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Registration of Pre-Seismic Signals Related to the Mediterranean Area with the RDF System Developed by the Radio Emissions Project

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***Abstract**: In recent years, monitoring systems have been developed and are being tested for the detection of potential pre-seismic candidates. This study presents the RDF - Radio Direction Finding system of the Radio Emissions Project. The Radio Direction Finding system is an electromagnetic detection system that covers the entire terrestrial surface. This coverage is subdivided into colorimetric areas to which very precise azimuths are associated. The first monitoring station was built in Lariano (Rome, Italy), was created by the LTPA Observer Project and the Radio Emissions Project and allows monitoring of "crust diagnosis" in real time, on a global scale. This study presents and discusses two earthquakes that occurred in Italy, whose pre-seismic signals were monitored and intercepted by the monitoring stations of Lariano (Rome) and Pisa, a few days before the event.*
***Keywords**: RDF system, earthquake prediction, SELF-VLF, preselection precursors candidates*.

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I. Introduction

The studies carried out for several years by the Radio Emissions Project show how the monitoring of the natural electromagnetic background often indicates the existence of important electromagnetic emissions, before a strong earthquake [1] [2] [3]. For this purpose, the continuous monitoring of the natural electromagnetic bottom developed by Daniele and Gabriele Cataldi, serves to detect any radio emissions that may have pre-seismic characteristics able to alert in time, the occurrence of destructive earthquakes on a global scale. The studies in fact indicate that before strong earthquakes it is possible to receive electromagnetic signals with important characteristics that can indicate, with a certain degree of error, the geographic area within which an earthquake will occur[4].

In this regard, continuous monitoring of the SELF-VLF electromagnetic band (0-32 kHz) is active, through the use of a newly developed monitoring network, developed by the Radio Emissions Project.

In this study the results of this electromagnetic monitoring are treated, going to take as reference two Italian earthquakes occurred in 2018, and on which it was possible to perform an electromagnetic monitoring before these events occur.

1.1 – The RDF Network

The RDF Receiver Network, developed by the Radio Emissions Project is based on technology that evolved starting from the late 1800s thanks to the studies of Heinrich Hertz, who discovered the directionality of an open loop of wire used as an antenna. Compared to other electromagnetic monitoring systems employed within the scope of scientific research to forecast potentially destructive earthquakes (MW=6+), the RDF system allows 24/7 monitoring of a wide bandwidth of the Earth's background electromagnetic emissions to trace radio anomalies in seismically active areas of the terrestrial surface.

In 2017, 3 monitoring stations were equipped in the Italian national territory. In addition to that of Rome, it was activated in Pontedera (Pisa, Italy), equipped not only by a RDF system centered in the VLF band, but also a second RDF station centered in the SELF / SLF band ($3 > f \leq 30$kHz). Thanks to this monitoring network, the Radio Emissions Project has been able to carry out studies on the Earth's electromagnetic field, which have anticipated the occurrence of some earthquakes with a magnitude greater than M4 and other potentially destructive events occurring on a global scale.

1.2 – Mapping

The RDF - Radio Direction Finding system of the Radio Emissions Project, is a broadband electromagnetic monitoring system that covers the entire surface of the earth. This coverage is divided into

colorimetric areas to which very specific azimuths are associated (**Fig. 1a**).To understand the operation of the RDF system it is necessary to assume that the receiving system is able to provide a stereo signal coming from the antennas, aligned orthogonally and oriented towards the cardinal points.

The flow of radio signals coming from the antennas is subdivided into "colors" to which a forward direction is then associated.According to the colorimetric scheme used by the RDF station, the cardinal points and the goniometric values associated with the individual composing this scheme, indicate geographic areas (near or far) radially displaced with respect to the position of the monitoring station.

The result is a subdivision into "strips" all having the same length (about 20,000 km) that start from the geographic position where the station is located and all join at the "antipodal point" of the station itself.

II. Instrumental Used

2.1– The first RDF Station in Lariano (Rome, Italy)

The first RDF station (Radio Direction Finding) considered in this study is that of Lariano (Rome, Italy, Lat: 41.729535N, Long: 12.840968E), equipped with two 1 meter diameter Loop antennas containing 50 turns each (**Fig. 1b**), aligned orthogonally with respect to the geographical poles.

It is managed by Dr. Daniele Cataldi and is equipped with a prototype radio receiver designed and built by Gabriele Cataldi that is able to detect changes in the electromagnetic field in the band VLF (0.3-30kHz) 24/7.

2.2– The second RDF Station in Pontedera (Pisa, Italy)

The second RDF station (Radio Direction Finding) considered in this study is that of Pontedera (Pisa, Italy, Lat: 43.672479N, Long: 10.640196E), equipped with a prototype radio receiver identical to that present in the RDF station in Lariano (Rome, Italy) and two coil antennas instead of two loop antennas (**Fig. 1c**): this innovative RDF system was conceived to obtain a higher sensitivity to magnetic excursions of the Earth's geomagnetic field.

This electromagnetic monitoring network of the Radio Emissions Project was tested between 2017 and 2018 thanks to Mr. Carlo Magretti, radio amateur and collaborator of the Radio Emissions Project, which manages the Pontedera RDF monitoring network.

The antennas of the RDF monitoring station in Pontedera were built by Mr. Carlo Magretti and positioned about 2 meters above the ground, they have a length of one meter and each contain 2000 turns in enameled copper wire. The core of the two coil antennas is ferromagnetic: made up of 90 cm long soft iron bars. This station is centered on a detection frequency that goes from the SELF band to the SLF band (3> f≤150Hz) and operates 24H7. (**Fig. 2**).

III. Data

Case 1– Earthquake ML 4.2 - 28-09-2018 at 05:24:31 (UTC) - South-western Calabria coast.

The received signal

On 23 September 2018, at 11.00 UTC, the RDF station in Pontedera (Pisa, Italy) received an electromagnetic increase in the SELF-SLF band (3> f≤150Hz) of the impulsive type, which was detected until 03.40 am UTC of September 24, 2018, and then disappear in a few minutes. The total duration of the electromagnetic anomaly was 4 hours and 40 minutes. According to the RDF data, this electromagnetic increase (on the red / violet colored spectrogram) had an azimuth of precise origin: S-E - N-W. The morphology of the electromagnetic anomaly, when compared to the other anthropogenic radio emissions visible in the spectrogram (such as the 50Hz emission of the Italian domestic electricity grid, including the respective resonance harmonics at 100Hz and 150Hz (**Fig. 3**), was typical of a natural and not anthropic radio emission.

Possible source of the signal

The possible origin of the signal was therefore identifiable along the azimuthal axis of the emission, calculated by the RDF system with respect to the position of the city of Pontedera: S-E - N-W (**Fig. 4 and Fig. 5**).

The spectrographic characteristics of the electromagnetic anomaly have shown that it has presented a higher intensity between 80Hz and 160Hz, with peaks of increase recorded in the following times (UTC):

1. 23:40 – 23/09/2018
2. 00:10 – 24/09/2018
3. 01:10 – 24/09/2018
4. 01:30 – 24/09/2018
5. 03:10 – 24/09/2018

The earthquake

After about 1 hour from the disappearance of this strong electromagnetic increase (ended at 03:40 UTC), an earthquake of magnitude ML4.2 occurred (on 28-09-2018) at 05:24:31 (UTC) along the Calabria South West Coast of Italy (Catanzaro, Vibo Valentia, Reggio di Calabria).

It was located at the following GPS position (Global Positioning System): 38.38N 15.73E and at a depth of 11 km (INGV data).

The study of the data provided by the Pontedera station (Pisa, Italy) highlighted how the seismic epicenter was located right on the red / violet azimuth indicated by the Radio Emissions Project detection station and managed by Mr. Carlo Magretti (**Fig. 5**). The RDF compass has in fact highlighted precisely the origin of this increase.

In this context it was extremely important to note the presence of a strong natural signal coming from a precise azimuthal direction, and the position of the seismic epicenter, located along this axis highlighted by the RDF system of the Radio Emissions Project before the earthquake occurred. In this context the study group had already identified the Italian geographical areas positioned on this azimuthal axis.

The recording of this vast electromagnetic increase was possible thanks to the use of the radio receiver prototype built by the Radio Emissions Project and installed in the receiving station of Pontedera, Pisa, Italy.
The signals coming from the coil antennas, have been filtered and amplified to highlight these emissions contained in the SELF-VLF band.

Case 2 – EarthquakeMw3.7 of 21-08-2018 hours 00:33:45 (UTC) - 3 km N Bagnolo in Piano (RE), (**Fig. 6**).
On 19 August 2018, the RDF station of Lariano (Rome, Italy) of the Radio Emissions Project, recorded intense electromagnetic increments located on a precise azimuth (red/purple) between 07:35 UTC and 15:10 UTC (**Fig. 7 and Fig. 8**).

Also in this case the reception system, based on a prototype created by the Radio Emissions Project itself, identified the geomagnetic increments having a precise azimuth of origin, as visible from the spectrograms generated by the Spectrumlab software, used for the processing of electromagnetic signals coming from from the loop antennas (**Fig. 7**).
The recorded increase peaks appeared at the following UTC times with their precise electromagnetic frequency:

1. 07:35 - 2500-15000 Hz
2. 09:20 - 2500-20000 Hz
3. 10:00 - 5000 Hz
4. 10:10 - 5000 Hz
5. 12:00 - 5000-13000 Hz
6. 12:30 - 5000-13000 Hz
7. 13:20 - 6500-11000 Hz
8. 14:00 - 6500 Hz
9. 14:20 - 6500 Hz
10. 14:55 - 6500 Hz
11. 15:05 - 6500 Hz

Increases recorded by the station of Lariano, Rome, Italy, from 07:35 UTC at 15:05 UTC on 08/19/2018.

At approximately 18:30 UTC, on August 20, 2018, the RDF station in Pontedera (Pisa, Italy) recorded an intense electromagnetic increase with red azimuth, which lasted several hours, until it disappeared at 23:20 UTC, as shown in **Fig. 9**

The azimuthal data of both RDF stations indicated a very precise area ofItalian territory (**Fig. 6**); in fact they allowed to realize an azimuthal triangulation identifying a geographical area located in the North of Italy, a few kilometers from Parma (**Fig. 10**):

The two RDF monitoring stations (that of Pontedera and that of Lariano) are separated by a distance of about 282 km as the crow flies (**Fig. 11**): this separation allowed a certain degree of precision of the triangulation of the radio.

IV. Discussion

In the first case it is clear how the RDF system developed by the Radio Emissions Project has detected an important electromagnetic phenomenon (anomaly), whose azimuthal direction coincided with a geographical area in which, 5 hours later, the appearance of the electromagnetic anomaly an earthquake of magnitude ML4.2 has occurred. This increase occurred at a short distance from the earthquake and therefore it is possible to hypothesize that this signal was a Seismic Electromagnetic Precursor (SEP), ie an electromagnetic signal generated near the seismic epicenter, considering the azimuthal data.

In the second case, the RDF radio stations of the Radio Emissions Project Network allowed to detect an area of the Earth's surface relative to the Italian territory (Northern Italy), within which there occurred an earthquake of magnitude Mw3.7. The electromagnetic increments detected by the two RDF monitoring stations had the following characteristics:
Lariano (Rome, Italy):

- Appearance of radio-anomalies at 07:35 UTC on 19 August 2018.

Pontedera (Pisa, Italy):

- Appearance of radio-anomalies at 18.30 UTC on 20 August 2018.

If we consider that the earthquake Mw3.7 occurred at 00:33 UTC on 21 August 2018, it is clear that the electromagnetic signals detected by the RDF stations were received 41 hours before the earthquake (Lariano RDF station) and 6 hours before the seismic event (Pontedera RDF station). In this case, both RDF stations provided precise azimuth and spatial indications on the area where the earthquake occurred.

V. Conclusions

The RDF system of the Radio Emissions Project demonstrated the ability to record radio signals with azimuthal characteristics that allowed to highlight a geographical area on which, and several hours later, a seismic event of magnitude M3 + was recorded. Taking into consideration the characteristics of the azimuthal data provided by the RDF stations of the Radio Emissions Project it is clear that the Italian earthquake Mw3.7 was preceded by electromagnetic signals that, if interpreted with the right technologies (RDF), have a predictive meaning. The ML4.2 quake occurred off the coast of Calabria was indicated by a strong increase recorded by the RDF station in Pontedera, managed while the earthquake of magnitude Mw3.7 occurred north of Bagnolo in Pieno (Italy) was identified thanks to the triangulation radio signals (electromagnetic increments) recorded by both Italian electromagnetic monitoring stations belonging to the Radio Emissions Project Network (Pontedera-Lariano). In conclusion, this study demonstrates that there are natural electromagnetic sources that have potential characteristics of seismic predictivity, that is the electromagnetic seismic precursors.

Acknowledgments. We would like to thank Carlo Magretti for his direct commitment through electromagnetic monitoring through the Pontedera station (Pisa, Italy), which is essential for the progression of this study.

ReferencesCited

[1]. Straser, V., Cataldi, G. and Cataldi, D., 2016. SELF and VLF electromagnetic signal variations that preceded the Central Italy earthquake on August 24, 2016. NCGT Journal, vol. 4, no. 3, p. 473-477. Harvard-Smithsonian Center for Astrophysics, High Energy Astrophysics Division, SAO/NASA Astrophysics Data System.

[2]. Cataldi, G., Cataldi, D., Rossi, R. and Straser, V., 2016. SELF-ELF Electromagnetic signals correlated to M5+ Italian Earthquakes that occurred on August 24, 2016 and January 18, 2017. NCGT Journal, vol. 5, no. 1, p. 134-143.

[3]. Cataldi, D., Cataldi, G. and Straser, V., 2017. SELF and VLF electromagnetic emissions which preceded the M6.2 Central Italy earthquake that occurred on August 24, 2016. European Geosciences Union (EGU), General Assembly 2017. Seismology (SM1.2)/Natural Hazards (NH4.7)/Tectonics & Structural Geology (TS5.5). The 2016 Central Italy Seismic sequence: overview of data analyses and source models. Geophysical Research Abstracts Vol. 19, EGU2017-3675.

[4]. Straser V., Cataldi D., Cataldi G., Radio Direction Finding System, a new perspective for global crust diagnosis. New Concepts in Global Tectonics Journal, v.6, no. 2, June 2018, p. 203-211.

Figures

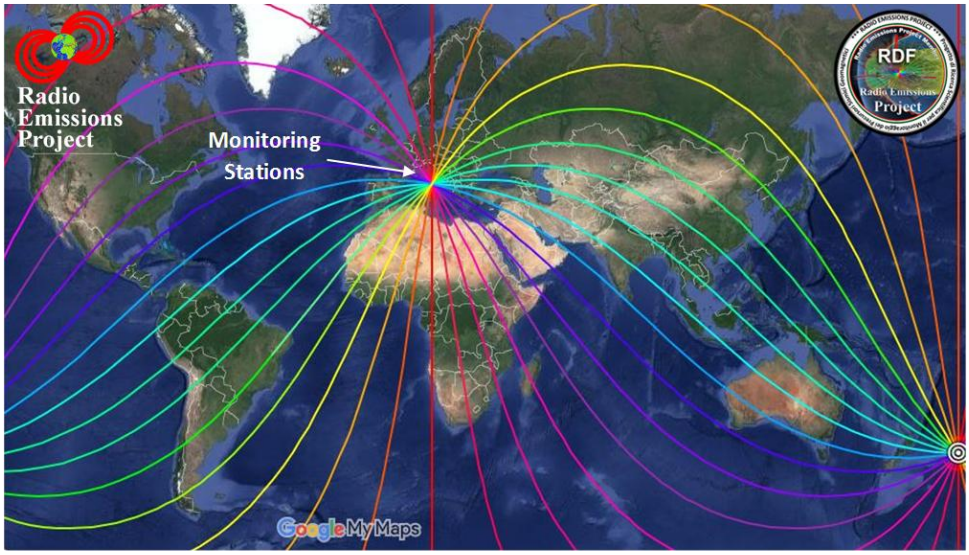

Fig.1a. World Mapping of the RDF system, developed by the Radio Emissions Project, located in Lariano (Rome, Italy).

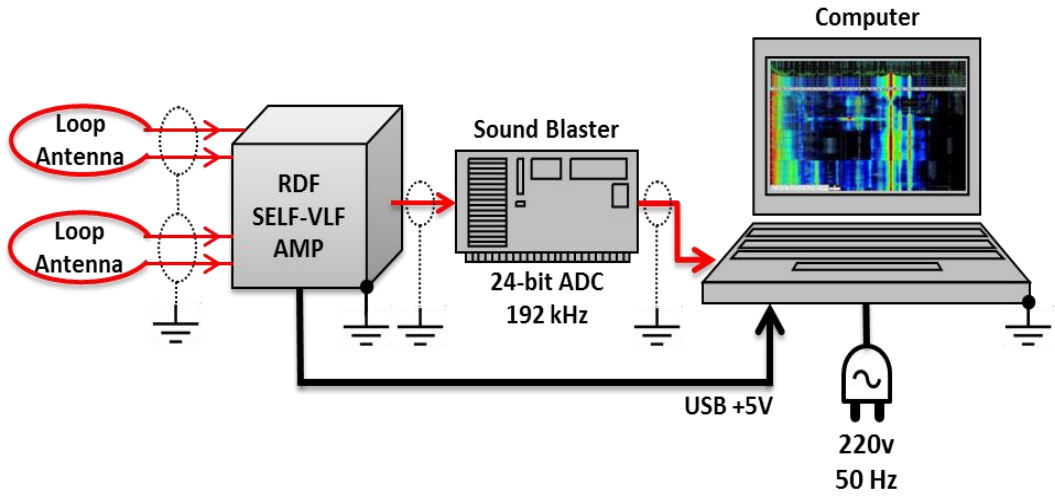

Fig.1b. Schematization of the RDF Radio Direction Finding receiving and amplification system located in Lariano, Rome, Italy; developed by the Radio Emissions Project, and used for this study. It consists of two Loop antennas, a radio amplifier (receiver), connected to the PC's microphone socket, via the Sound Blaster.

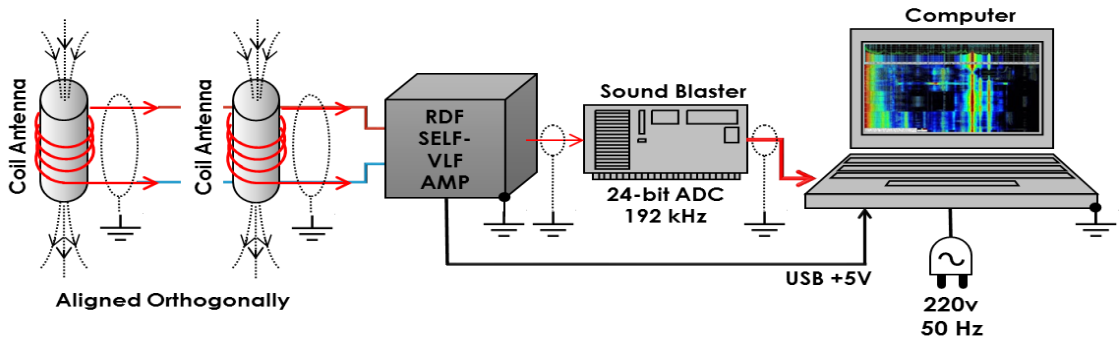

Fig. 1c. Schematization of the RDF Radio Direction Finding receiving and amplification system located in Pontedera, Pisa, Italy; developed by the Radio Emissions Project and Carlo Magretti, and used for this study. It consists of two coil antennas, a radio amplifier (receiver), connected to the PC's microphone socket, via the Sound Blaster.

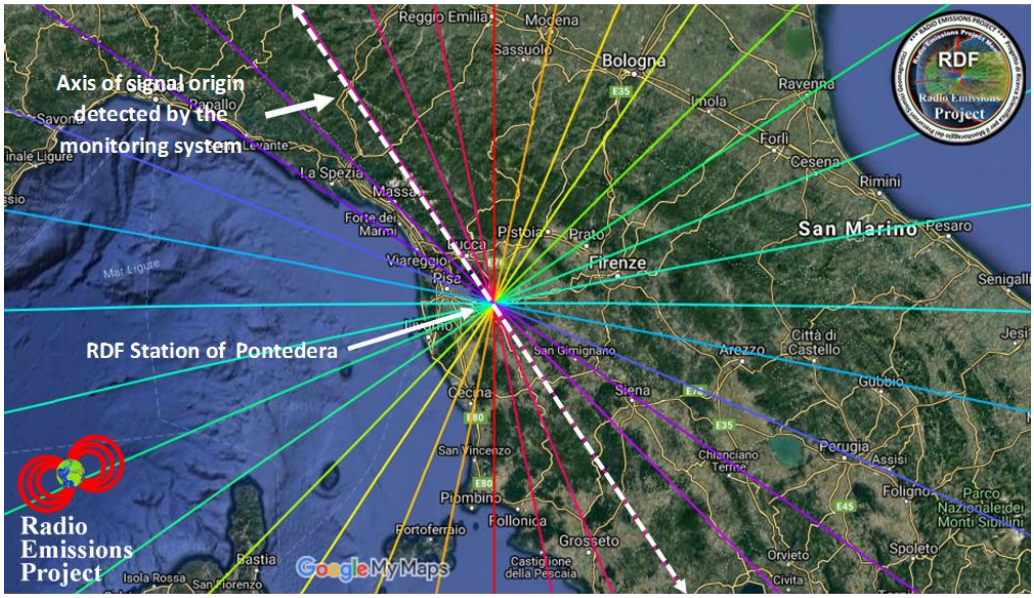

Fig. 2. Word Mapping of the RDF system, developed by the Radio Emissions Project Network, located in Pontedera (Pisa, Italy).

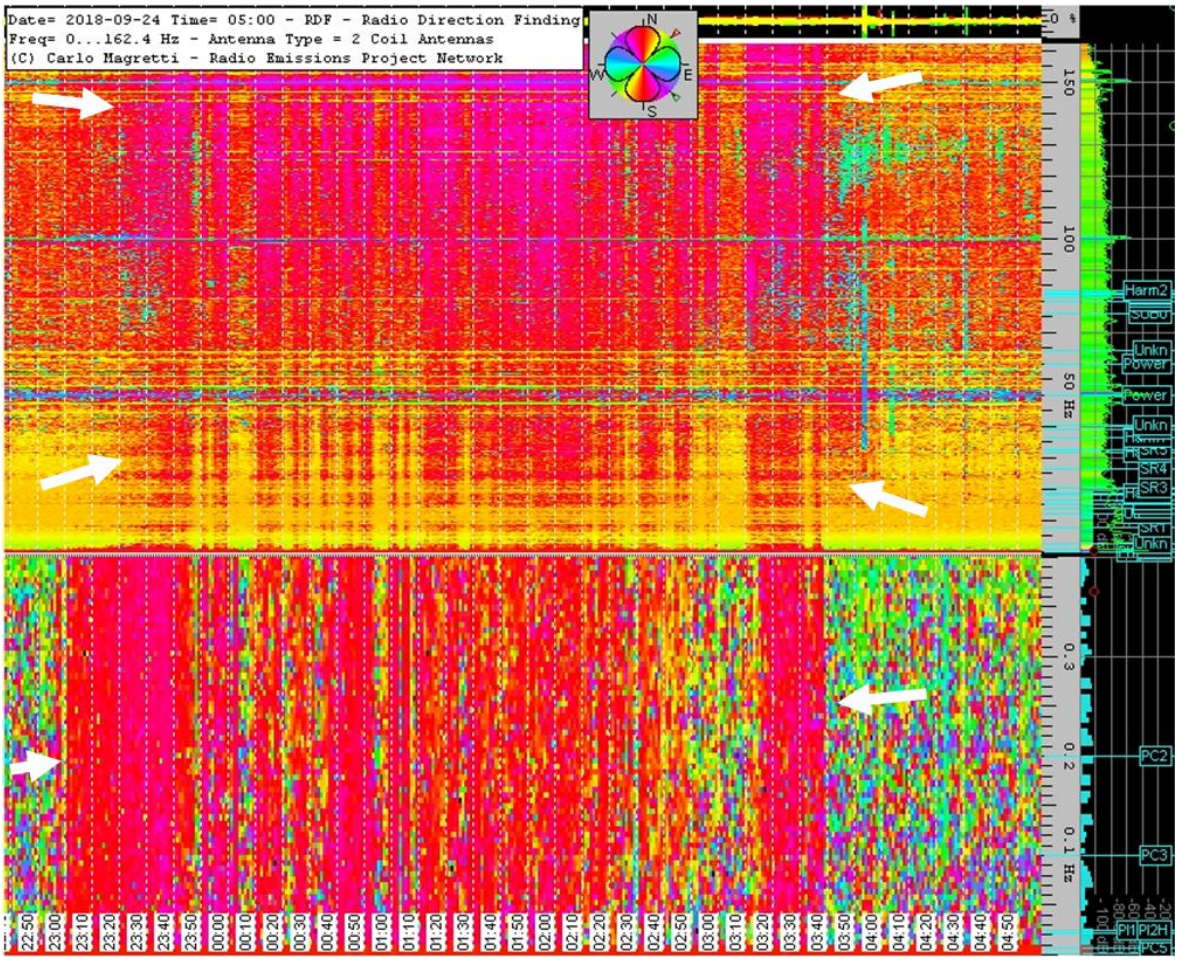

Fig. 3. Word Mapping of the RDF system, developed by the Radio Emissions Project Network, located in Pontedera (Pisa, Italy). In this case it is observed that the area indicated by the signal received was south Italy or the north of the Peninsula.

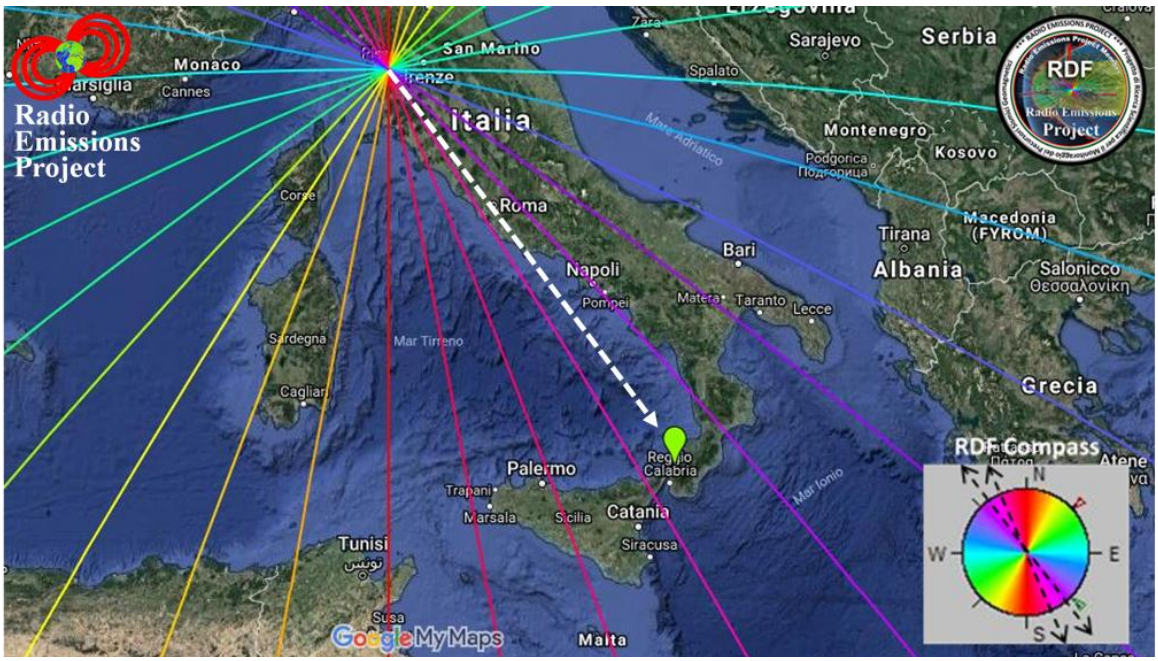

Fig. 4. Word Mapping of the RDF system, developed by the Radio Emissions Project Network, located in Pontedera (Pisa, Italy). In this case the position of the seismic epicenter considered in the study.

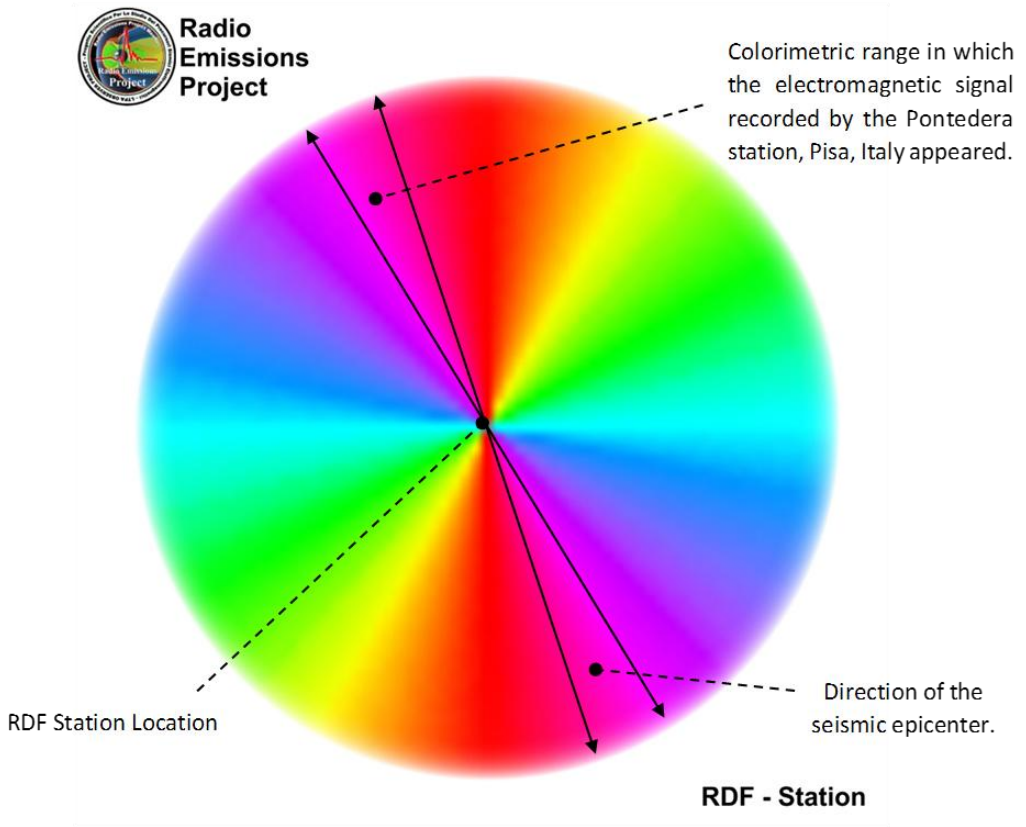

Fig. 5b. Colorimetric mapping of the azimuths of the RDF stations developed by the Radio Emissions Project.

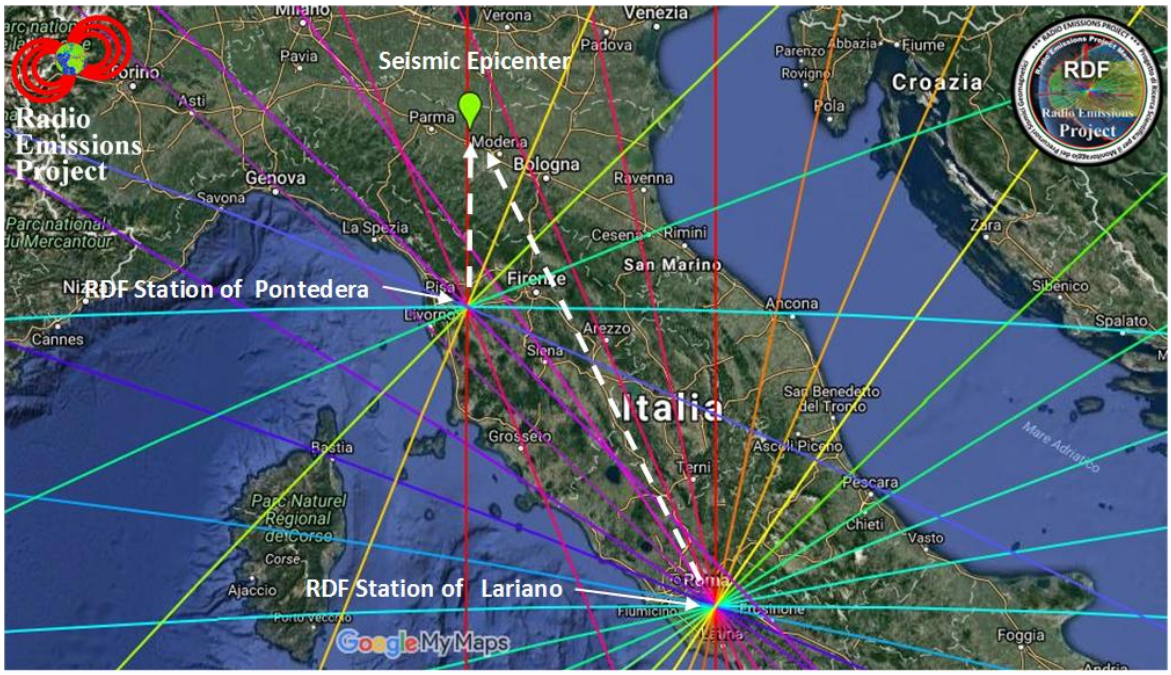

Fig. 6. Seismic epicenter and the world map of the RDF system developed by the Radio Emissions Project. It shows the position of the earthquake and the triangulation of the signals made by the two Italian stations (Lariano, Rome, Italy and Pontedera, Pisa, Italy).

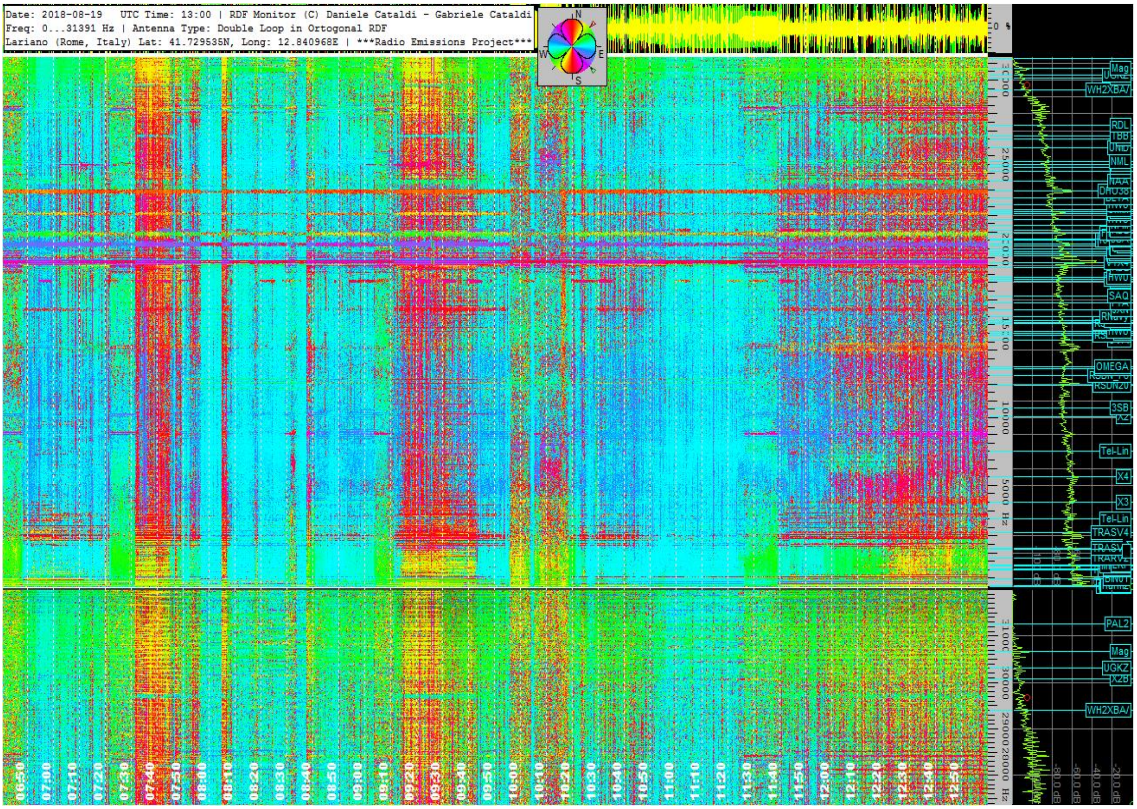

Fig. 7. Spectrogram of the RDF system of the Radio Emissions Project, where the presence of the signal with red / violet azimuth is highlighted.

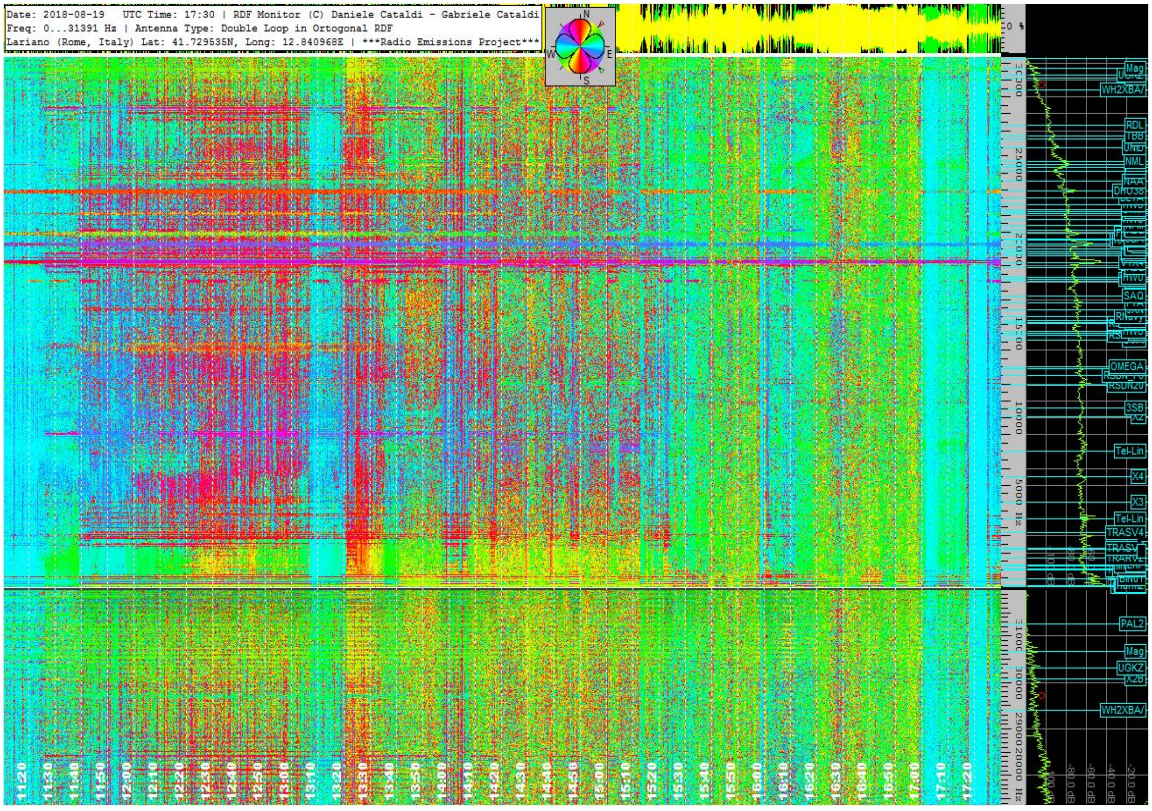

Fig. 8. Spectrogram of the RDF system of the Radio Emissions Project, where the presence of the signal with red / violet azimuth is highlighted.

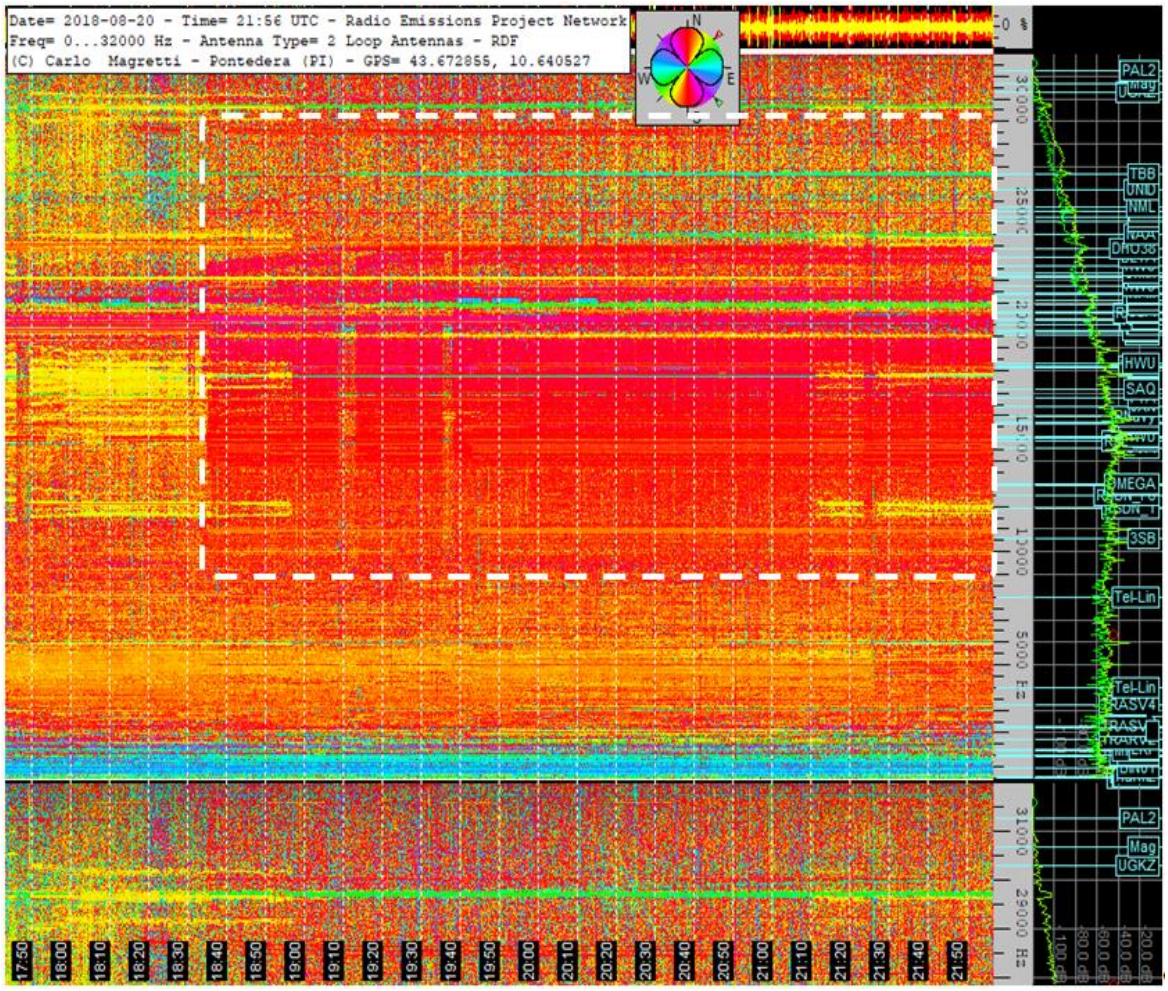

Fig. 9. Intense increase appeared on red azimuth, identified by the RDF station in Pontedera, Pisa, Italy.

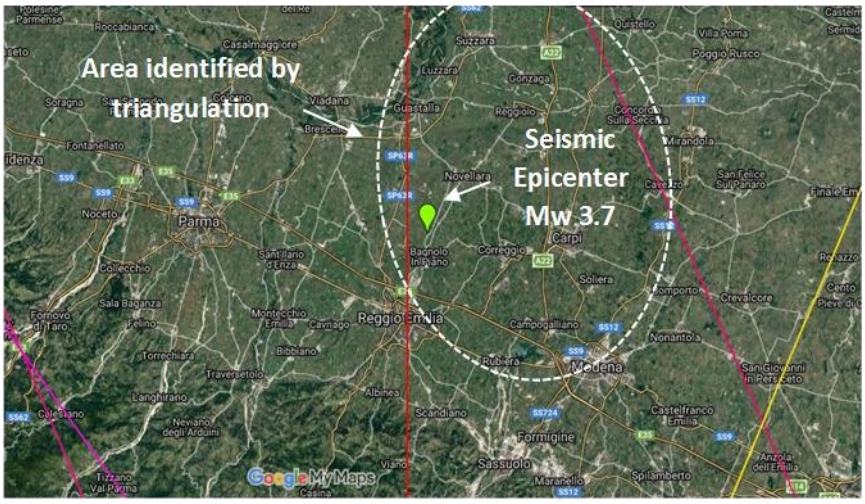

Fig. 10. Position of the seismic epicenter.

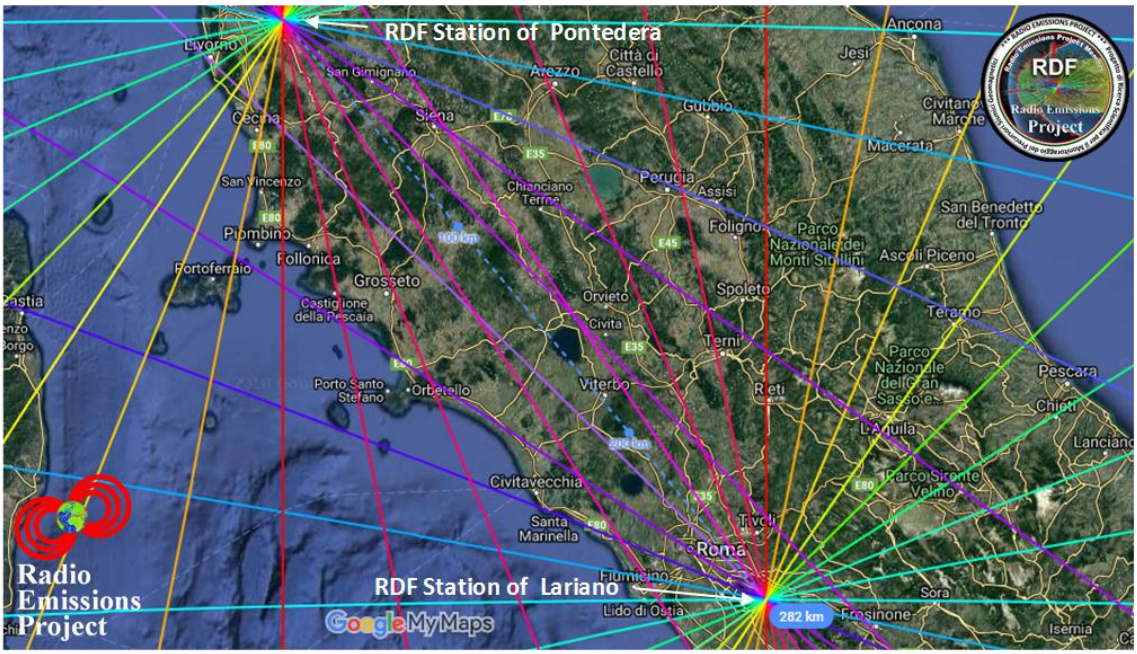

Fig. 11. Italian map showing the position of the two RDF stations considered in this case.

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