

ROMANIAN SEISMIC NETWORK

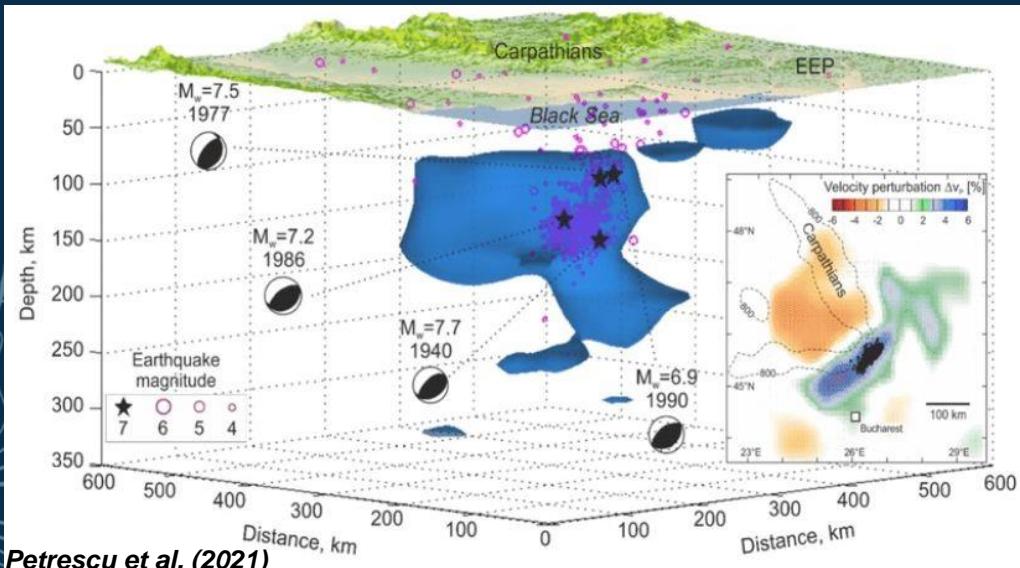
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National Institute for Earth Physics, Romania

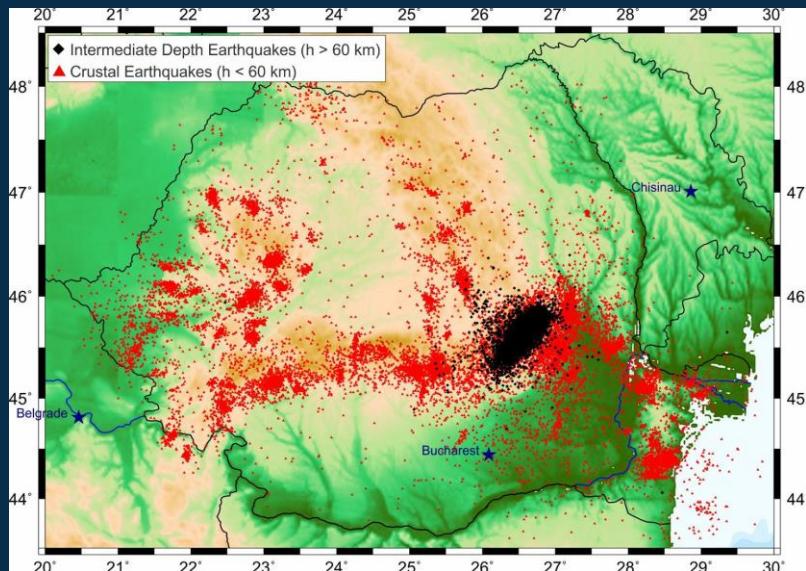
European Antelope Users Group Meeting June 2023

Seismic Activity in Romania

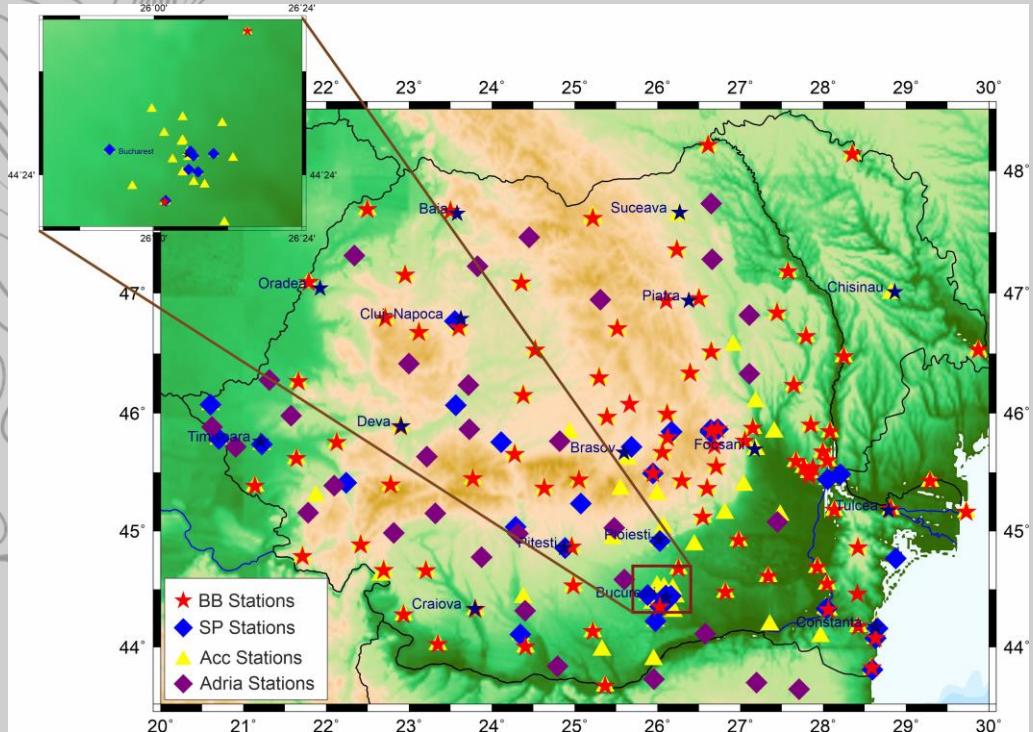
- Romania is characterized by moderate seismicity, generated by the occurrence of both crustal and intermediate-depth earthquakes
- Seismic activity is dominated by the subcrustal earthquakes generated in the upper mantle beneath the SE Carpathians (Vrancea Region) confined to a narrow ~ 100 km(height) $\times 70 \times 30$ km volume
- These earthquakes are the primary source of seismic hazard for Romania and Eastern Europe, with the most recent largest events reaching Mw 7.7 and 7.4 in 1940 and 1977, respectively, causing substantial damage.



Petrescu et al. (2021)



Real Time Romanian Seismic Network

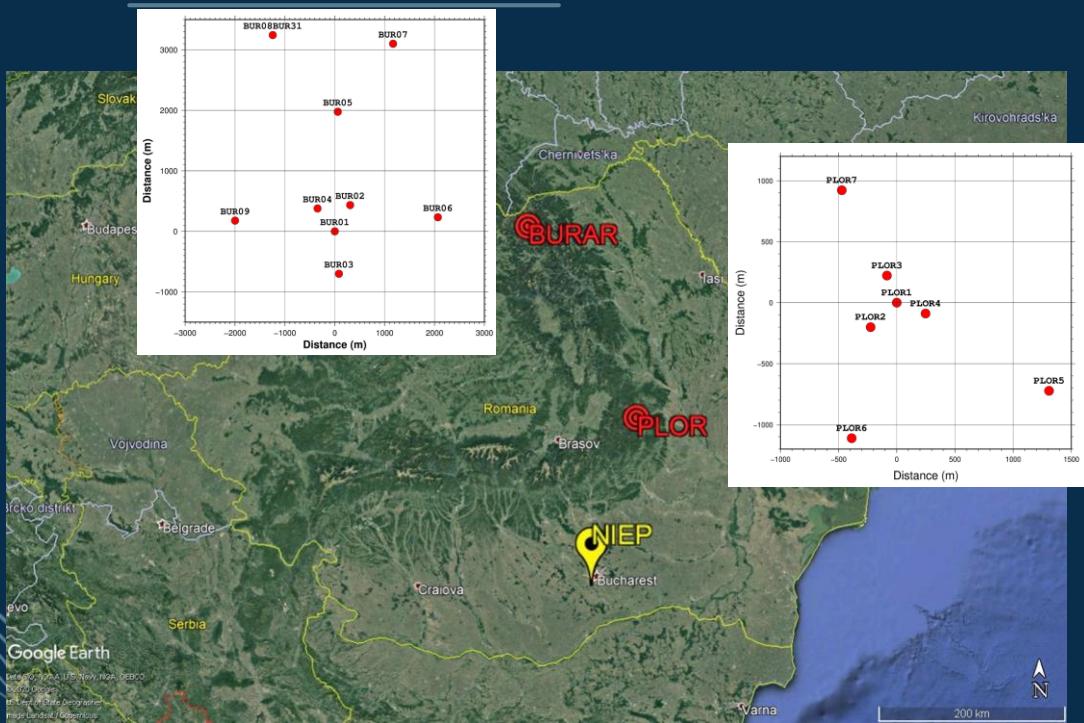


At present RSN operates:

- 2 seismic arrays
- 98 Broad Band Stations
- 52 Short Period Stations
- 180 Strong Motion Stations (21 in Bucharest area). Most of them are collocated with the velocity sensors.)

The RSN consists of different kind of instruments from various manufacturers: short-period sensors (Teledyne-Geotech S13 SH-1, GS21, Mark Products - I4c, L22, Kinematics - Ranger), broadband sensors (Guralp CMG3ESP, CMG40T, CMG-3T, Streckeisen STS2, Geotech KS2000, KS54000, MBB2, PBB, GEObit).

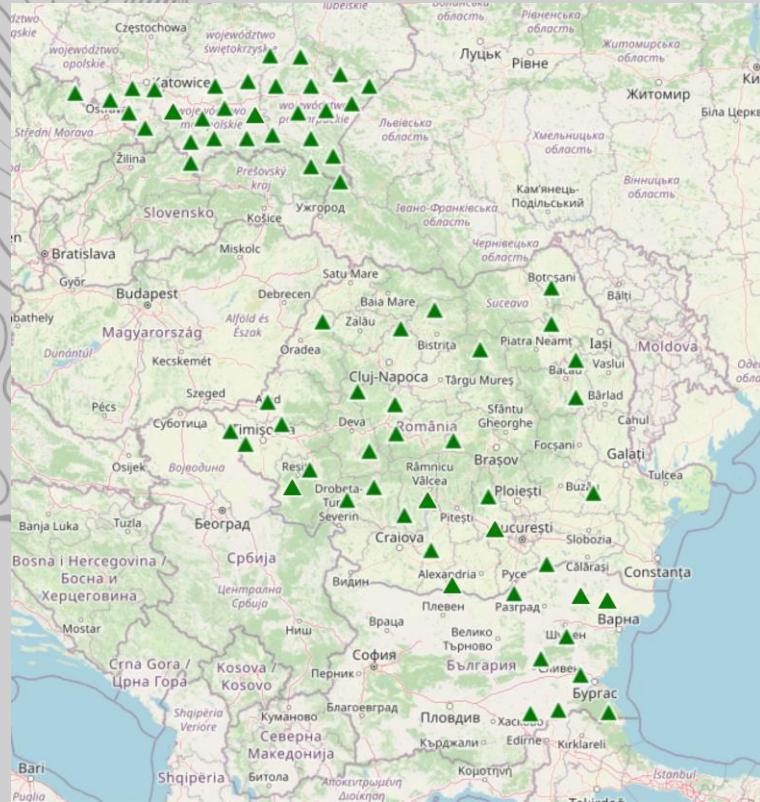
Seismic arrays in Romania



The 10 seismometers of the BURAR array are located in boreholes of 30, 45 and 60 m depth. Nine sites (BUR01, BUR02,..., BUR09) are equipped with vertical 1-C SP GS21 (Geotech Instruments) instruments; the tenth site of array (BUR31) is equipped with 3-C BB instrument: KS54000 (Geotech Instruments) (between 2002 and 2017) and CMG-40T (Guralp) (since August 2017).

The 7 seismometers of the PLOR array are located in vaults of 3 m depth. Six sites are equipped with S13 short period instruments and one (PLOR) - with 3-C BB mbb2 seismometer.

Contribution to Adria Array Network



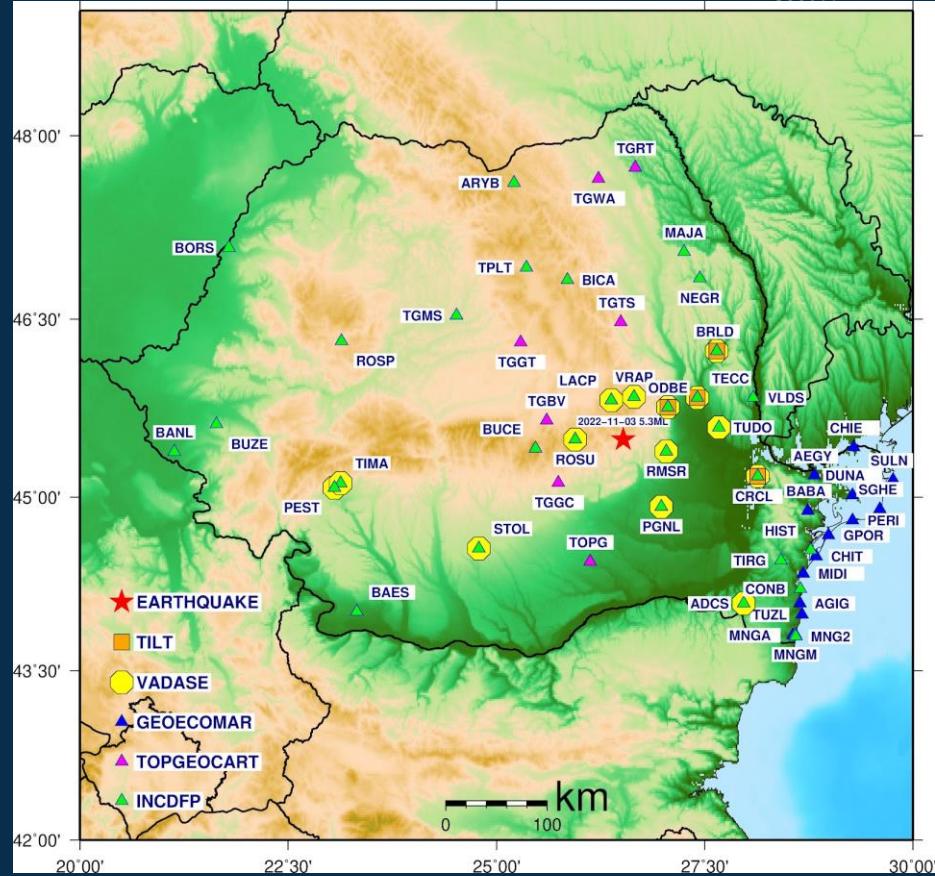
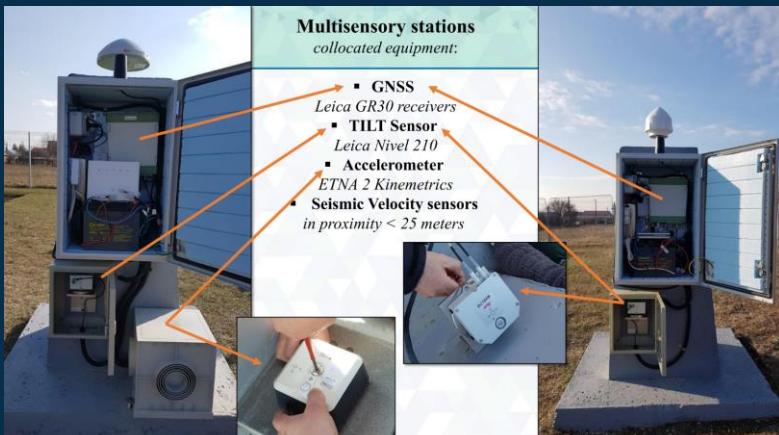
AdriaArray is a multi-national effort to cover the Adriatic Plate and its active margins in the central Mediterranean by a dense regional array of seismic stations to understand the causes of active tectonics and volcanic fields in the region. Plate-scale observations are complemented by local and LargeN experiments in key areas. The AdriaArray region reaches from the Massive Central in the west to the Carpathians in the east, from the Alps in the north to the Calabrian Arc and mainland Greece in the south.

The installation of the AdriaArray temporary stations started in June 2022. Since then, 75% of the approximately 400 planned temporary stations have already been installed in Europe.

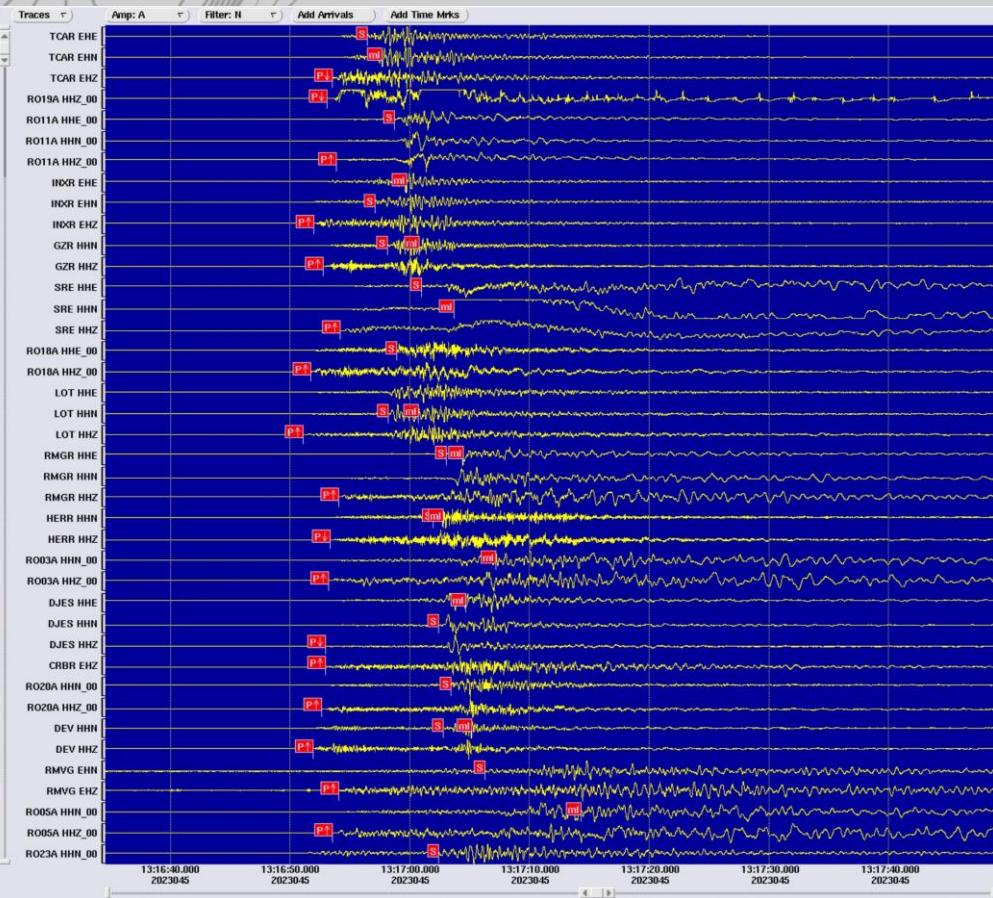
GNSS - Network

32 Real Time GNSS station

The GNSS permanent stations have different equipment, most of them are produced by Leica Company: GRX 1200 GG Pro, GRX 1200 + GNSS, GR10, GR30 si GR50 Professional and antenna models used are LEIAT 504, LEIAT 504 GG, LEIAR 10 și LEIAR 20 and three stations Septentrio



Antelope Software



Automatic processing:

- P-wave picking
- event association
- event localization
- computation of magnitude
- sending e-mail / SMS alerts
- Generating ShakeMaps

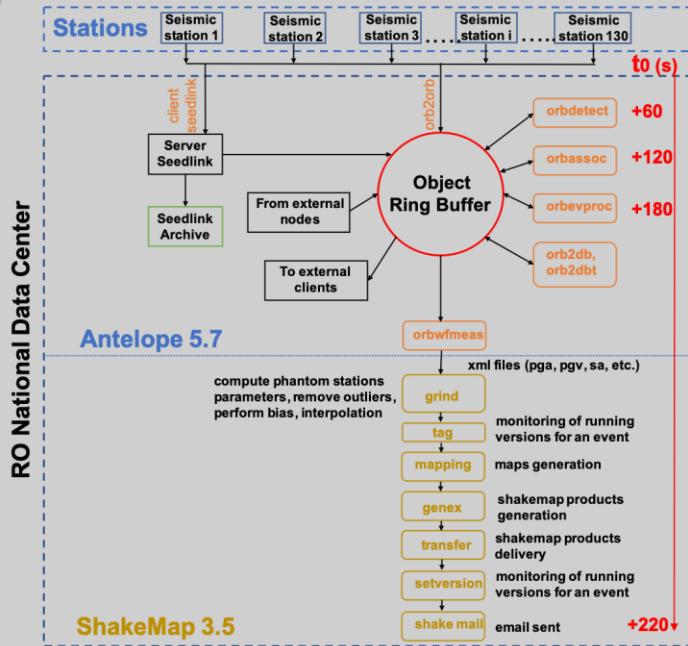
Manual processing:

- phase picking
- event association
- computation of magnitude
- creation of database
- sending reports/ bulletins
- Generating ShakeMaps

Shake Map

- Allows the rapid estimation of the intensity and severity of the ground motion after an important earthquake;
- PGA, PGV, SA and intensity maps are usually generated within 3-4 minutes after the earthquakes;
- ShakeMap output is input for any system for estimating seismic damage (in Romania, near-real time SEISDARO);
- Implemented in Romania in 2007.

Shake Map



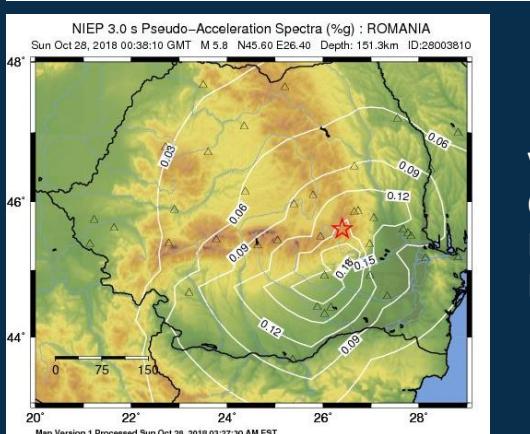
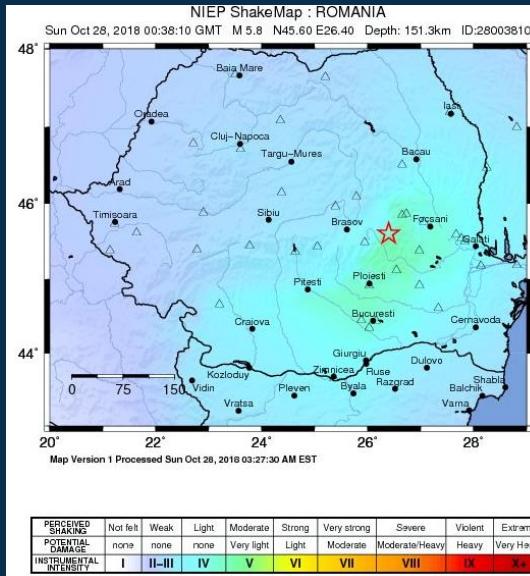
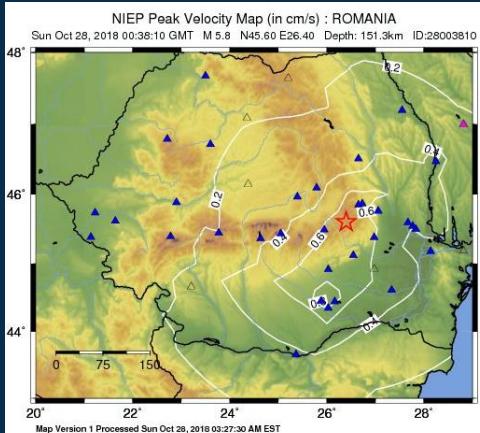
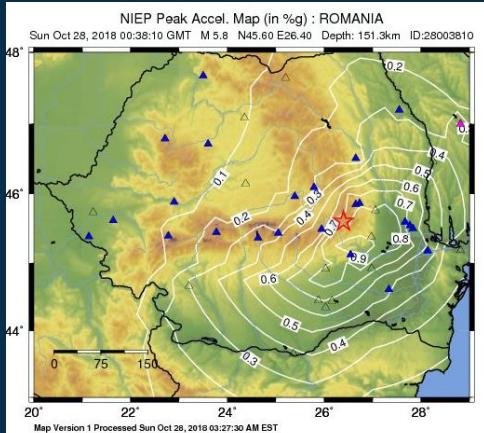
➤ ANTELOPE system:

- Acquire and process data in real-time
- Different processes to detect events, associate phases, process the event (location and magnitude), save data
- ~ 3 minutes until the automatic location is released (depending of the magnitude of the event and the number of stations used in localization)
- Module orbwfmeas performs waveform measurements (PGA, PGV, SA) for ShakeMap

➤ Grind module – main ShakeMap program

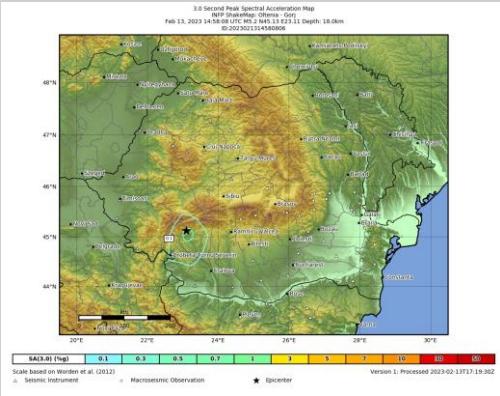
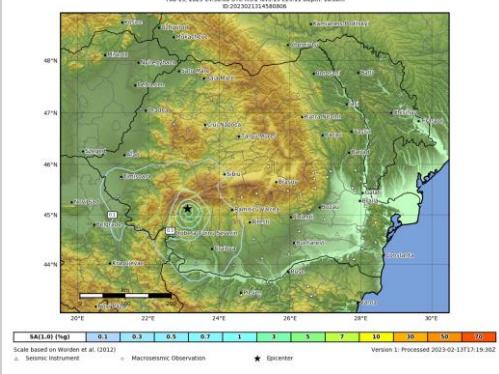
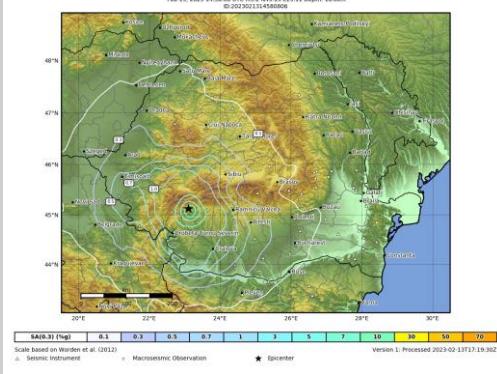
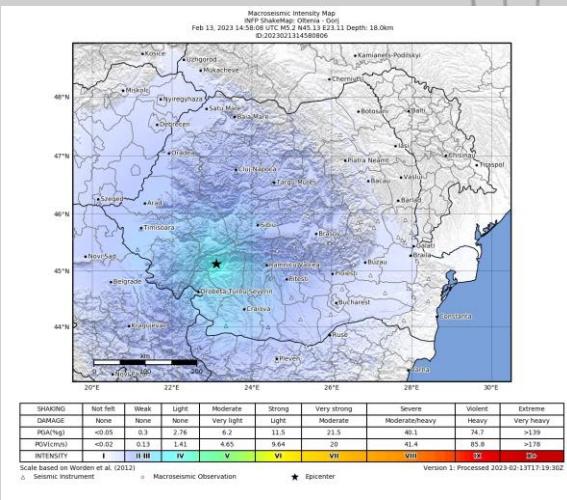
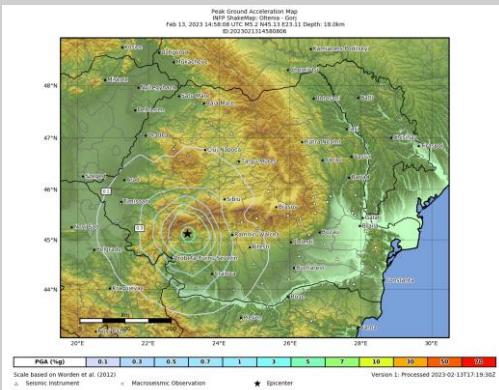
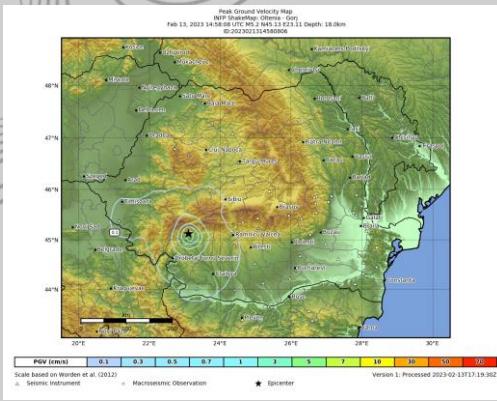
- ~ 5-6 minutes to generate automatic ShakeMap

Shake Map 3.5



Vrancea, 28
October 2018,
Mw=5.5,
Depth=148 km

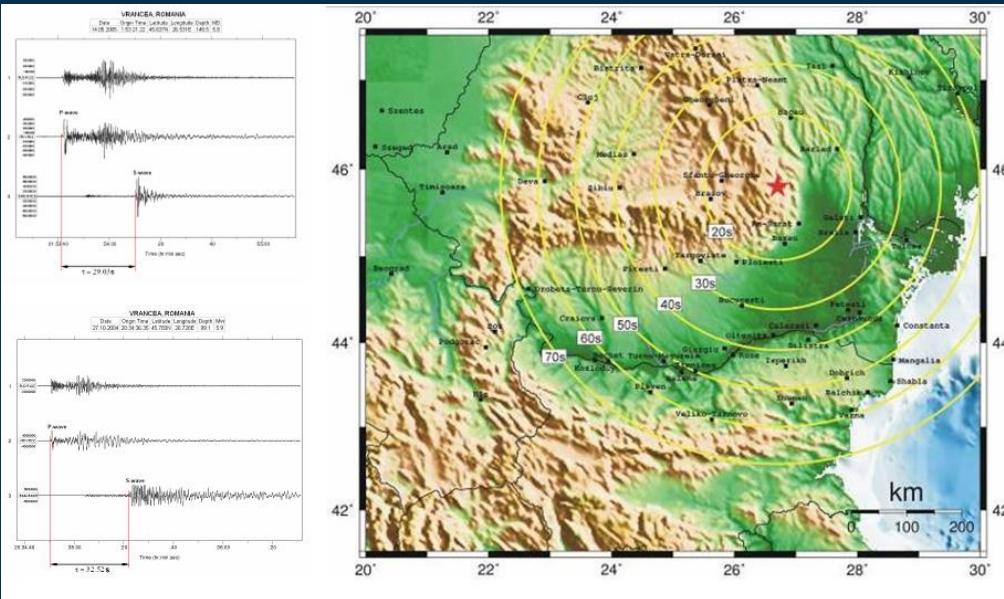
Shake Map 4.0



Gorj, 13
February 2023,
ML=5.2,
Depth=18 km

EEW in Romania

- Seismic risk in Romania dominated by deep Vrancea earthquakes
- 4 events M6.9 – M7.7 from 1940 – 1990. M7.5 1977 >1500 casualties, mainly in Bucharest.
- Current Operational EEW System uses a network of 35 stations centred on Vrancea providing location and magnitude focusing only on these deep events
- 25 – 35 s warning for Bucharest 130km to South

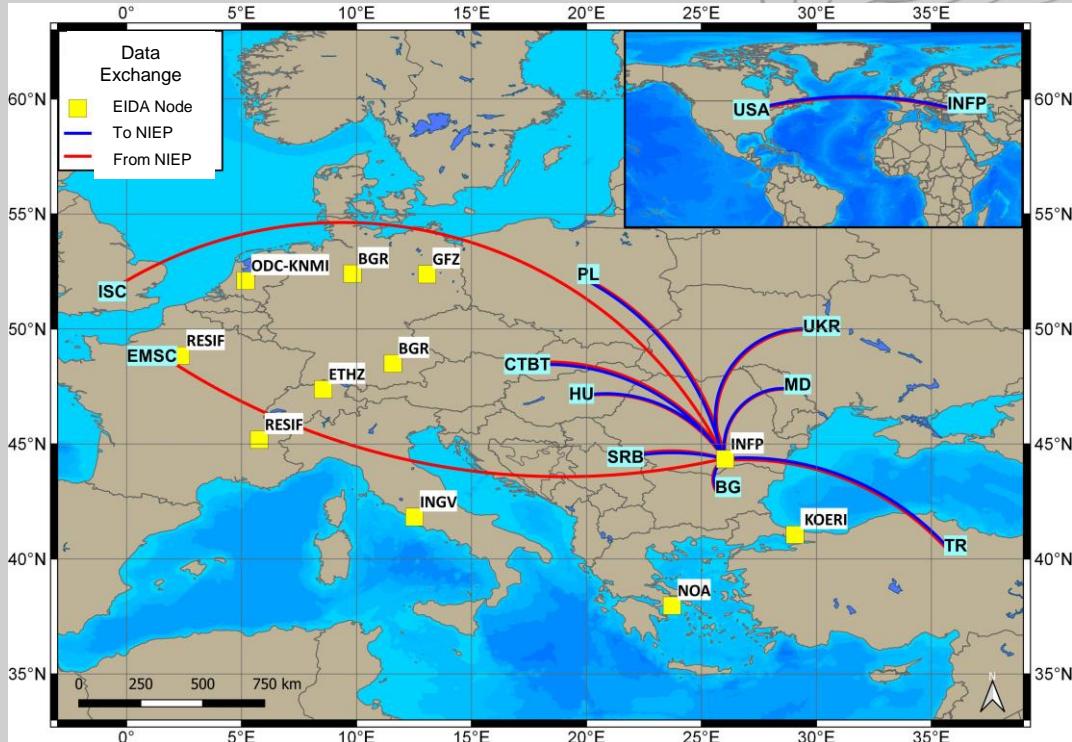


Data Exchange

NIEP is and EIDA Node since 2014

EIDA (European Integrated Data Archive) is a European data center that archives and provides access to seismic waveforms and related instrumentation within European research infrastructures.

EIDA Node NIEP archives a total number of 259 stations. This node archives data for networks:BS MD RO UD Y8



<http://www.infp.ro/index.php?i=eida>

Observatories



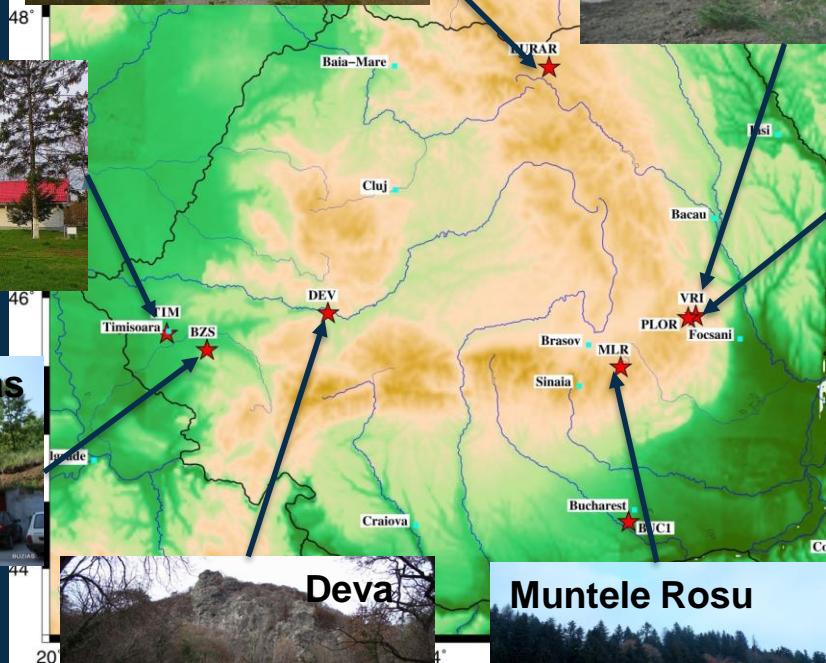
Bucovina



Vrincioaia



Timisoara



Plostina



Buzias



Deva



Muntele Rosu



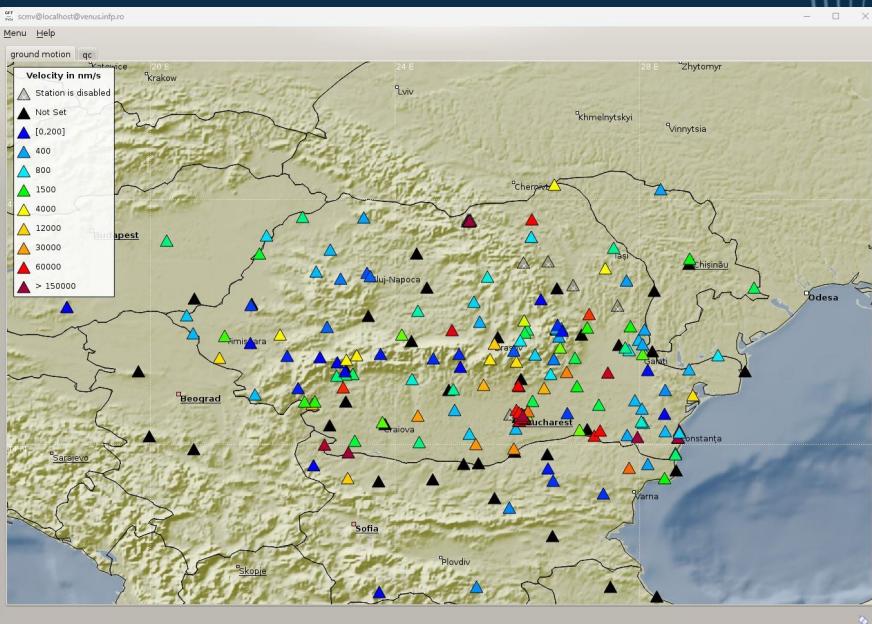
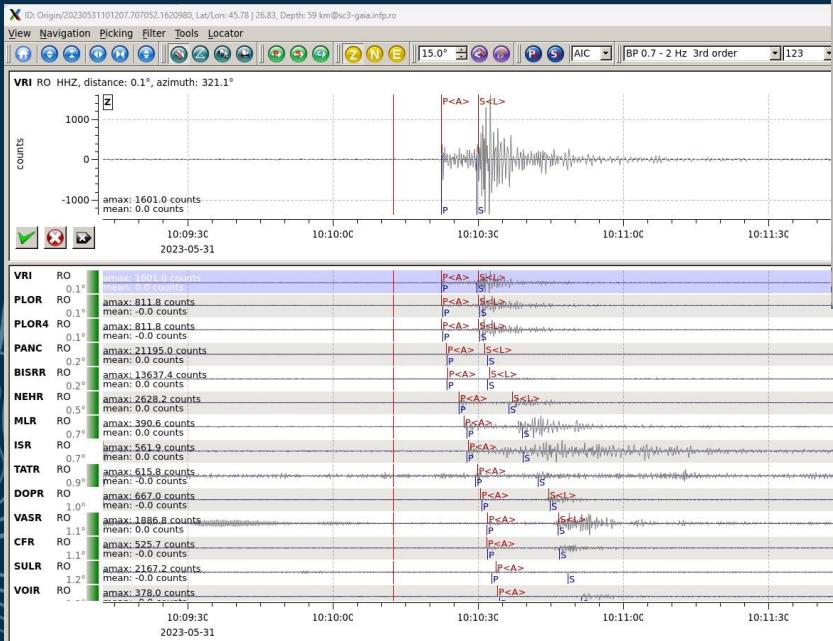
Dobrogea

National Data Center



Seiscomp Software

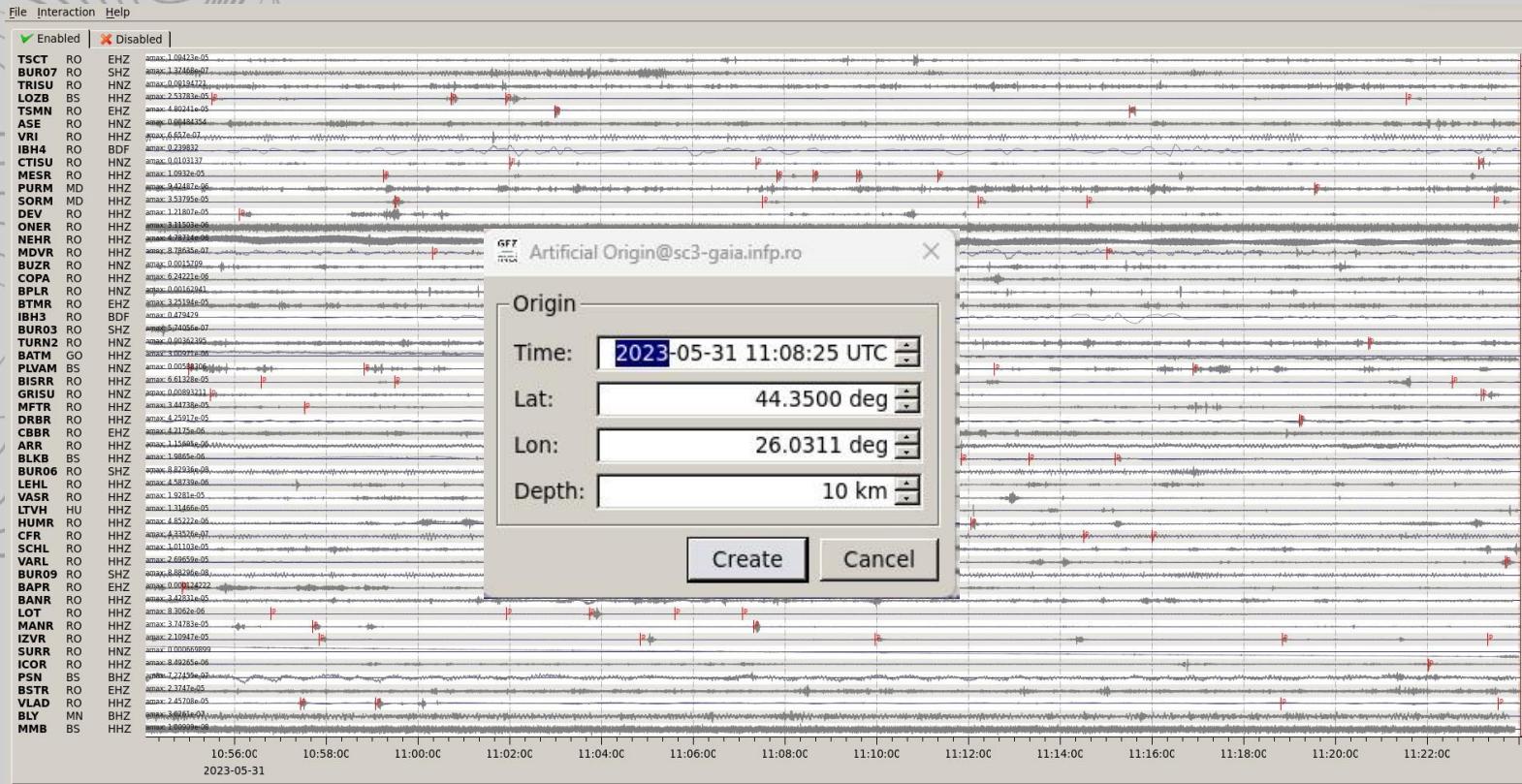
- Data acquisition
- Data quality control
- Data recording
- Real-time data exchange
- Real-time data processing



Waveform archiving
Automatic event detection and location
Event Parameter archiving
Waveform data distribution
Real-time data processing

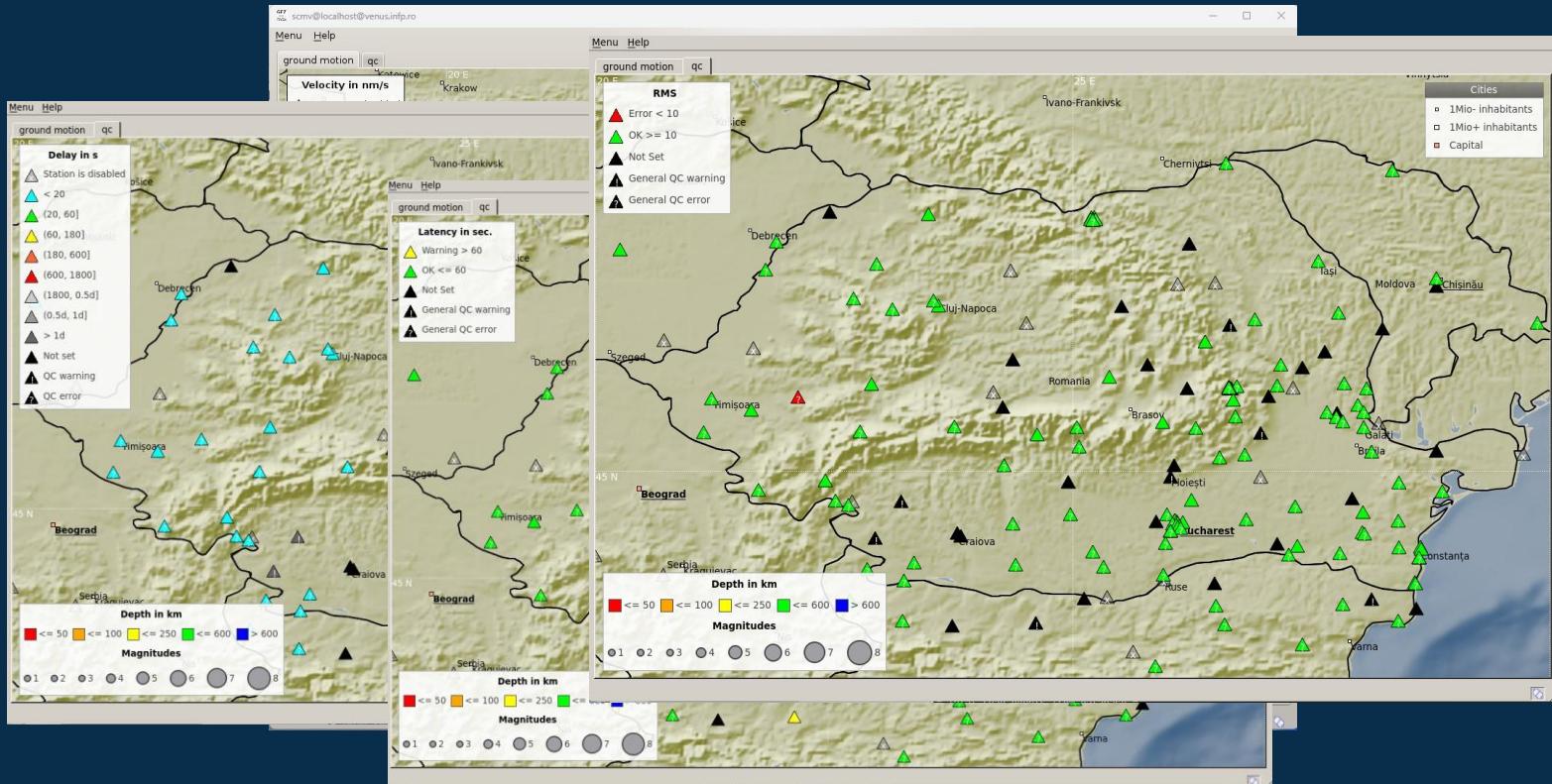
Seiscomp Software

scrttv - real time waveforms



Seiscomp Software

scmv - Map with Stations



Seiscomp Software

Options View Help
Summary | Events |

2023-05-29 03: Options View Help

2 days and 8 hour

Romania



Summary | Events |

OT(UTC)	M	TP	Phases	Lat	Lon	Depth	Stat	Agency	Region	ID
2023-05-31 10:10:12	2.7	M	37	45.78 N	26.83 E	60 km	C	RO_NDC	Romania	infp2023kovp
2023-05-31 00:19:38	2.2	M	24	45.60 N	26.45 E	159 km	A	RO_NDC	Romania	infp2023kocc
2023-05-30 20:17:08	2.2	M	22	45.86 N	27.70 E	5 km	A	RO_NDC	Romania	infp2023knuc
2023-05-29 23:49:50	2.5	M	13	44.83 N	23.30 E	10 km	A	RO_NDC	Romania	infp2023kmfq
2023-05-29 03:25:28	3.5	M	38	46.07 N	21.59 E	4 km	A	RO_NDC	Romania	infp2023kkrg
2023-05-29 00:01:15	2.2	M	10	44.77 N	26.09 E	10 km	A	RO_NDC	Romania	infp2023kkkm
2023-05-28 02:30:13	3.5	M	10	45.88 N	31.08 E	10 km	A	RO_NDC	Ukraine/Moldova/SW Russia Region	infp2023kitx
2023-05-28 02:12:05	3.5	M	10	45.72 N	30.67 E	5 km	A	RO_NDC	Ukraine/Moldova/SW Russia Region	infp2023kitl
2023-05-27 01:52:50	1.6	M	16	46.10 N	26.77 E	5 km	A	RO_NDC	Romania	infp2023kgxe
2023-05-26 18:37:00	4.1	M	12	52.91 N	45.95 E	10 km	A	RO_NDC	Baltics/Belarus/Northwestern Russia Reg.	infp2023kgiu
2023-05-26 05:10:43	3.9	M	10	45.58 N	16.45 E	10 km	A	RO_NDC	NW Balkan Region	infp2023kfif
2023-05-25 19:00:49	4.0	M	11	39.26 N	48.79 E	10 km	A	RO_NDC	Armenia-Azerbaijan-Iran Border Reg.	infp2023keob
2023-05-25 15:45:00	-	-	11	56.46 N	28.69 E	720 km	A	RO_NDC	Baltics/Belarus/Northwestern Russia Reg.	infp2023kehq

scesv – last located events

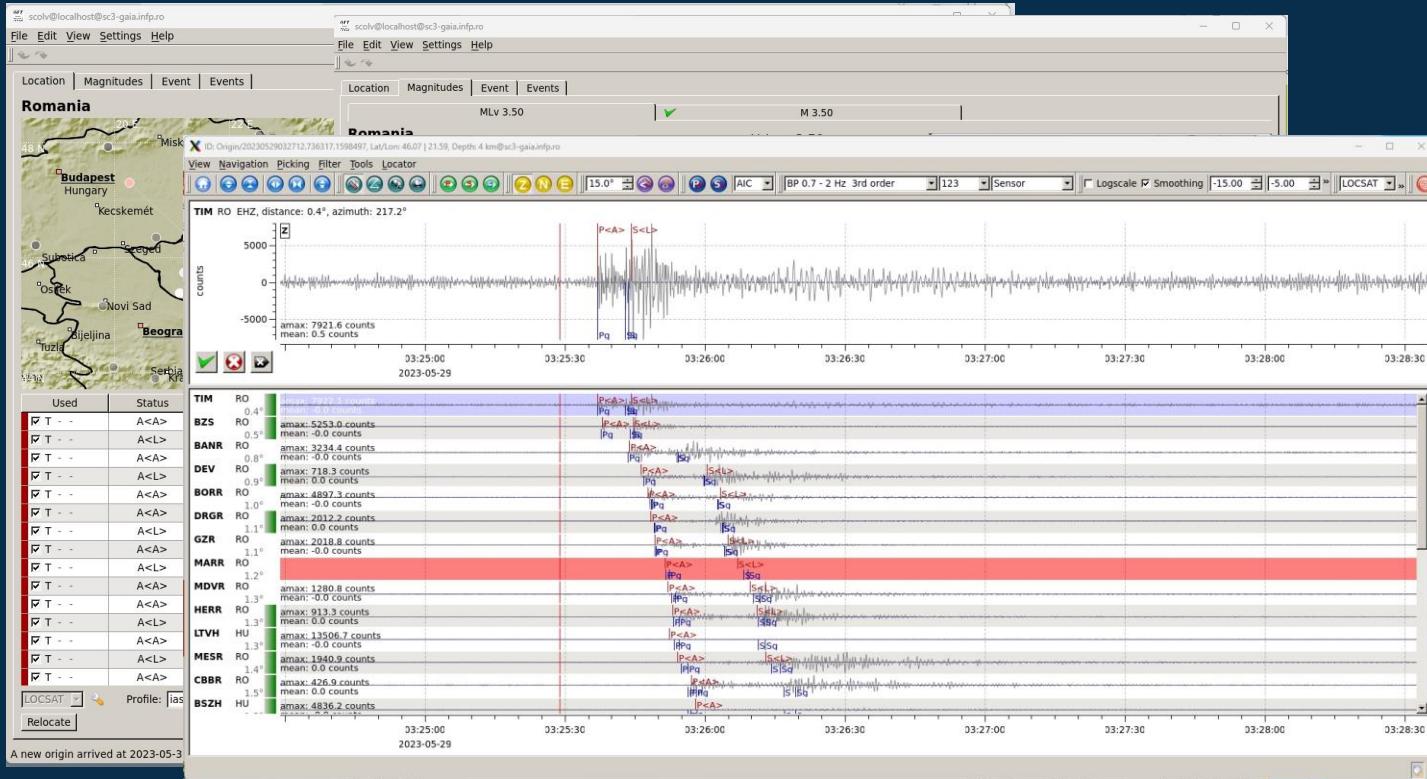
From: 2023/05/24 11:40:03 To: 2023/05/31 11:40:03 Read

Hide other/fake events Show only own events

Hide events outside [- custom - ...] region

Seiscomp Software

solv- origin revising



Seiscomp Software

scqcv - Data Quality Check

scqcv@localhost:4803 <@scomp3>

Options View Help

QcReport QcOverview

streamID	enabled	latency	delay	timing quality	offset	rms	gaps count	overlaps c...	availability	spikes count
RO.MILM..HHZ	on	1 m	7.0 s	59.9 s	100	925.56	65.73	0	0	100%
RO.MLR..HHZ	on									
RO.MSAB..HHZ	on									
RO.MTUR..EHZ	on									
RO.ODBI..EHZ	on									
RO.PETR..HHZ	on									
RO.PGOR..EHZ	on									
RO.PLAR..EHZ	on									
RO.PLOR..HHZ	on									
RO.PRAR..EHZ	on									
RO.RMGR..EHZ	on									
RO.RMVG..EHZ	on									
RO.SECR..EHZ	on									
RO.SIBR..EHZ	on									
RO.SIRR..HHZ	on									
RO.SRE..HHZ	on									
RO.SULR..HHZ	on									
RO.TESR..HHZ	on									
RO.TIM..EHZ	on									
RO.TLCR..EHZ	on									
RO.TLBR..HHZ	on									
RO.TLCR..EHZ	on									
RO.TNRR..EHZ	on									
RO.VOIR..HHZ	on									
RO.VRII..BHZ	on									
RO.ZIMR..EHZ	on									

QcReport QcOverview

Detailed Info

streamID	enabled	latency	delay	timing quality	offset	rms	gaps count	overlaps c...	availability	spikes count
RO.MSAB..HHZ	on	1 m	7.0 s	59.9 s	100	925.56	65.73	0	0	100%
BE.MEM..HHZ	BS.JMB..BHZ	BS.KDZ..HHZ	BS.MMB..HHZ	BS.PLD..BHZ	BS.PRD..HHZ	BS.PSN..BHZ				
CH.BNALP..BHZ	CH.BOURR..BHZ	CH.FUORN..BHZ	CH.GIMEL..BHZ	CH.MUGIO..BHZ	CH.SLE..BHZ	CZ.MORC..BHZ				
CZ.VRAC..BHZ	GB.DYA..BHZ	GB.GAL1..BHZ	GB.JSA..BHZ	GB.KPL..BHZ	GB.LRW..BHZ	GB.MCH1..BHZ				
GB.SOFL..BHZ	GB.SWN1..BHZ	GE.APE..BHZ	GE.ISP..BHZ	GE.KWP..BHZ	GE.MALT..BHZ	GE.PSZ..BHZ				
GE.TIRR..BHZ	GO.AKH..HHZ	GO.CHVG..HHZ	HU.PKSM..BHZ	HU.TRPA..BHZ	IU.ANT0..00.BHZ	KO.BCA..BHZ				
KO.BZK..BHZ	KO.CTYL..BHZ	KO.DIKM..BHZ	KO.EZN..BHZ	KO.KDZE..BHZ	KO.KLYT..BHZ	KO.KTUT..BHZ				
KO.LEF..BHZ	KO.PHSR..BHZ	KO.SILT..BHZ	KO.TKR..BHZ	MD.KIS..HHZ	MD.SORM..HHZ	MN.AQU..BHZ				
MN.DIVS..BHZ	MN.VTS..BHZ	NL.OPLO..BHZ	NL.WIT..BHZ	NL.WTSB..01.BHZ	NS.TRO..00.BHZ	RO.AMRR..EHZ				
RO.ARCR..HHZ	RO.ARR..HHZ	RO.BANR..HHZ	RO.BAPR..EHZ	RO.BMR..HHZ	RO.BSTR..EHZ	RO.BTMR..EHZ				
RO.BUC..EHZ	RO.BUC1..EHZ	RO.BUR32..BHZ	RO.BVCR..EHZ	RO.BZS..HHZ	RO.CFR..HHZ	RO.CIOR..EHZ				
RO.CJR..HHZ	RO.CRAR..HHZ	RO.CVD..EHZ	RO.CVD1..HHZ	RO.DEV..HHZ	RO.DOPR..HHZ	RO.DRGR..HHZ				
RO.EFOR..EHZ	RO.GHRR..HHZ	RO.GIUM..HHZ	RO.GOLR..EHZ	RO.GRER..EHZ	RO.GZR..HHZ	RO.HARR..EHZ				
RO.HUMR..HHZ	RO.IAS..HHZ	RO.INCR..EHZ	RO.ISR..HHZ	RO.LEOM..HHZ	RO.LOT..HHZ	RO.MANR..EHZ				
RO.MDB..EHZ	RO.MILM..HHZ	RO.MLR..HHZ	RO.MSAB..HHZ	RO.MTUR..EHZ	RO.ODBI..EHZ	RO.PETR..HHZ				
RO.PGOR..EHZ	RO.PLAR..EHZ	RO.PLOR..HHZ	RO.PRAR..EHZ	RO.RMGR..EHZ	RO.RMVG..EHZ	RO.SECR..EHZ				
RO.SIBR..EHZ	RO.SIRR..HHZ	RO.SRE..HHZ	RO.SULR..HHZ	RO.TESR..HHZ	RO.TIM..EHZ	RO.TLB..HHZ				
RO.TLCR..EHZ	RO.TNRR..EHZ	RO.VOIR..HHZ	RO.VRII..BHZ	RO.ZIMR..EHZ						

Thank You!

