and geotechnical dataset from the tube excavation, and to calibrate the subsurface soil parameters following a back-analysis of the 2016-17 earthquake recordings input to a 1-3D numerical simulation. Once calibrated, the model will be used to predict seismic shaking in areas of the city where records are lacking. In addition, we will use the hazard scenarios generated during the project to predict the shaking induced by a variety of seismogenic sources.

The subsurface model of the study area is constrained by the interpretation of a large dataset of borehole stratigraphies (more than 800 boreholes with an average depth of about 50-60m) organised in a GIS and will be validated by the drilling of three dedicated boreholes to collect original stratigraphic and geotechnical data in situ.

In addition, several geophysical experiments will be carried out, including: ambient vibration measurements in single station and array configuration, downhole measurements in the three wells drilled, a high-resolution seismic reflection profile, fiber optics testing, and the installation of a three-station seismic network, one of which will be in borehole and surface configuration.

Our project will try to answer 3 questions, among others:

- What are the levels of shaking induced in Rome by future events (local and regional)?
- How relevant are 3D effects due to heterogeneity compared to 2D and 1D effect
- Would these future events induce a strain level exceeding the volumetric threshold [Bozzano et al., 2008, Bonilla et al., 2010, Bozzano et al., 2016], for which some numerical approaches, such as linear and equivalent linear (EL) methods, would not provide conservative results, making the use of nonlinear (NL) approaches mandatory?

An important dissemination phase is foreseen, which will be devoted to the return of the results to all potential users, including citizens, decision-makers and other stakeholders, using different media.

Keywords

Numerical modelling; Seismic wave propagation; Seismic response; Seismic shaking prediction, Seismology in urban areas

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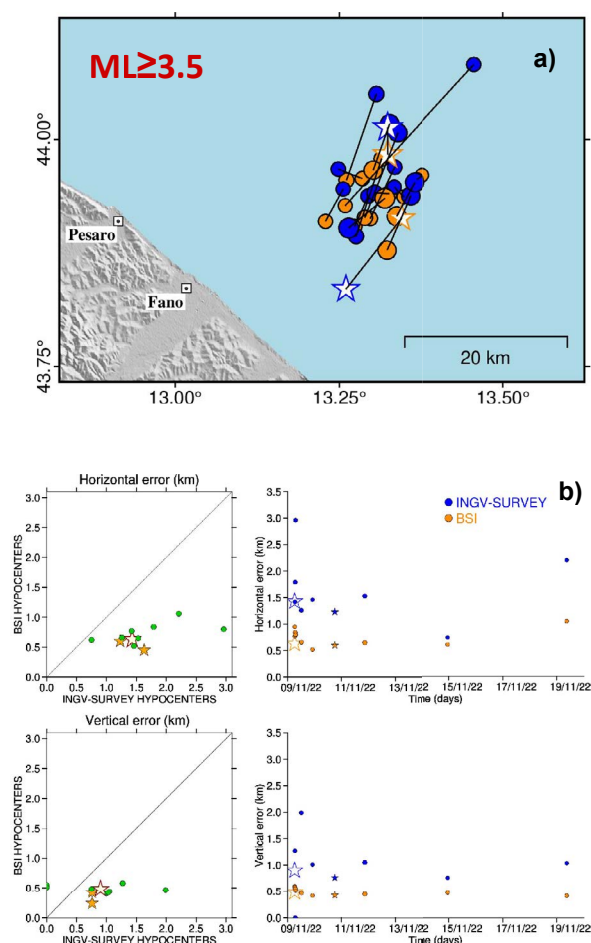
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The INGV provides hypocentral parameters and magnitudes of the Italian instrumental seismicity [Margheriti et al., 2021]. For rapid communication with the DPC (Dipartimento di Protezione Civile), earthquake parameters are manually analyzed by the shift staff of the INGV seismic surveillance service within 30 minutes. Their final products strike the best balance between accuracy in hypocenter/magnitude solutions and speed.

Figure 1 a) Map showing the distribution of earthquakes with a magnitude (M_L) of 3.5 or greater recorded in the early days of the seismic sequence that occurred in the Adriatic offshore following the M_w 5.5 event on November 9th, 2022. Blue symbols represent the hypocenter solutions provided by the INGV surveillance service in Rome, while orange symbols represent the revised hypocenter solutions of the BSI working group.
b) Comparison of horizontal and vertical errors in the hypocenter solutions obtained by the surveillance service (x-axis) with those of the BSI working group (y-axis).



The BSI working group's activity starts after this initial step and is addressed to the research community with the objective of publishing a seismic bulletin and more accurate information on Italian seismicity. The BSI analysts manually revise the seismological data assembling a catalog of earthquakes that includes P and S phase arrival time readings, hypocenter locations, magnitudes and focal mechanisms.

BSI products are released every 4 months (<http://terremoti.ingv.it/bsi>) and are integrated into the ISC (International Seismological Center) bulletin (www.isc.ac.uk/iscbulletin). From 2015, the BSI working group has rapidly revised events with $M_L \geq 3.5$ publishing their parameters and focal mechanisms after 24-72 hours. For earthquakes with $M_L \geq 5.0$, like the M_w 5.5 event on November 9th, 2022, occurred in the Adriatic offshore (Figure 1; [Latorre et al., 2022]), we perform a fast analysis of the waveforms recorded after the main shock. If significant missing earthquakes are identified (e.g., the M_L 5.2 earthquake that occurred ~1 minute after the mainshock), we publish their parameters as soon as possible. Our recent activity is focused on establishing a new website (Figure 2) where all our products will be accessible to the scientific community.



Figure 2 Screenshot of the new BSI website homepage, where all the products of the BSI will be accessible to the scientific community.

Keywords

Seismic bulletin; Italian seismicity; Seismological data; Data publication

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Earthquake Locations of the Adriatic Thrust Fault of the 2021 Seismic Sequence with sP Depth Phases

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During the daily poster exhibition, we showed our colleagues the latest results regarding the locations of offshore earthquakes by using the on-purpose designed code by Zhao et al. [2011 and ref. therein], modeling the sP converted phases.

We dedicated our study of the sequence that occurred in 2021 in the central Adriatic, but also to the analysis of earthquakes that occurred in the Ionian Sea and in the northern Adriatic Sea. Regarding the 2021 seismic sequence, which started on 2021 March 27th, with a mainshock of Mw 5.2 at 13:47 UTC, in the Central Adriatic region (Italy off-shore), we re-located 70 earthquakes. The mainshock occurred about 20 km north of the Palagruza island, 80 km from the Gargano promontory, and about 40 km from the Croatian island of Lastovo. It was felt in many central-southern Italian regions, from Ancona to Foggia, and in Central Dalmatia. All the epicenters of this seismic sequence lie in the open sea, about 100 km to the SE and about 50 km to the NW of the 2003 Jabuka seismic sequence, and the 1988 Palagruza seismic sequence, respectively.

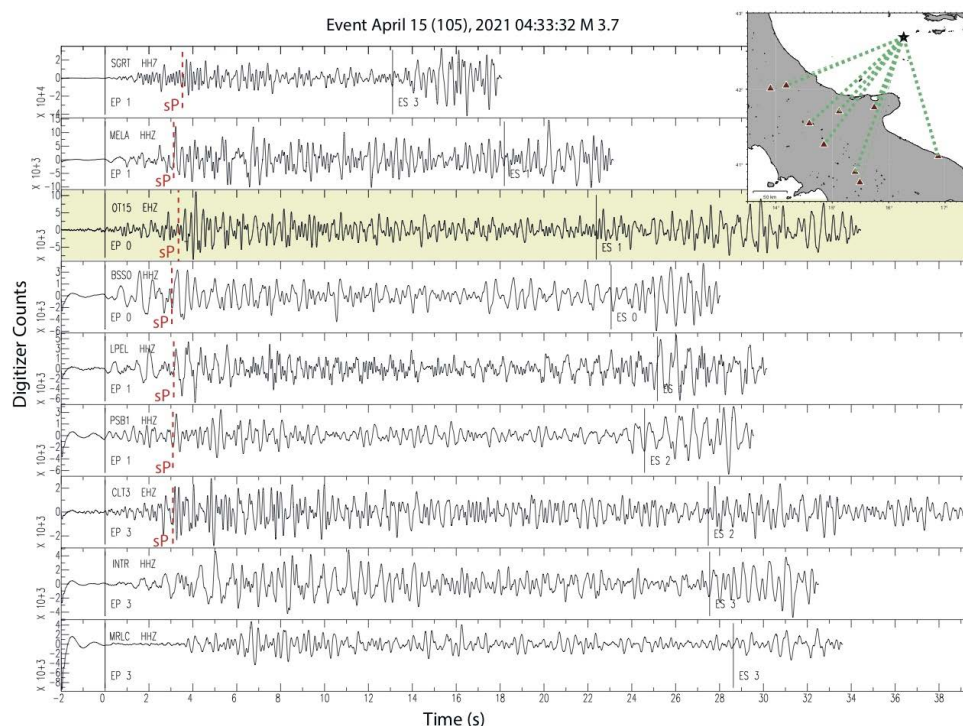


Figure 1 Example of vertical components waveforms of the event 15 April 2021 MI 3.7 T04:33 aligned on the P onsets; the red dashed lines denote possible sP onset on different waveforms, in this case at about 3 s after the P onset; the yellow highlighted waveform hosts the chosen sP onset, at the station OT15. Inset: The red triangles, the star, and the green dashed lines are the seismic stations recording the traces shown in the figure, the location of the reported earthquake, and the projection of the ray-paths at the surface, respectively.

The color version of this figure is available only in the electronic edition.

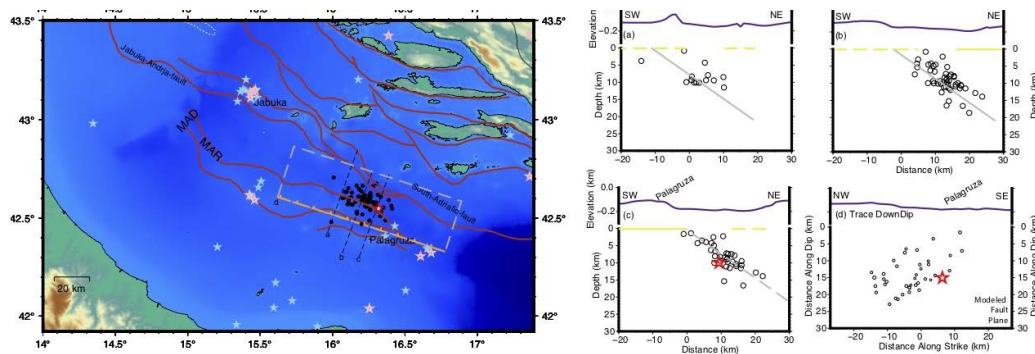


Figure 2 Left: The open circles denote $M < 5$ earthquakes, whereas the red star denotes the mainshock (M_w 5.2) that occurred on 27 March 2021. The gray dashed line denotes the mean modeled 35° dipping plane. (d) Distribution of earthquakes' hypocenters that occurred within 3 km of the modeled dipping plane, as shown in panels (a–c) and in Map, gray dashed box. Right: (a–c) Vertical cross sections showing the hypocentral distributions along the three profiles shown in Map. The open circles denote $M < 5$ earthquakes, whereas the red star denotes the mainshock (M_w 5.2) that occurred on 27 March 2021. The gray dashed line denotes the mean modeled 35° dipping plane. The yellow dashed lines are the traces of the halokinetic structures reported on the map. (d) Distribution of earthquakes' hypocenters that occurred within 3 km of the modeled dipping plane, as shown in panels (a–c) and in Map, gray dashed box. (Modified from Di [Stefano et al., 2022] and references therein).

Though the seismicity in the central Adriatic Sea has been recorded by improving seismic networks, especially in recent decades, the precise location of the Adriatic offshore earthquakes was hampered mainly by the large distance of the closest stations, and by the large gap in the distribution of seismic stations.

The possibility to model the sP depth phases enables us to estimate the epicentral parameters and focal depths of these offshore earthquakes more accurately, thanks to the peculiar ray-path that mimics the presence of a receiver approximately on top of the hypocenter. The refined earthquake locations allow us to make inferences on the structure responsible for the seismicity of the 2021 seismic sequence, a thrust fault NW-SE striking and $\sim 35^\circ$ NE-dipping, and on its seismotectonic context [Di Stefano et al., 2022].

The use of depth-phase arrival times to constrain the off-network events' locations is of particular interest to Italy due to the peninsula's peculiar shape and the extreme scarcity of seafloor stations, whose cost and management are very expensive and complex. We present the first attempt to apply this off-network location technique to the Italian offshore seismicity to improve the hazard estimation of these hard-to-monitor regions.

Keywords

Adriatic Seismic Sequence; sP Depth Phases

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Scientific Outreach and street artists

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The meeting between the INGV researchers and the street artists of the *Ile Flottante* theater group, a consolidated reality in the production of professional shows, takes place in 2022 on the occasion of the organization of the Genoa Science Festival. For 2023, we wanted to present something that could involve and excite people of a wide range of ages thanks to shows based on legends and nursery rhymes that talked about our Earth, earthquakes, and volcanoes.

Thus, was born a beautiful and profitable collaboration which, thanks to the texts written by M. G. Ciaccio, G. De Astis, G. Soldati, and M. G. Piangiamore and the theatrical adaptation by director Francesca Satta Flores, stages three shows which, under the autumn sky of a late October in Genoa, between rhymes, music, juggling, fire and sparks, they managed to enchant children and adults.

Figure 1 Festival of Science, Genoa, 2023. The shows were curated by INGV (texts written by M. G. Ciaccio, G. De Astis, G. Soldati and M. G. Piangiamore, theatrical adaptation by the director Francesca Satta Flores) and Studio Bottoni; artists Lara Panizzi, Valentina Greco and Paolo Mele.



“Turtles and Earthquakes”, “The Ladies of the Earth,” and “V.V.V. Fickle Volcanoes for Sale” narrated, with engaging language, humanity's relationship with our planet and the scientific knowledge developed over the centuries. They tell the legends of the planet's birth, about gender prejudices in the world of science, and the melancholy Aztec story that explains the origin of two imposing volcanoes in Mexico. Many people, many children came to listen to our stories, to see the evocative acrobatics of the fire eater, his mastery in drawing incandescent lines in the air.

Strengthened by the success achieved, the three shows has been repeated as part of INGV's participation in the Rome Science Festival, 2023. We also decided to participate in the concomitant and very lively Villaggio per la Terra in Rome, 2023: here they are the boys and girls from the nursery school classes came to visit us, and the show performed was "Turtles and Earthquakes" in which the legend of the Giant Turtle merges with the Earth Nursery Rhyme giving a narrative, partly true and partly magical, the evolution and characteristics of our planet. <https://ingvterremoti.com/2023/05/25/tartarughe-e-terremoti-larte-di-strada-incontra-la-divulgazione-scientifica/>



Figure 2 Festival of Science, Genoa, 2023.

Risk perception

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Risk perception studies arise from the need to understand why experts and non-experts often disagree about how dangerous technologies and natural hazards are.

Authors such as Paul Slovic defined risk perception studies as the analysis of the judgment that people make when asked to characterize and evaluate dangerous activities or technologies.

In this acceptance the researches on risk perception is useful to:

- support risk analysis and political decisions as they help understand and anticipate public responses to danger;
- improving communication and information between ordinary people, experts and policy makers.

Theoretical approaches to the study of risk perception refer to several levels:

- anthropological and socio-economic approaches;
- sociological approaches;
- psychological approaches, cognitive and affective factors;
- cognitive psychology, heuristics and information processing.

Since 2012, our research group has conducted several investigations on risk perception, mainly on seismic and tsunami risk. The questionnaires on the perception of seismic risk (SRPQ: online earthquakestest.it) and the questionnaire on the perception of tsunami risk were created.

The SRPQ allows you to obtain scores on 5 perception indicators: Hazard; Exposure; Vulnerability; People and communities (preparedness and resilience); Seismic phenomenon and to obtain a single risk perception index.

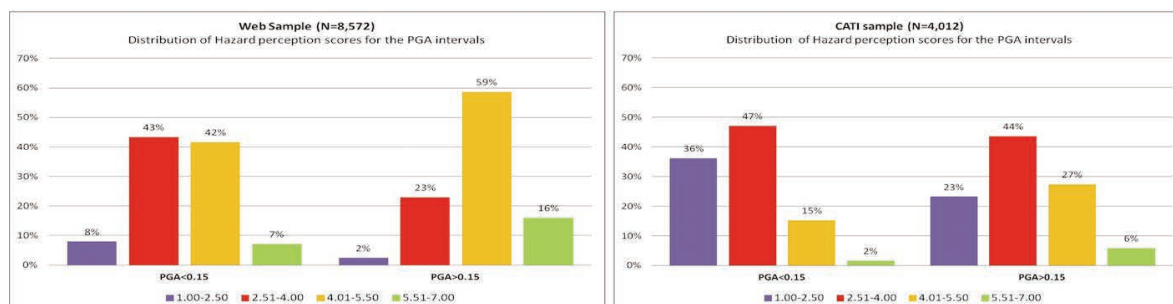


Figure 1 Hazard Risk Perception results for the CATI survey (n=4,012) and the Web survey (n=8,572).

The Tsunami Risk Perception Questionnaire (TRPQ) is currently being validated. It also allows the Hazard, Exposure and Vulnerability and Capacity indicators to be obtained, in accordance with the most recent developments indicated in the Sendai Framework in order to prevent the creation of new risk, reduce existing risk and increase resilience.

La percezione del rischio Tsunami nel centro e sud Italia

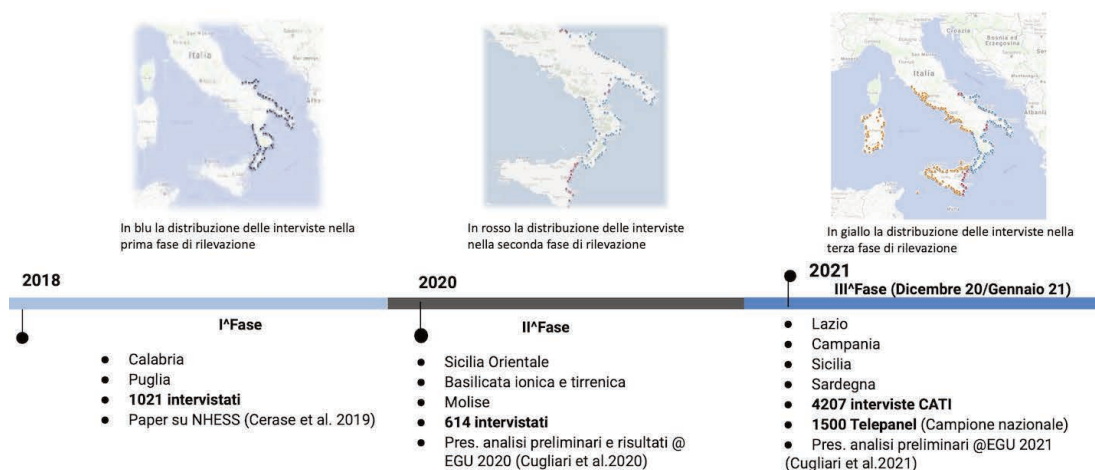


Figure 2 The surveys on the Perception of Tsunami Risk in Central and Southern Italy.

La percezione del rischio tsunami nelle municipalità costiere del centro e del sud Italia

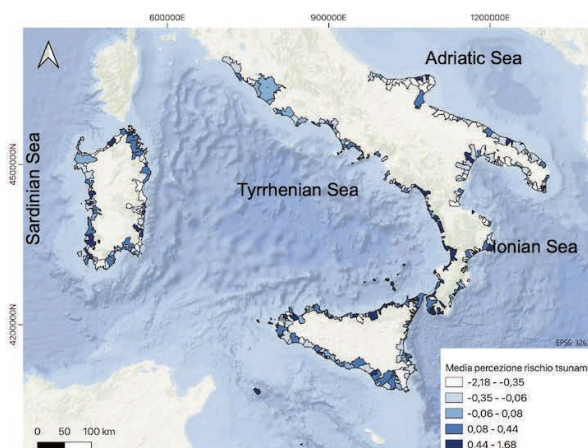


Figure 3 The Perception of Tsunami Risk in the municipalities of central and Southern Italy.

Keywords

Risk perception; Hazard, Exposure; Vulnerability; Capacity; Human perception

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Rumors about earthquakes. The case of the 2012 seismic sequence in the Po Valley

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Emergency situations are characterized by strong social apprehension. In these situations, rumors and fake news are generated, proliferate and spread with great force and speed among people and communities.

For this reason, rumors and fake news are of great interest for the institutions and authorities involved in an emergency and may contribute significantly to fueling the state of social anxiety and produce real crisis situations.

For this reason, as happened on the occasion of the L'Aquila seismic sequence in 2009, following the earthquakes of May 2012 in the Po Valley our research group carried out a long and complex training and information initiative, which in various phases, between May and September 2012, involved the population.

In the structure of the meetings of the "Earthquake, let's talk about it together" campaign, having data available on rumors was considered information of considerable importance. An online collection of rumors has been started on the websites of the institutions promoting the campaign (DPC, Emilia-Romagna Region, INGV, Edurisk Project).

In the period 14.06.2012 – 12.10.2012, a number of 239 rumors were collected.

The rumors were classified in different categories based on their content. The most common are: explanatory (when the rumor focuses on the cause of the earthquake); catastrophic (when it suggests disruptive outcomes); conspiracy (when the emphasis is on alleged truth distortion by media or public institutions). (B). Reliability of the rumor's source. We considered the institutions (such as the national Civil Protection Department) as trustworthy sources, while individuals and social media are considered unreliable. According to this classification, most rumors originated from unreliable sources. (C). Rumor diffusion indicates if and how much the reported rumor was shared with other people. Most rumors had ample diffusion. (D). The level of confidence, or trust, expresses how much the survey respondents believed in the reported rumor. Most rumors are accompanied by medium or high level of confidence.

In order to identify the most frequent and dangerous topics, we used the indicators described above to compute the rumor strength [La Longa et al., 2014]. According to Allport and Postman [1947], the strength of a rumor, R , is the product of the subject relevance, S , and its degree of ambiguity, A .

This procedure allowed us to stiled a useful distribution of rumors by strength and subject. Most of the rumors revolve around anthropic nature (146 rumor reports, with an average strength of 7.0) and the supposedly hidden magnitude of the earthquakes (79 rumor reports, with average strength 6.7). Other rumors forecast future events (49 reports, average strength 7.3) or report the occurrence of anomalous phenomena, possibly related with the seismic sequence (8 reports, average strength 6.9). Twenty other rumors regard other topics (average strength 7.2).

This classification based on the strength of the rumor allowed us to focus our attention on those found to be the most dangerous and frequent and to adopt better communication strategies to combat them in the meetings with the population.

Keywords

Rumors; Earthquake; Fake News; Risk Communication

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CRISP: an archive for the site characterization of permanent seismic stations

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The CRISP database (<http://crisp.ingv.it>) is a new archive of site characterization for the INGV National Seismic Network (RSN). With respect to other Italian databases providing site information, it refers to all the RSN sites instrumented with velocimetric or accelerometric or both, and includes a very large number of indicators and analyses for a complete site-response evaluation of the site: instrument housing, thematic maps on geological characteristics, seismic analysis on recordings and available geophysical investigations and proxy indicators.

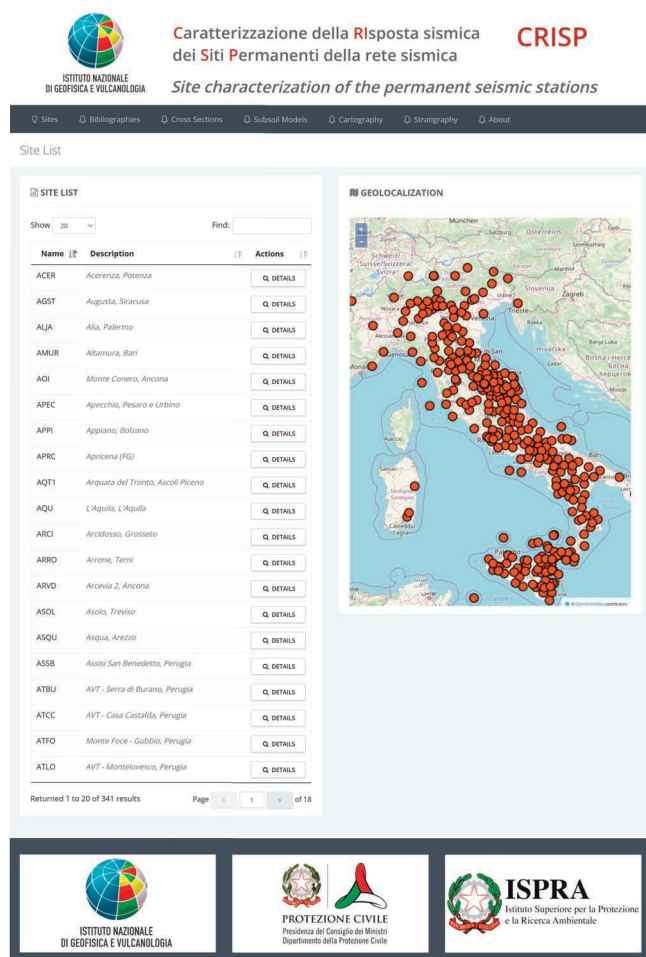


Figure 1 CRISP home page (<http://crisp.ingv.it/>; [Cultrera et al., 2022; Mercuri et al., 2023]).

The physical database was implemented by DBMS PostgreSQL/PostGIS and integrated in a web application with GIS functionality. It uses web services managed by ISPRA to display maps around the station and information on the local geology, and it is populated with data from pre-existing INGV archives or specifically computed.

CRISP is constantly updated with new data of archived sites or new seismic stations. It fits into the European efforts for a complete site characterization of the seismic networks and the interoperability of the stored information through web services. This goal is necessary for qualifying the records metadata, useful to carry out many innovative studies from seismic research and surveillance to engineering seismology and infrastructure.

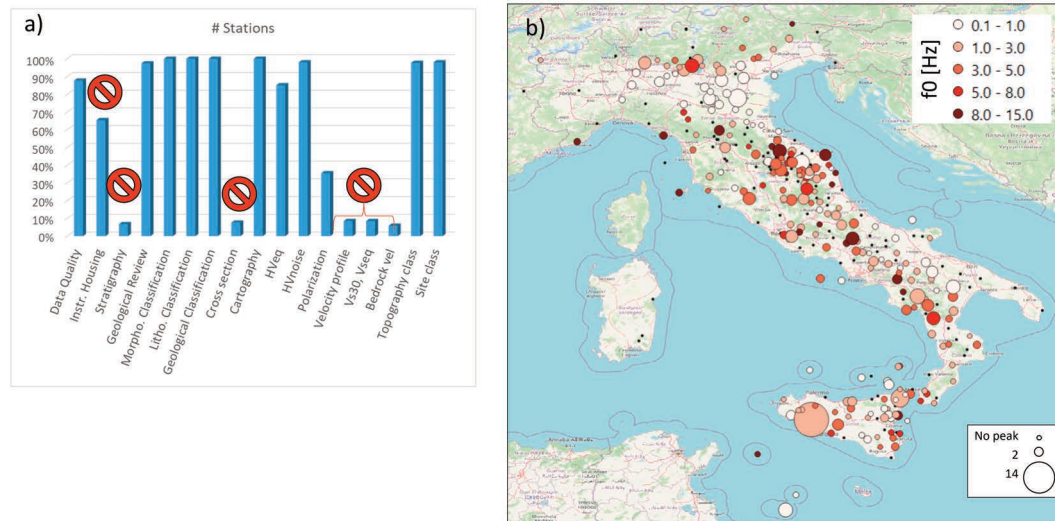


Figure 2 a) Statistics of information stored in CRISP and referred to the main sections (stations indicate the number of sites having at least one value of the respective indicator);
b) resonance frequency from Horizontal-to-Vertical spectral ratio on noise (www.geopsy.org): 0.1-15 Hz, 1 day with windows up to 120s.

Keywords

Site effect; Seismic network; Station characterization

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Science and Scientists from children's point of view

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We conducted an analysis of the perception of science and scientists based on drawings created by Italian primary school children in 2011 and 2021 for the INGV calendar competitions. The title of the 2011 competition was "*Scienziato anche io! La Scienza e gli scienziati visti dai bambini*" (Figure 1).



Figure 1 Ensemble of the 2011 calendar awarded drawings.

For the 2021 competition, we proposed the title: "*La Scienza in crescita, immaginare la scienza del Futuro*" (Figure 2). We observed both similarities and significant differences in the ten years that separate the two sets of data (Table 1). Although the image of a scientist is still predominantly male, we noted a noteworthy increase in female scientists represented in the 2021 dataset. Female scientists were depicted by girls, indicating a sense of identification and recognition of their potential to become scientists. This shift can positively influence girls' perceptions of their future prospects and aspirations.

The depiction of a "mad scientist" stereotype persists, primarily associated with male scientists. The percentage of inventions in the 2021 dataset showed an increase, possibly reflecting a growing confidence in the benefits of science. In terms of inventions, children primarily portrayed themselves as technologists, with boys inventing slightly more than girls. Several inventions were related to environmental impact, suggesting an aspiration to combat climate change and pollution. It is noteworthy how environmental themes have seen a substantial increase in 2021, reflecting a positive trend in the younger generation's awareness



Figura 2 Back cover of the 2020-2021 calendar with the thumbnails of the awarded drawings.

Many drawings featured fantasies of space and time travel, with proud rockets and spaceships, with a higher percentage in the 2021 dataset. This suggests that children may perceive space exploration as more achievable with advancements in space technologies.

	2011	2021
Drawings depicting scientist	599 (67.8%)	146 (44.7%)
Scientist is a woman	29.2%	36.5 %
Scientist is a man	58.3%	55.4%
Undefined scientist gender	6.7%	1.4%
girl drawing women scientist	53.5%	62.2%
boy drawing women scientist	4.8%	4.7%
girl drawing men scientist	32.3%	29.3%
boy drawing men scientist	84.7%	90.6%
Scientist is young	83%	87.6%
Scientist is senior	17%	12.4%
girl drawing young scientist	51.8%	56.7%
boy drawing young scientist	48.2%	43.3%
girl drawing senior scientist	39.3%	55.6%
boy drawing senior scientist	60.7%	44.4%

Table 1 Comparison between drawings depicting scientists in 2011 and 2021 datasets.

Keywords

Children's drawings; Perception of science; Gender disparity; Science stereotypes

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The activities of the EMERSITO INGV emergency task force following the Mw 5.5 Costa Marchigiana-Pesarese earthquake

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A. Bobbio, C. Bottari, G. Brunelli, C. Calamita, M.G. Ciaccio, R. Cogliano, A. Costanzo, G. De Luca, A. Di Filippo, L. Falco, C. Felicetta, A. Fodarella, S. Hailemikael, C. Ladina, S. Lovati, C. Mascandola, M. Massa, G. Mele, A. Memmolo, A. Mercuri, G. Milana, L. Minarelli, L. Nardone, N.M. Pagliuca, D. Pantaleo, M. Pischiutta, S. Pucillo, R. Puglia, G. Sgattoni, G. Tarabusi

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After the Mw 5.5 (M_L 5.7) event of November 9, 2022 06:07:24 UTC (Costa Marchigiana Pesarese area), EMERSITO emergency task force of INGV (<http://emersitoweb.rm.ingv.it/>), aimed at site effects and seismic microzonation studies, acted immediately to collect multidisciplinary information regarding the epicentral areas.

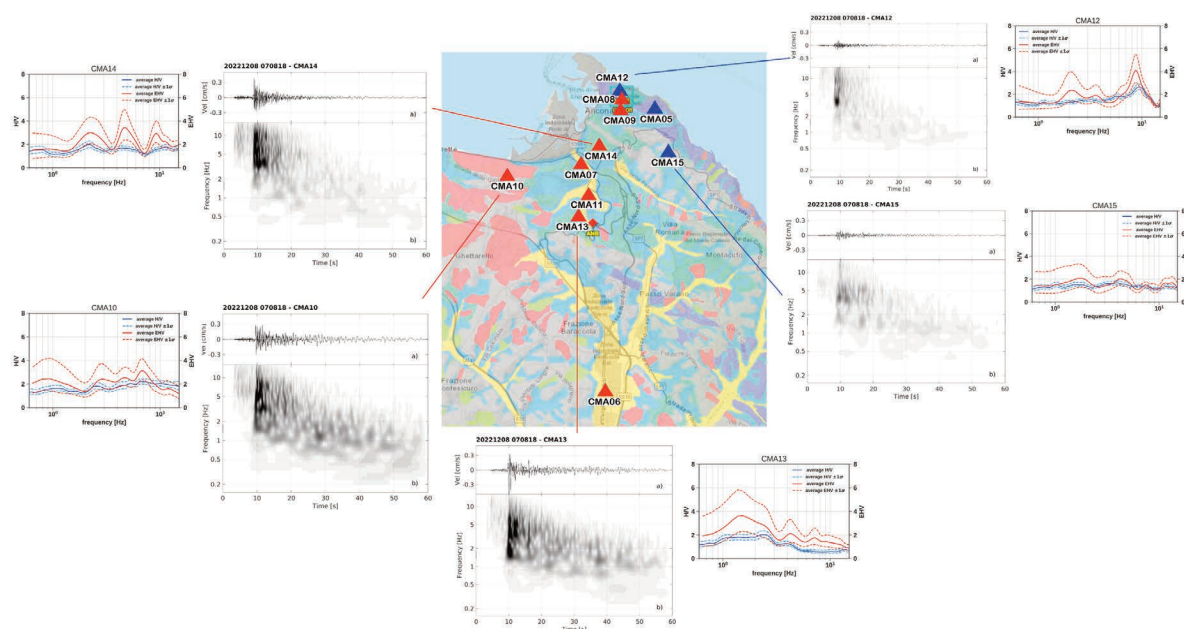


Figure 1 S-transform [Stockwell et al., 1996] calculated for the M 3.9 event (08-12-2022) recorded by the 6N EMERSITO network is reported (grey plots) for some representative sites with different geological condition. At stations on sedimentary deposits, the energy release is prolonged in time and amplified in site and source-dependent frequency ranges. The spectral ratios analysis [Vassallo et al., 2022] of earthquakes and ambient noise (red and blue respectively) is useful to have a first idea of the seismic response of the sites.

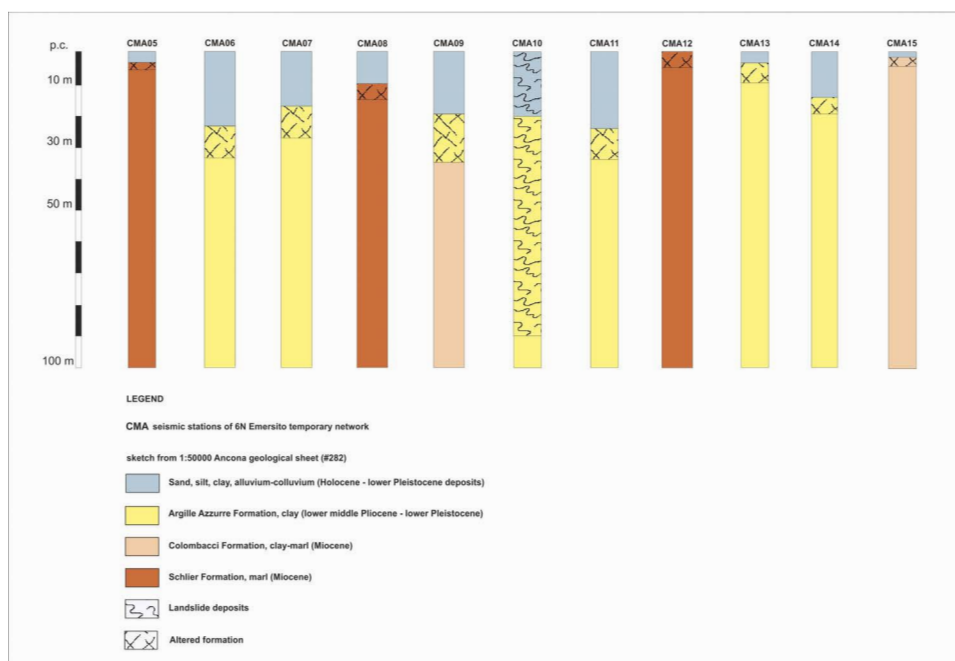


Figure 2 1D stratigraphic models of 6N seismic network sites, built considering investigations and 2D geological cross-sections located between 5 and 250 meters from the stations.

EMERSITO decided to focus the scientific intervention at Ancona, the main city of the Marche region. This choice was driven by: a) the values of peak ground accelerations recorded during the main shock; b) the observed damage and evacuations reported by the Fire Brigades; c) the scientific interest in the evaluation of the local seismic response in urban areas. The intervention of EMERSITO concerned the installation of a temporary seismic network (registered as 6N by FDSN) consisting of 11 seismic stations equipped with both velocimetric and accelerometric sensors. All continuous data will be transferred to the European Integrated Data Archive (EIDA) repository, with a Digital Object Identifier (DOI) and made public after a pre-established restriction period. In this work we present the seismic dataset composed of ambient vibrations and aftershock recordings acquired by the 6N network during the experiment. Preliminary data analysis [Gruppo Operativo EMERSITO, 2023] suggests a variability of the site responses depending on the outcropping lithologies [Borcherdt 1970]. We believe that this dataset will be the base for a general assessment of the seismic response of different areas of the city of Ancona.

Keywords

EMERSITO; Seismic sequence; Site effects; Microzonation

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HERMES HEmera Returning MESsenger

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A common issue for long-duration balloon flights in the polar area is high bit rate data transferring. Just a few hours after launch, balloons are not reachable with direct radio link and often satellite links are not fast enough to allow the necessary transfer rate or, simply, too expensive. For this reason, stratospheric balloon borne experiments carry out on board data recording systems that need to be recovered after termination in order to have the complete data set. But not always it is easy or possible to reach the landing site, especially during the polar winter.



Figure 1 The payload with the glider in flight configuration.



Figure 2 The moments before launch at the Esrange base.



Figure 3 A picture from the stratosphere.

The aim of the project is to provide an autonomous glider capable of physically carrying the data (stored on a SSD memory) from the stratospheric platform to a recovery point on the ground and transporting physical objects (like air samples) obtained at float too. We estimate that an electrical motorglider released in the stratosphere can fly for several hundred kilometers.

The glider is installed on the balloon payload through a remotely controlled release system and connected with the main computer to receive data and geographic coordinates of the recovery point. The system is composed of a payload, glider and ground station. The main modules that make up the payload handle battery power and communications. Also present are the flight computer simulator and the glider release system.

In July 2022 the first experimental flight of HERMES was successfully carried out. The payload was launched with a zero-pressure balloon from the Esrange Space Center (Kiruna, Sweden). The launch was operated by Swedish Space Corporation (SSC).

Keyword

LDB; Stratospheric platform; UAV

References

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VULCANOPOLY: playing towards a better future

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The goal of scientific dissemination is to reach all levels of age and social origin of the population, simplifying scientific concepts and making them appealing to the general public. A common and understandable language has always been the visual one, for this reason many authors use images as a tool to convey scientific notions and discoveries. From its origins, science has placed images at the center of its communication processes: drawings, diagrams and then, subsequently to scientific discoveries, photographs, films up to satellite images. In this framework, we emphasize the importance of playful-didactic activity and visual language to facilitate learning and, in particular the development of scientific games. Our working group has been collaborating for years in the organization of dissemination events with the aim of increasing knowledge on the major geological issues for the protection of the planet. In this context it is important to highlight the role of scientific dissemination and the different methodologies to be used. One of the most used and appreciated tools has been the creation of scientific-didactic games: to simplify concepts, the game has in fact proved to be a fundamental tool.



Figure 1 Billboard of the Game.

We present VULCANOPOLI, inserted in a series of science games that started with MAREOPOLI [Locritani et al., 2017] and inspired by Hasbro's famous MONOPOLY. The main topic is volcanoes, both from a scientific and a historical point of view. Thanks to this game the historical evolution of some of the most important Italian Volcanoes can be reconstructed. The rules are those of the original game with some additional questions and concepts to remember, to conquer cities and accumulate points. The VULCANOPOLY game-board consists of thirty-six spaces containing twenty-one villages and cities on three main Italian active volcanoes (Mount Vesuvius, Mount Etna and Stromboli Island) and one quiescent volcano (Colli Albani Volcanic District), four Chance spaces and four Community Chest spaces, a hot water baths space, a geothermal energy space, an underpass space, and the four corner squares: GO, Viewpoint, Magma Chamber and Connecting way. A deck of thirty-two Chance and Community Chest cards (sixteen each) which players draw when they land on the corresponding squares of the track, and follow the instructions and myths, legends and folklore tales based on real events printed on them. Each time a player's token lands on or passes over GO, whether by throw of the dice or by drawing a card, the Volcanologist gives that player a volcanic rock (basalte, tuff, pozzolana, pumice, obsidian, scoria). The game can be played at secondary schools with the participation of INGV researchers. The game follows the same rules as the MONOPOLY but mediated by the presence of a researcher.

Keywords

Scientific dissemination; Game; Playful-didactic activity

References

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EPOS-DCAT-AP a representation for enabling cross-disciplinary collaboration in solid Earth sciences

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The European Plate Observing System (EPOS), recognized as the ESFRI Landmark infrastructure for solid Earth sciences, aims to comprehensively understand the dynamic Earth system by utilizing e-science methodologies and by amalgamating various advanced Research Infrastructures within Europe's solid Earth sciences domain. A central challenge lies in integrating a multitude of multidisciplinary resources, including datasets, software, and services, from existing thematic infrastructures-designated as Thematic Core Services (TCS)-into a cohesive structure known as Integrated Core Services (ICS). To attain this integration and ensure seamless interoperability between ICS and TCS, metadata plays a pivotal role. EPOS has introduced a representation, the EPOS-DCAT Application Profile (EPOS-DCAT-AP), constructed upon renowned standards such as W3C and incorporates elements from familiar vocabularies, including DCAT and Schema.org. EPOS-DCAT-AP, based on Core Concepts emblematic of the EPOS domain, facilitates user interaction by presenting abstracted high-level views, while also providing detailed information essential for the scientific communities within EPOS. The profile is available on GitHub <https://github.com/epos-eu/EPOS-DCAT-AP>.

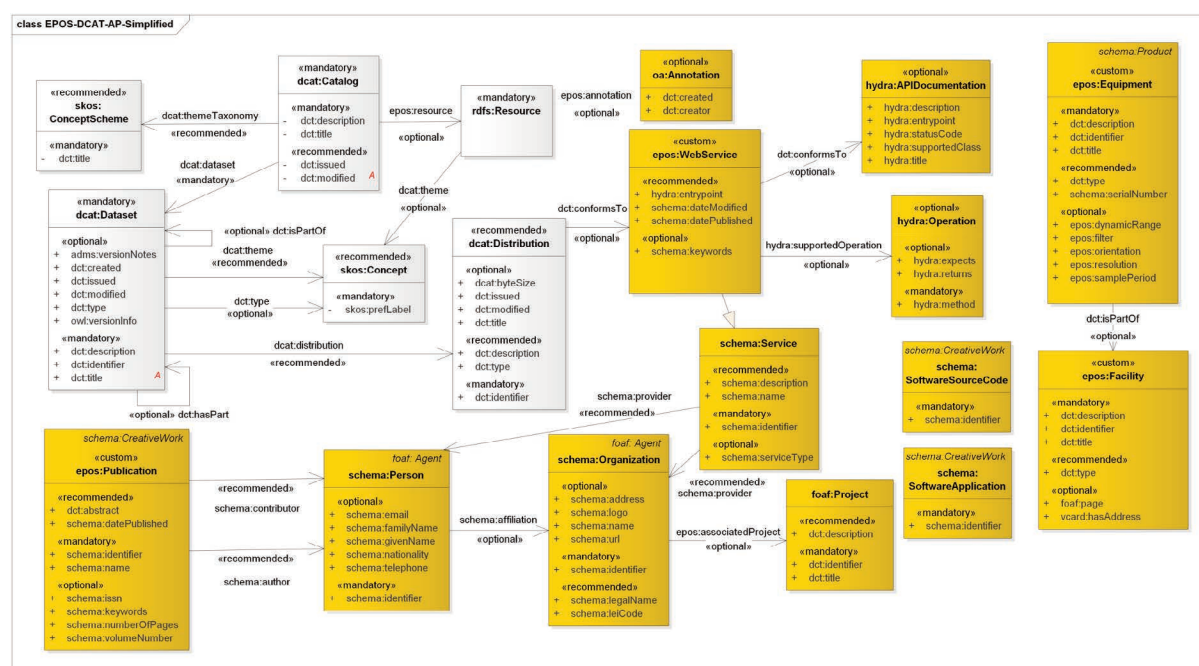


Figure 1 High-level UML class diagram of the EPOS-DCAT-AP model. It extends DCAT-AP v1.1 by introducing additional classes (in yellow) and relationships.

Keywords

EPOS; Metadata; Thematic Core Services; EPOS-DCAT Application Profile; Solid Earth Sciences

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Long-term geochemical monitoring in both cold and thermal aquifers in two seismically active sectors of Southern Apennines: Irpinia and upper Sele Valley. Results from the INGV project “Myburp”

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The study of geochemical transients in groundwater associated to seismicity needs long time series of observations for answering the main questions regarding the role of fluids in the earthquake preparing phases (e.g. Chiodini et al., [2020]; Gori and Barberio, [2022] and references therein). As such, since May 2021 a multidisciplinary INGV project named “Myburp” is currently on going in two seismically active areas of southern Italy (Irpinia and upper Sele Valley). The sites selected for monthly samplings are: i) two large cold springs, named Caposele and Cassano Irpino and ii) two CO₂-rich thermo-mineral aquifers, located in the upper Sele river valley (Capasso) and in the Ansanto valley (San Teodoro, Irpinia), respectively (Figure 1).

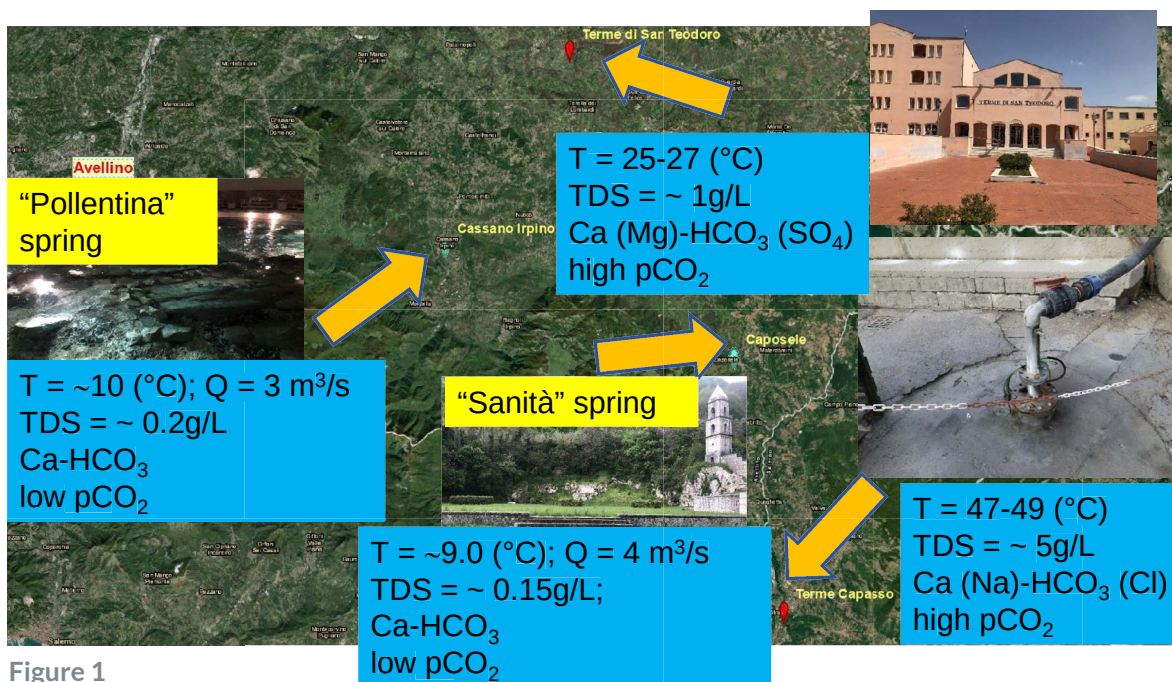


Figure 1

Cold and thermal waters are both Ca-HCO₃-type, but physical-chemical parameters, ionic abundance, minor and trace elements content, dissolved gas and isotopic composition between the two groups show noticeable differences (Figure 1). Cold waters (T = 9 -11°C) have alkaline pH (7.7-8.2) and low salinity (290-380 μS/cm), while thermal waters, showing temperatures between 26 and 49°C, are slight acidic (pH in the range 6.4-6.6) and with medium to high salt content (**1.3-6.6 mS/cm**). The observed water’s features mainly reflect the differences in: i) lengths (i.e. residence time) and depths of the hydrological circuits, ii) type and degree of gas-water-rock interaction (GWRI) processes and iii) dissolved CO₂ content. The origin of the dissolved carbon was investigated by comparing the concentration of the C_{ext} with its isotopic composition (δ¹³C_{ext}), Figure 2.

Low C_{ext} content and largely negative values of $\delta^{13}\text{C}_{\text{ext}}$, both falling in the expected range for the infiltrating waters dissolving the carbon from a biogenic source in the soils, characterizes cold waters. By contrast, thermal waters dissolve a heavier carbon component, having an isotopic signature similar to the typical values of the CO_2 -rich gas emissions located in the study area.

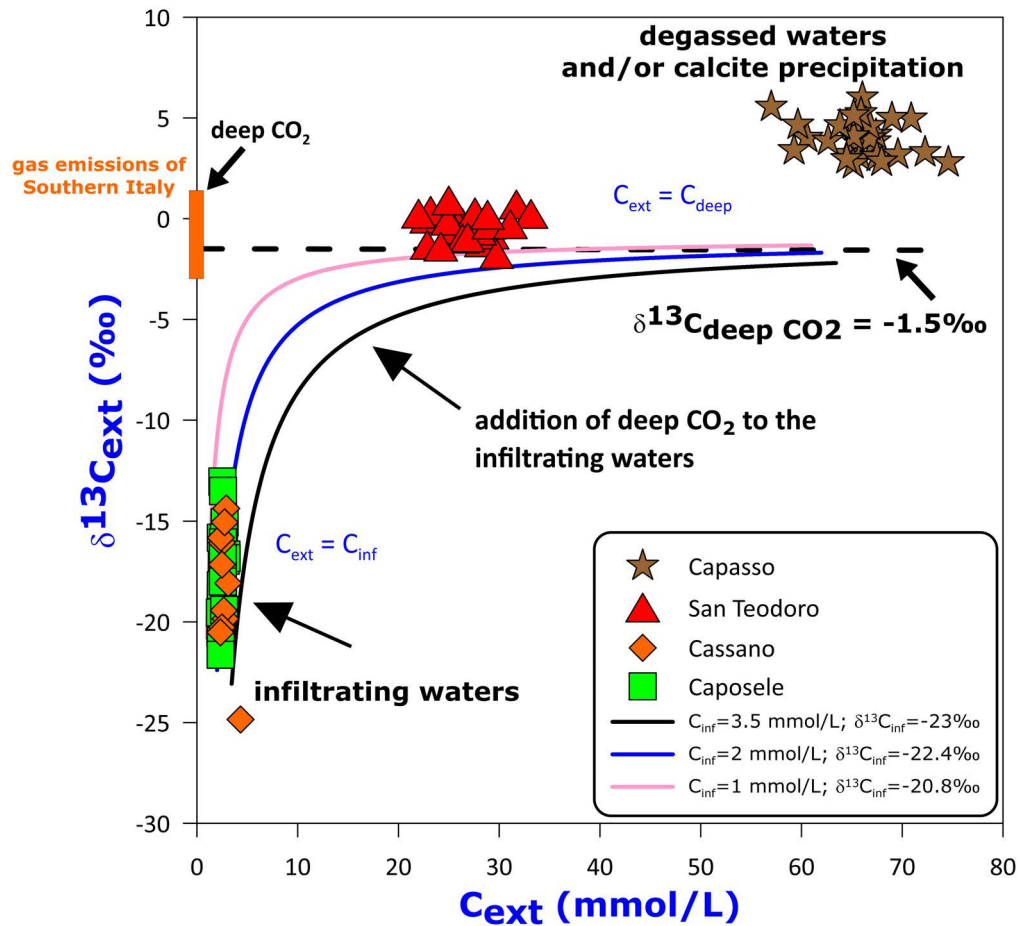


Figure 2

Keywords

Geochemical monitoring; Deep CO_2 ; Cold and thermal groundwater; Irpinia

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Indoor Radon measurements in public and private buildings in the Ciampino municipality and risk perception assessment

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Radon is a natural radioactive gas produced by the decay of its parent nuclide in bearing rocks and soils. Inhalation of radon gas poses a serious risk for human health and the World Health Organization stated the doubtless correlation between long exposure to radon gas and lung cancer. In this context, 76 indoor radon measurements in private and public buildings were performed in the Ciampino municipality. This study was carried out within the framework of the LIFE-Respire project. Indoor radon concentration was measured by using passive nuclear track detectors (CR-39) and analyzed using the RADOSYS system at INGV Radionuclides laboratory (Figure 1).



Figure 1 RADOSYS system used at the INGV Radionuclides laboratory (A) to perform analyzes on passive nuclear track detectors (CR-39) (B). Track-etch that are used in exposures for prolonged periods (months), as indicated by the European directive 2013/59 Euratom dated 5/12/2013. Computerized analysis of CR-39 by electron microscope for automatic detection of traces and obtaining the average indoor radon concentration during the exposure period (C).

Measurements were carried out in winter and summer seasons to assess the range of seasonal fluctuations, as recognised elsewhere. Results show a substantial increase of maximum indoor values in winter (up to 1575 Bq/m³) that are two times higher than those measured in the summer period (up to 764 Bq/m³). The annual mean and median values (283 and 203 Bq/m³, respectively) are both below the EU recommended limit of 300 Bq/m³. A Geogenic Radon Potential map of the Ciampino municipality was provided to the local authorities (Figure 2).

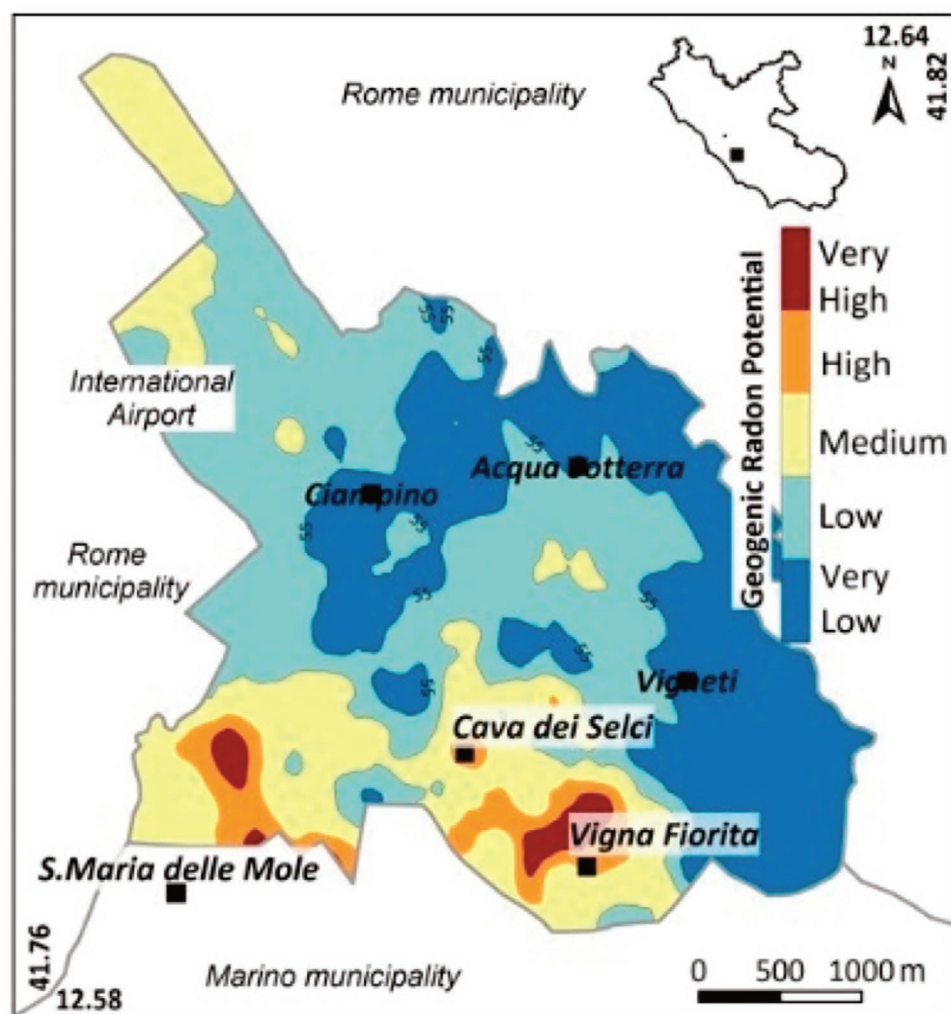


Figure 2 Geogenic Radon Potential (GRP) map of the Ciampino municipality.

Moreover, a questionnaire on radon risk perception was designed for the specific context of the LIFE-Respire project and distributed in a sample of residents and students in the Municipality of Ciampino to measure, among many other aspects, the salience of the hazard, knowledge of the hazard and of hazard mitigation strategies, perceived preparedness of and trust in officials, sources of received information and preferred methods of receiving information, and the level of interest in the project approach (including remediation measures).

Keywords

Radon indoor; Seasonal monitoring; Radon risk perception; Life-Respire project

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^{222}Rn , ^{220}Rn and soil gas content in Taylor Valley, Antarctica 37620461_2.7

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The stability of polar regions is at risk due to global warming and can lead to significant impacts. The modern carbon cycle is impacted by the stability of permafrost in the northern polar regions, which could potentially store significant amounts of greenhouse gasses. Indeed, rapid and recent warming of the Arctic permafrost is resulting in significant greenhouse gas emissions. The warming effect can be increased by the melting of permafrost by doubling the anthropogenic effect of fossil fuel combustion, agriculture, and land use changes.

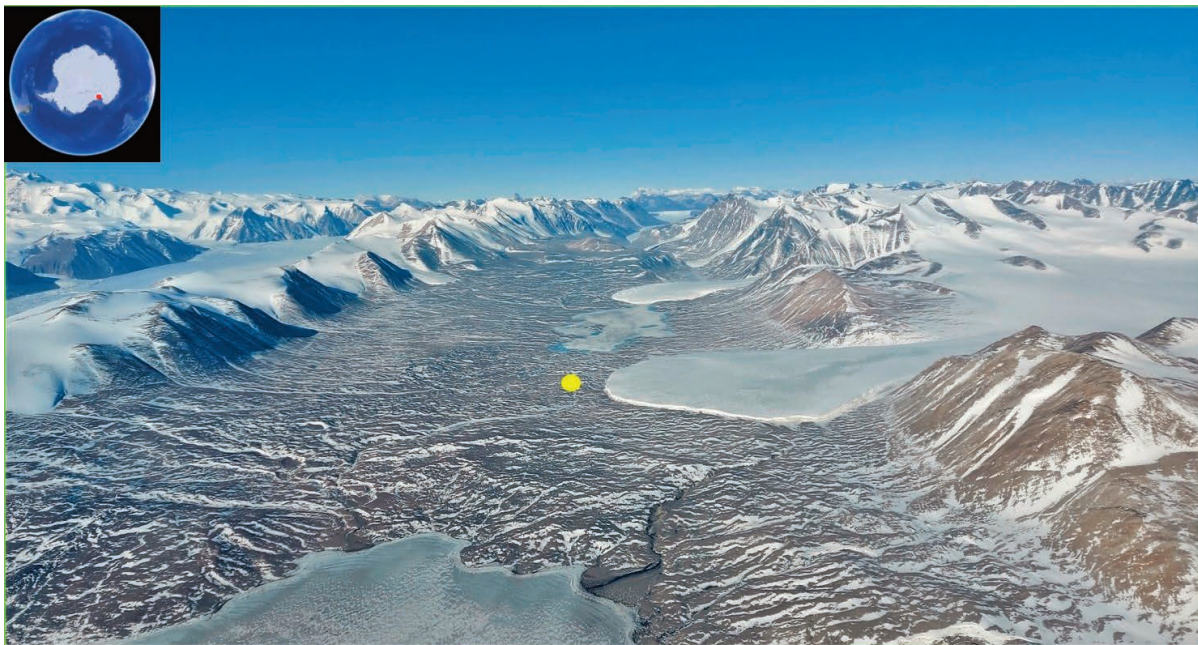


Figure 1 View of Taylor Valley from the E to W and location site.

Rn transport can be intensified by permafrost thawing because of increased fluid saturation and soil permeability. The migration processes of melting permafrost gases can be studied starting

with a detailed study of ^{222}Rn and ^{220}Rn activity levels in polar soils. Despite conducting numerous studies in Arctic regions, there is a dearth of data from the Southern Hemisphere. The Italian – New Zealand “SENECA” project aims to fill this gap and to provide the first evaluations of gas concentrations and emissions from permafrost and/or thawed shallow strata of the Taylor Valley, Antarctica (Figure 1). Permafrost investigations can be conducted in Taylor Valley, which is one of the few Antarctic regions uncovered by ice.

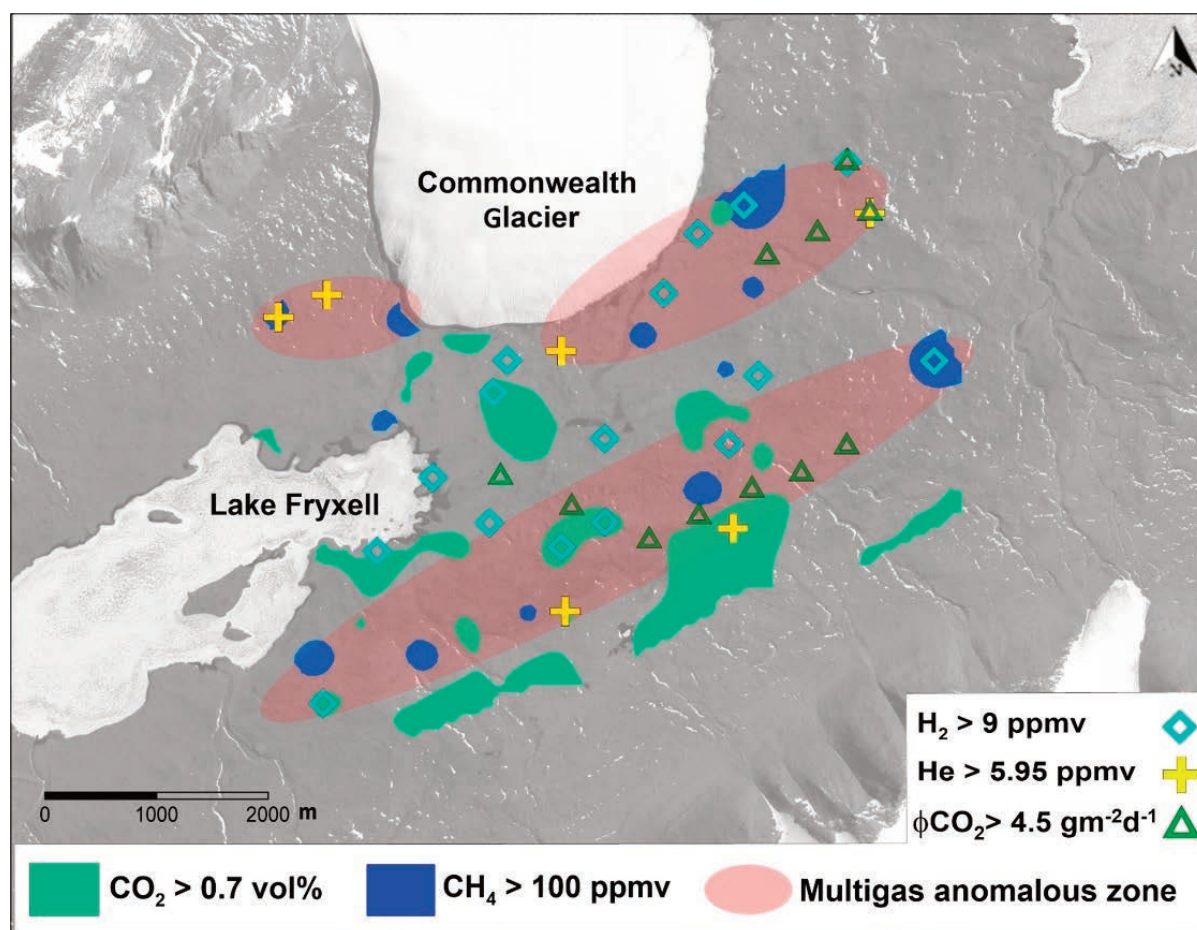


Figure 2 The map shows contour areas of CO_2 (green) and CH_4 (blue) concentrations higher than 0.7 vol% and 100 ppmv, respectively, samples with H_2 higher than 9 ppmv (light blue rhombuses), He higher than 5.95 ppmv (yellow crosses), ϕCO_2 higher than $4.5 \text{ g m}^{-2}\text{d}^{-1}$ (green triangles). The multigas anomalous zones are shown by the pink ellipsoids.

This research examines all the soil gas concentrations and flux measurements carried out in Taylor Valley during the Southern Summer 2019/2020. Significant concentrations of CO_2 , CH_4 , and He at the base of the active layer were revealed by the analytical results (Figure 2). Our field measurements indicate that ^{220}Rn has higher values than ^{222}Rn , which suggests that there is a surface source. The control over ^{222}Rn activity values is generally determined by the radionuclide content, soil temperature, porosity, and water content (Figure 3).

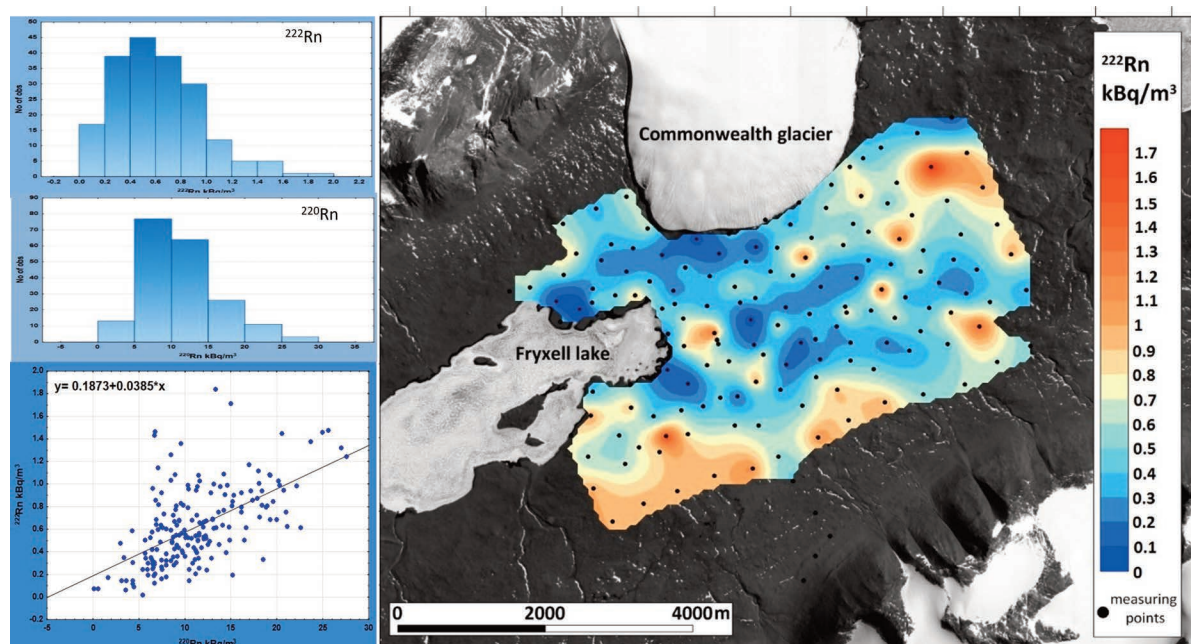


Figure 3 Statistical and geostatistical elaboration of ^{222}Rn and ^{220}Rn measured in Taylor Valley in 2019/20 field works.

These results demonstrate the presence of preferential gas pathways through the permafrost from a deep source. It is the first time that this type of study has been performed in Antarctica and can make a significant contribution to understanding the melting permafrost processes and its implications for the environment. Our suggestion is that the gas source is linked to the deep frost that moves from the interior to the coast under the permafrost layer. Future surveys can be made to monitor the rate of variation of gas emissions from the Antarctic permafrost and the potential origin of gasses using this data as a baseline.

Keywords

Radon; Permafrost thawing; Gas origin; Taylor Valley

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The Real-time estimation of the Gutenberg–Richter b-value parameter for an ongoing seismic sequence. Application to the 2022 Marche (Central Italy) earthquake sequence

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The real-time estimation of the b-value parameter in the Gutenberg–Richter law for earthquake magnitudes is essential in short-term forecasting of ongoing seismic sequences. The spatiotemporal variability of this parameter is indeed often interpreted in terms of physical processes, and therefore as a precursor of upcoming strong events.

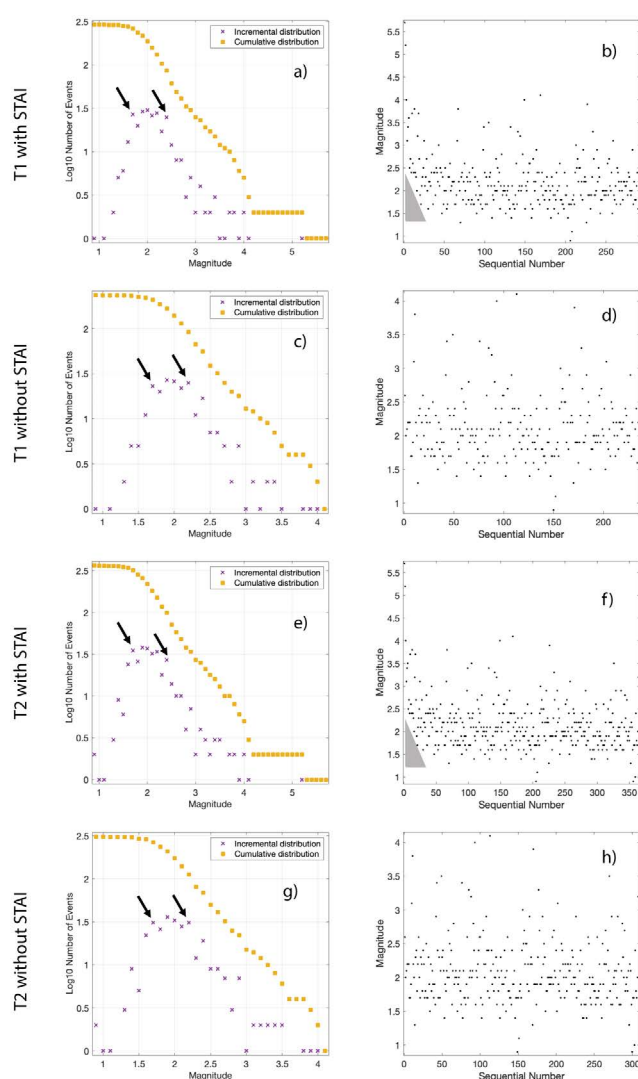


Figure 1 Frequency-magnitude distributions (left panels) and magnitude VS sequential number (right panels) for the 4 days (T1) catalogue and the 7 days (T2) catalogue, with and without STAI. Purple dots represent the incremental distribution. Yellow squares represent the cumulative distribution. Panels (a) and (b): T1 with STAI. Panels (c) and (d): T1 without STAI. Panels (e) and (f): T2 with STAI. Panels (g) and (h): T2 without STAI. Black arrows in panels (a), (c), (e) and (g) indicate an anomalous number of events in the bins 1.7 ML and 2.4 ML. Gray triangles in panels (b) and (f) show the lack of small magnitude events due to STAI.

Nonetheless, the b-value estimation is known to be susceptible to several sources of bias, such as the completeness magnitude, and this may lead to a wrong interpretation of the estimates obtained. Still, the global increase of the coverage of seismic stations, as well as the development of new algorithms for detecting earthquakes in the last decades, allowed us to enormously expand the number of events in instrumental seismic catalogs, thus reducing some potential biases. This led to increase the interest in studying the spatial and temporal variations of the b-value, with particular focus on real-time estimation.

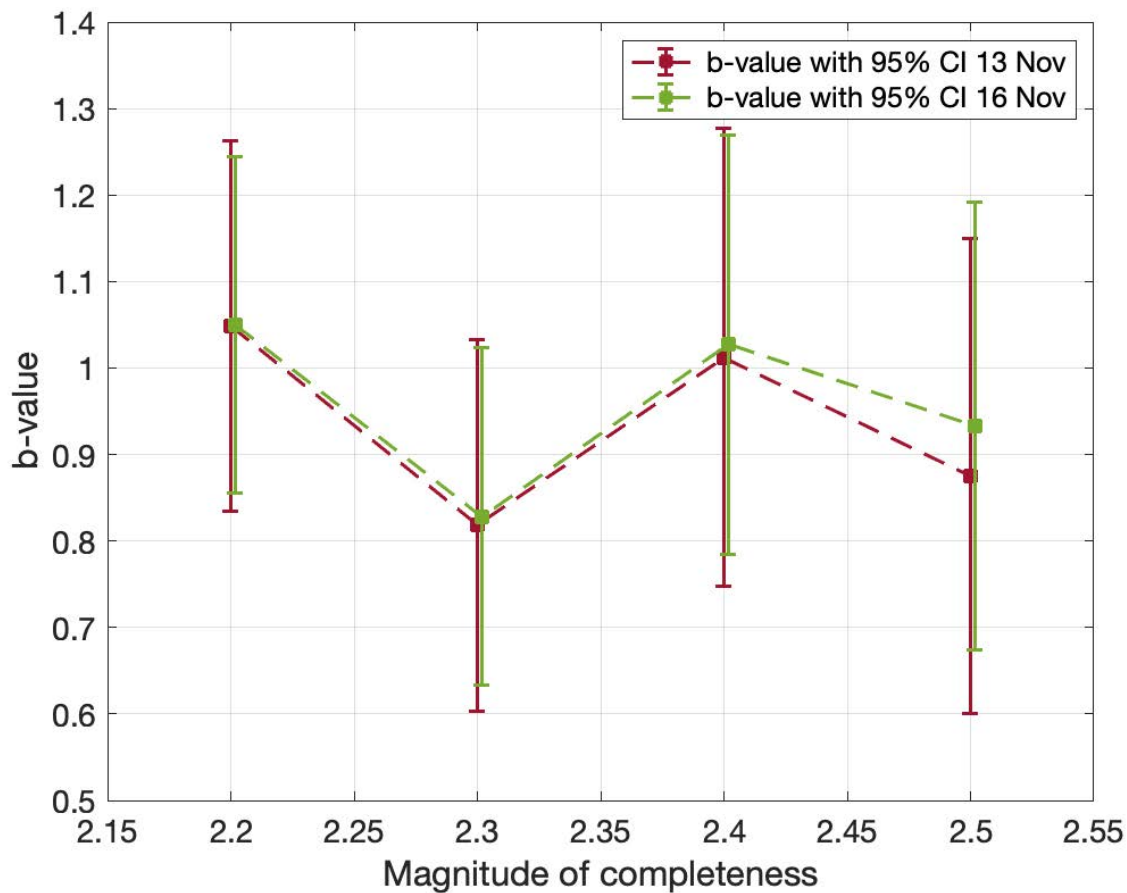


Figure 2 b-value and 95% Confidence Interval estimation for different magnitude of completeness thresholds, for the 4 days (T1) catalogue (red line) and the 7 days (T2) catalogue (green line).

In line with this promising research branch, here we present the results of an analysis we performed in the early stage of the Costa Marchigiana (Italy) seismic sequence, started on November 9th, 2022 with Mw 5.5 (ML 5.7) event that occurred on 2022-11-09 06:07:25 UTC in the sea at about 30 km NE from Fano (Pesaro-Urbino municipalities, Italy). In particular, we estimated both the completeness magnitude M_c and the b-value within the first 4 and 7 days after the initial strong event, both with and without adjustment for Short-Term Aftershock Incompleteness (STAI), and interpret the results in terms of “forecasting avail”. We highlighted some critical issues to consider in the real-time evaluation of both M_c and the b-value. These are ascribed to the roughness of the data recorded at an early-stage, an unreliable evaluation of M_c with statistical approach, the short-term aftershock incompleteness entailed after the initial strong event, and the magnitude binning.

Keywords

B-value parameter; Statistical seismology; Probabilistic forecasting; Real-time estimation

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Earthquake Perception Data Highlight Natural Frequency Details of Italian Buildings

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Buildings act as resonators, amplifying shaking at specific frequencies and affecting earthquake perception. We analyzed 286,000 reports from people in buildings up to 10 stories high to understand the effect of floor and building height [Tosi et al., 2023]. Results show that the percentage of people who felt earthquakes increased on higher floors and decreased on lower floors, with more significant variations in buildings taller than five stories.

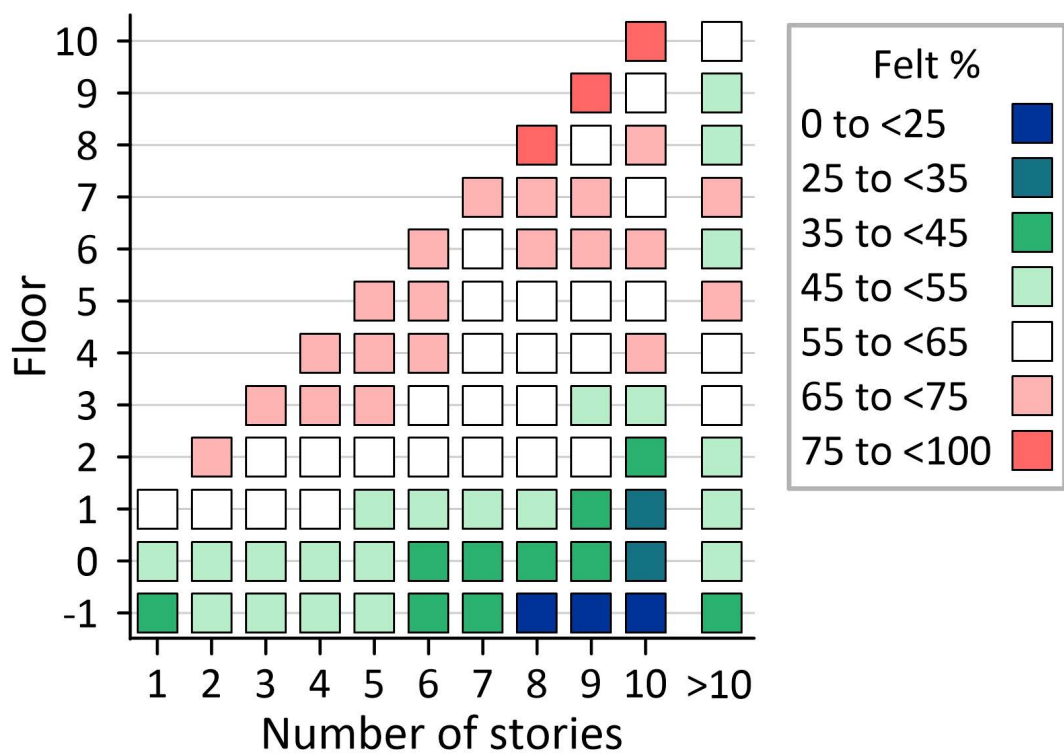


Figure 1 Percentage of “Felt” reports from stationary observers located in each floor and building height combination.

We also analyzed the distance from the hypocenter within which citizens felt the shaking and its variation as a function of the earthquake magnitude. By comparing the results to a seismic response spectra model, we estimated the vibration frequency perceived on each floor/height combination. Low buildings exhibited a narrow range of frequency, while tall buildings had multiple frequencies, due to higher vibration modes. The vibration periods of the top floor of buildings increased with building height, with a coefficient of proportionality (0.017) very similar to that estimated by ambient noise. Ground floors had similar vibration periods, but basement floors showed an increase with building height.

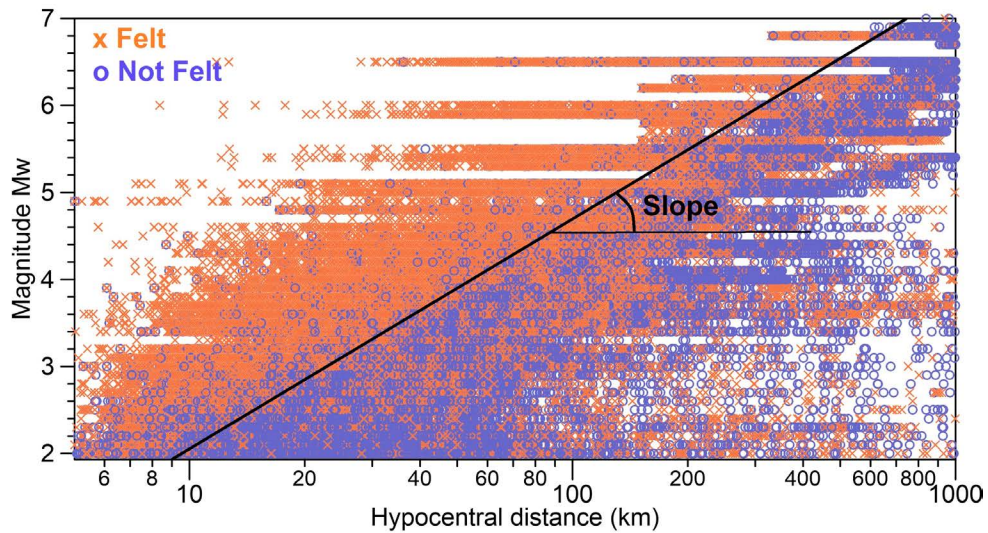


Figure 2 “Felt”-“Not felt” discriminant line for all stationary observers inside a building. Slope=2.64.

Our findings highlight the influence of floor and building height on earthquake perception. Accurate macroseismic intensity assessment requires considering ground motion frequencies and building resonance.

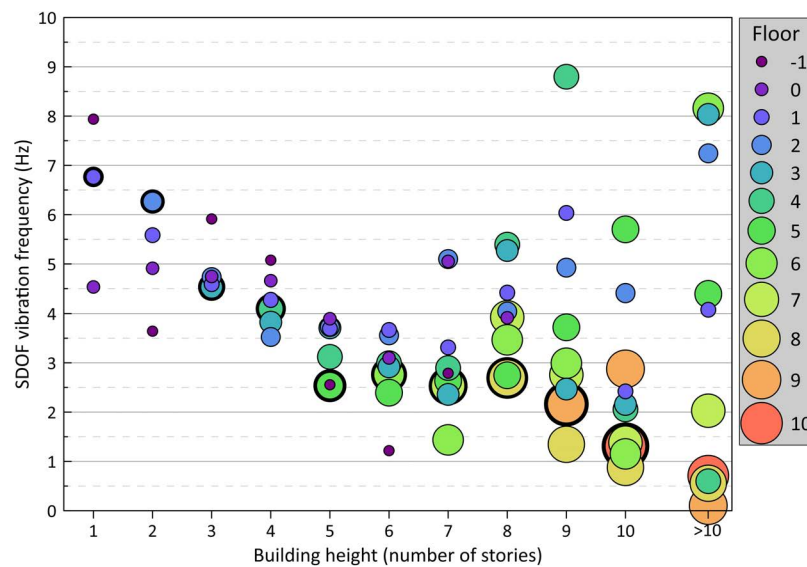


Figure 3 SDOF vibration frequencies, estimated by comparing slope values (Figure 2), calculated for each floor and building height combination, with those obtained from the GMM by Cauzzi and Faccioli (2008). Bold circles identify top floors.

Figures are taken or modified from Tosi et al. [2023].

Keywords

Earthquake perception; Floor, Building height; Vibration frequency

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The subsoil of the city of Rome (Italy): results from a dense temporary seismic network

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We present the results from a temporary seismic network of 24 stations installed in the urban area of Rome (Italy) in the period 10/01-08/04/2021 [Vassallo et al., 2024], with the aim of studying the city's urban subsoil through analysis based on ambient seismic noise in the framework of an INGV open research project (RicercaLibera 2019).

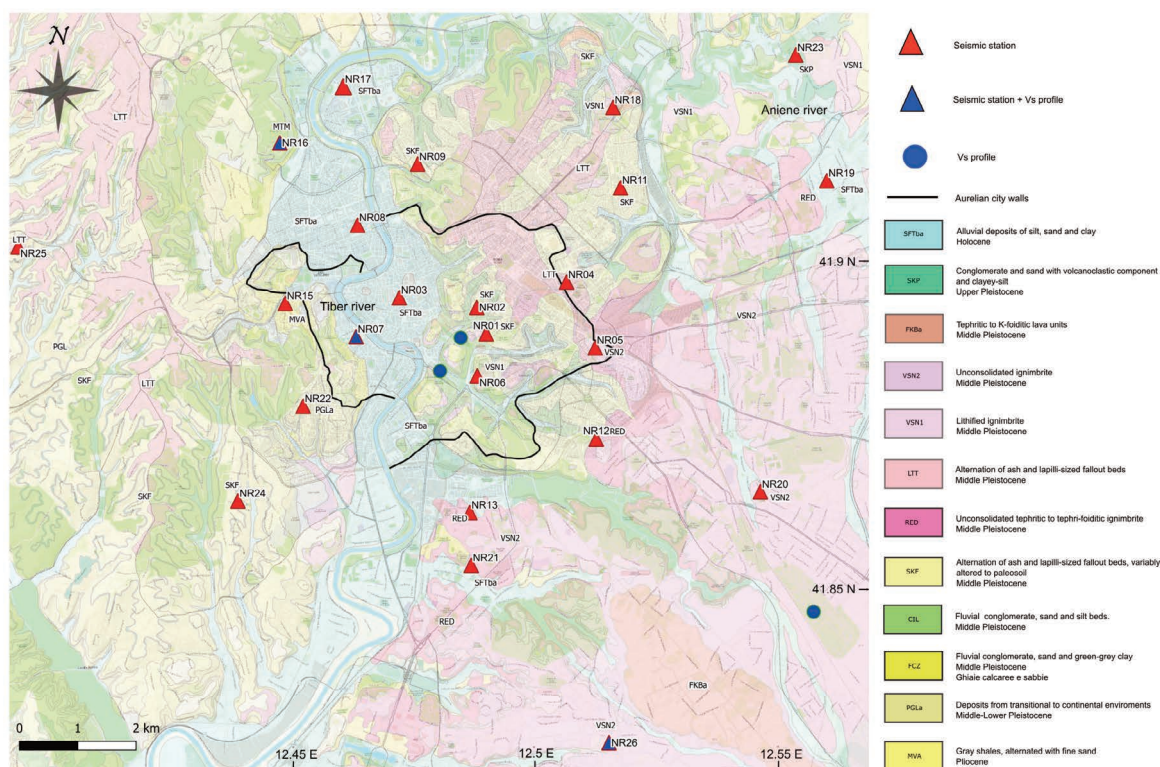


Figure 1 SPQR network deployed in the city of Rome, with simplified geological map. The black line demarcates the ancient city walls and thus the historic center of Rome.

Rome is the largest Italian city of about three million inhabitants, with a history of art, architecture and culture dating back almost 3000 years ago. The city retains a monumental heritage characterized by a high fragility due to its age, making the city particularly vulnerable to possible earthquakes, even if the seismic hazard of the area is considered as moderate.

The continuous recordings from the network allowed the use of ambient seismic noise to derive spectral ratios at sites located in different geological and lithological contexts [Vassallo et al., 2023]. Moreover, signals from regional earthquakes were surprisingly well recorded despite the high anthropic noise-level, showing a clear areal variability referable to site effects. In this case, we also benefit from a low-noise period due to the partial lockdown for COVID19 pandemia.

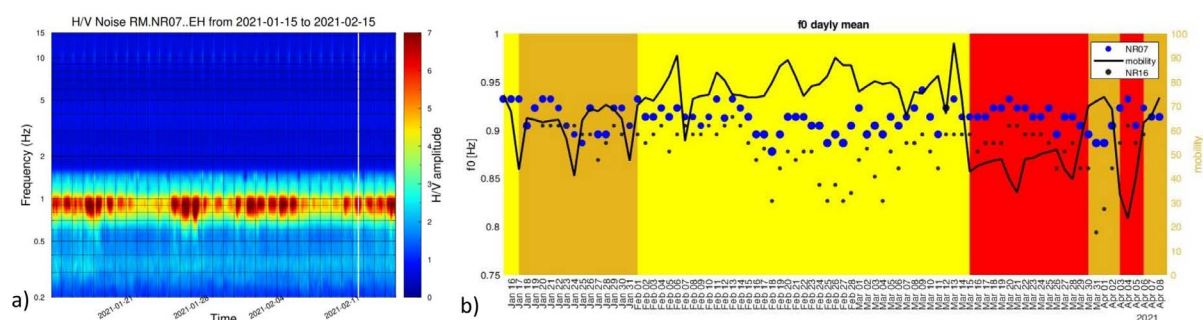


Figure 2 Horizontal-to-Vertical spectral ratios computed with HVNEA software [Vassallo et al., 2023] to evaluate the temporal variability of frequencies and amplitude peaks in connection with anthropogenic noise and the restriction regime of citizens' activities due to the COVID-19 pandemic. a) HV amplitude as a function of time and frequency for NR07. b) variability of frequency and amplitude peaks (scale on left side), compared with car traffic in black line (scale on right side) and anthropic activities in general (Yellow: primary schools and stores open up to 6.00 PM. Orange: stores only for take away, prohibition of movement between municipalities. Red: schools and stores closed).

Interferometric analysis, based on seismic noise cross-correlation of acquired data, shows that it is possible to reconstruct the surface waves at the different station pairs in the frequency band between 0.2 and 1 Hz. It is then possible to perform a 3D velocity model through Ambient Noise Tomography to characterize shapes, thickness and properties of different geological and lithological units of the subsoil of the city [Vassallo et al., 2019; Di Giulio G. et al., 2020].

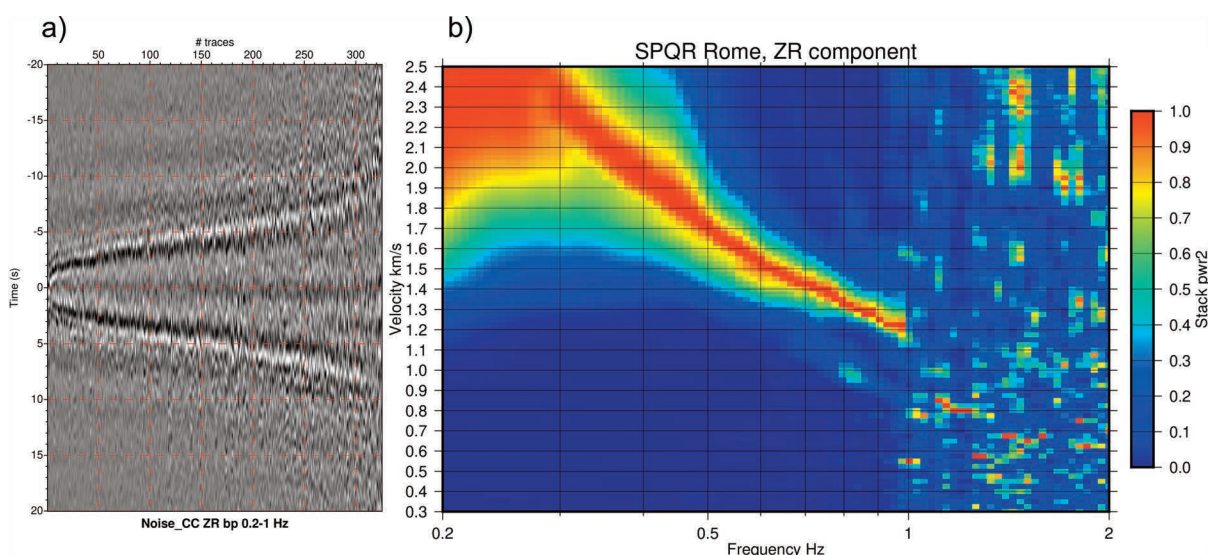


Figure 3 a) Cross-correlation stack functions (ZR components) showing empirical Green's functions of station pairs, with traces organized for increasing interstation distance, filtered in 0.2-1 Hz and normalized to its maximum value. b) Surface-waves velocity on ZR cross-correlations functions in 0.2-2 Hz; color scale is the normalized Phase-Weighted Stack value.

Keywords

Urban Seismology; Passive Seismic Interferometry; Site effects

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EPOS Open Source: A platform for integrating high-quality research products and services

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The European Plate Observing System (EPOS) is an integrative, multi-disciplinary research infrastructure, for the solid Earth science community in Europe. Aimed at fostering sustainable answers to questions about geo-hazards and relevant geodynamic phenomena, EPOS bridges the gap between Earth scientists, IT professionals, decision-makers, and the public. At the heart of EPOS is the EPOS Data Portal, which offers a seamless interface for the discovery, access, and integration of data and services. To promote a more collaborative and open approach, EPOS has launched an open-source version of its Data Portal (<https://www.ics-c.epos-eu.org/>). This open-source release includes the software's entire microservice-based code, detailed documentation, and is available under the GPLv3 license. The EPOS Open Source initiative not only allows for a broader user spectrum, from individual researchers to infrastructure developers, but it also encourages contributions from the global community. This participatory approach ensures the adaptability and advancement of the platform, enhancing scientific collaboration across diverse disciplines. The entire platform and its resources are openly available on GitHub (<https://epos-eu.github.io/epos-open-source/>), fostering transparency, inclusivity, and progress in Earth science research.

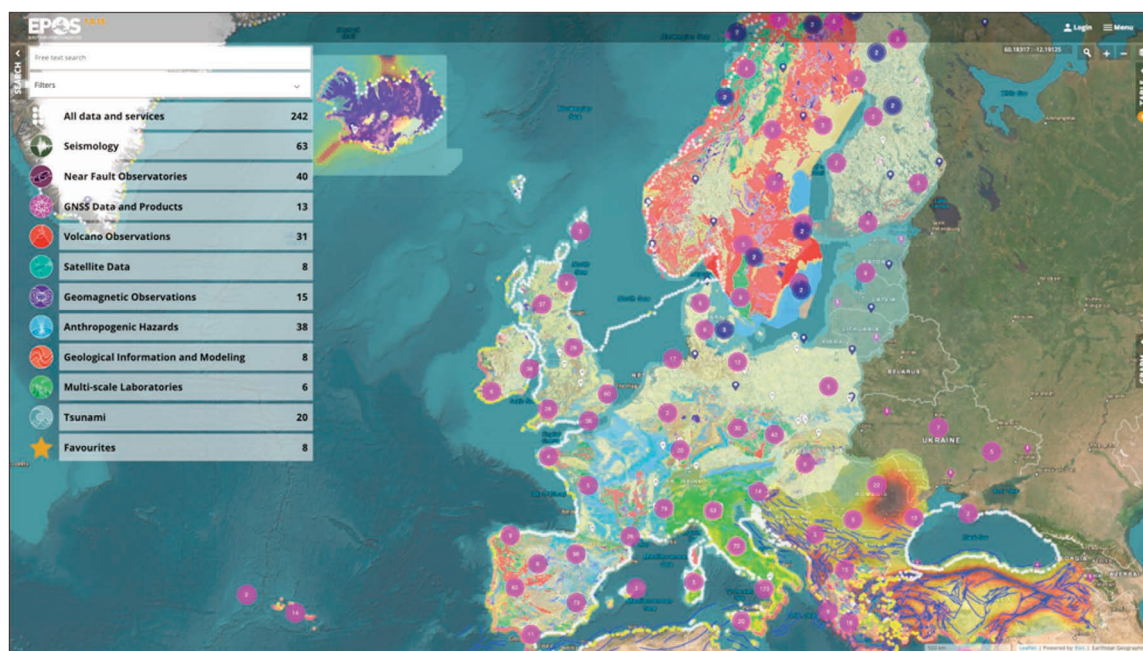


Figure 1 A screenshot of the EPOS Data Portal showing simultaneous visualization of heterogeneous datasets obtained from different disciplines in the solid earth domain. <https://www.ics-c.epos-eu.org/>

Keywords

EPOS; Open Source; Data Portal; Geo-hazards; Microservice-based Software

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