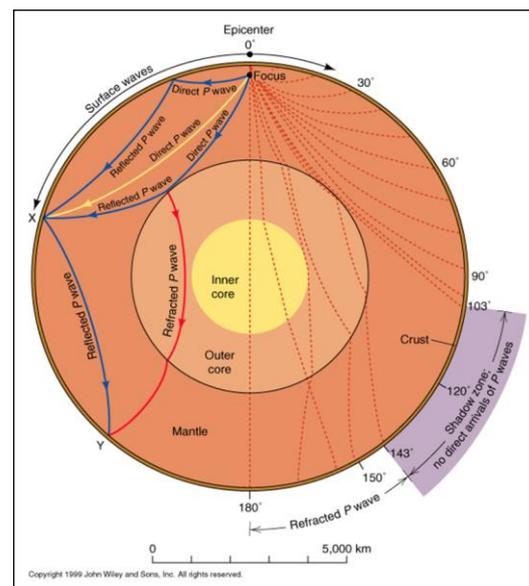
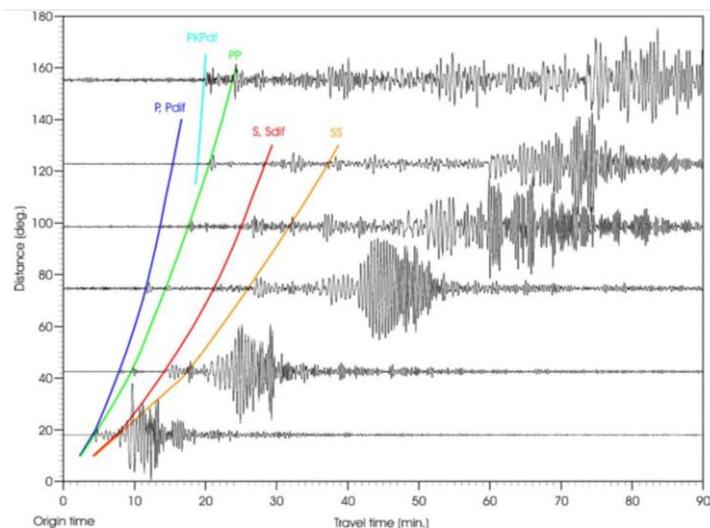




Sismometria e Monitoraggio Sismico

2020/21

La maggior parte di ciò che sappiamo oggi sulla struttura interna e le proprietà fisiche della Terra, e quindi sulle forze interne che guidano i movimenti delle zolle e che sono la causa delle principali caratteristiche geologiche, è stato derivato da dati sismologici. La sismologia continua ad essere fondamentale strumento per indagare la cinematica e la dinamica dei processi geologici a tutte le scale. Con i continui progressi della sismologici che speriamo di comprendere, prevedere e utilizzare meglio il nostro ambiente geologico e i suoi processi che lo guidano con i loro vantaggi e pericoli per la società umana.



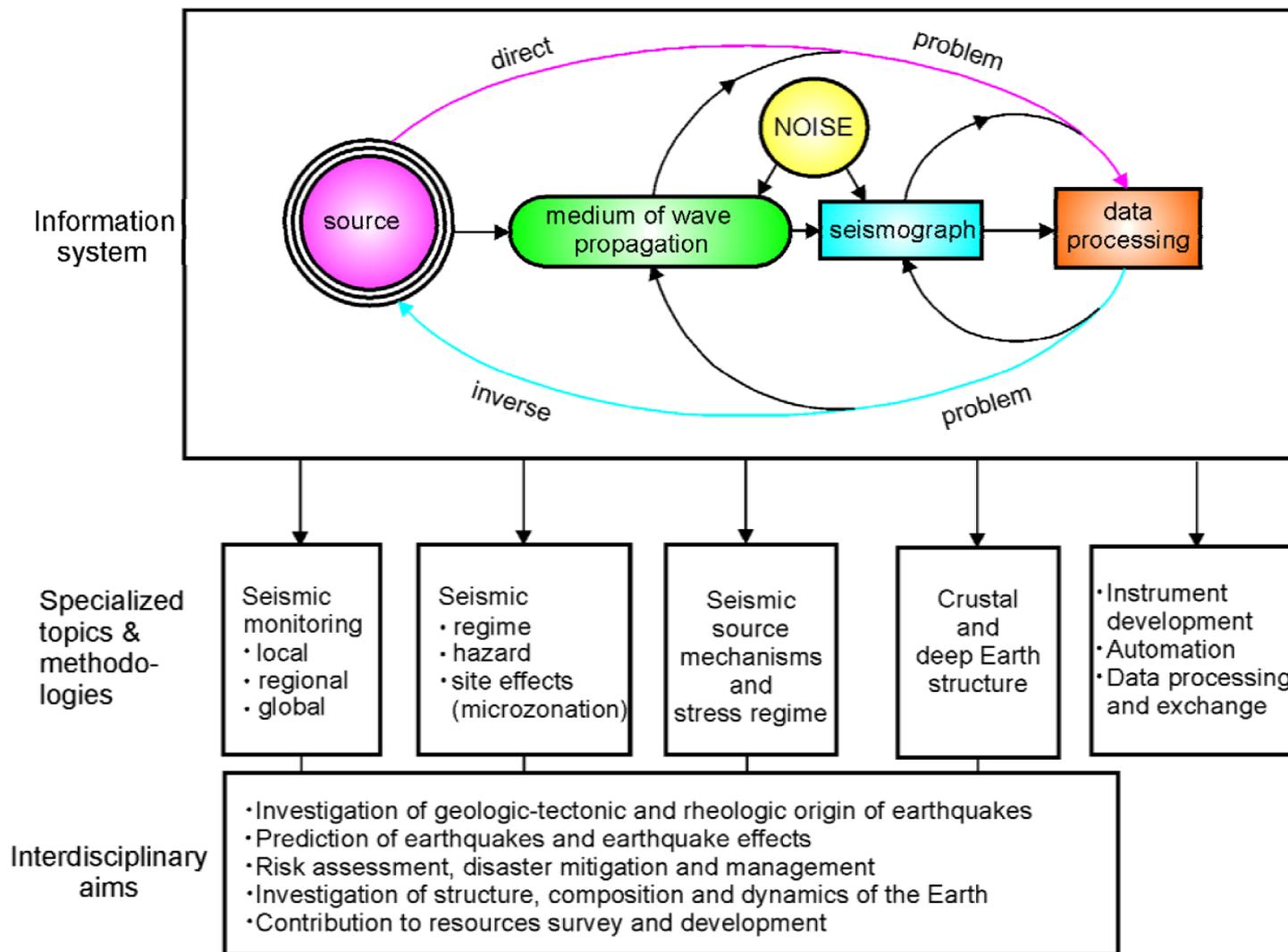


Diagramma che illustra la sismologia come analisi di un sistema informativo complesso collegato a una varietà di compiti specializzati e interdisciplinari di ricerca e applicazioni.

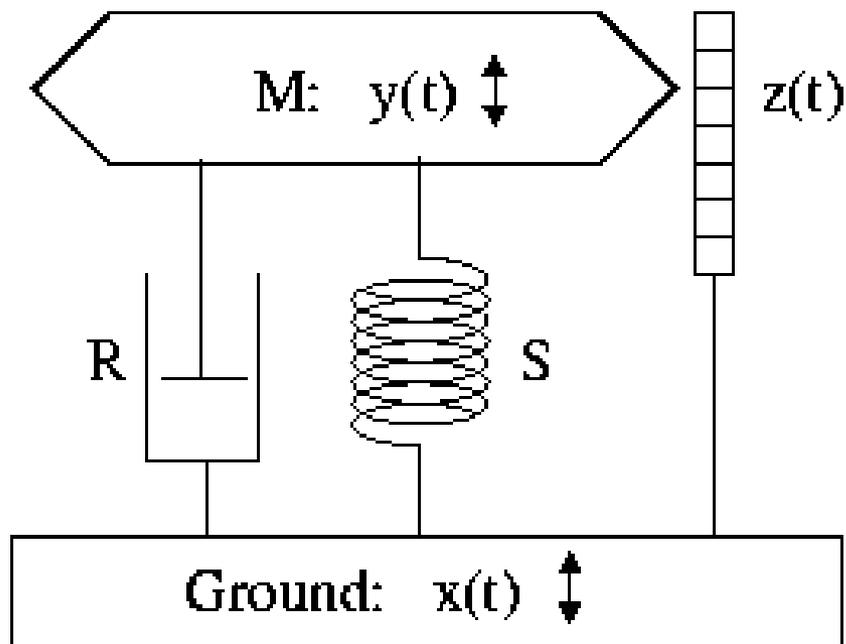
La sismometria è la disciplina tecnica che si occupa della rilevazione e misura del moto del terreno.

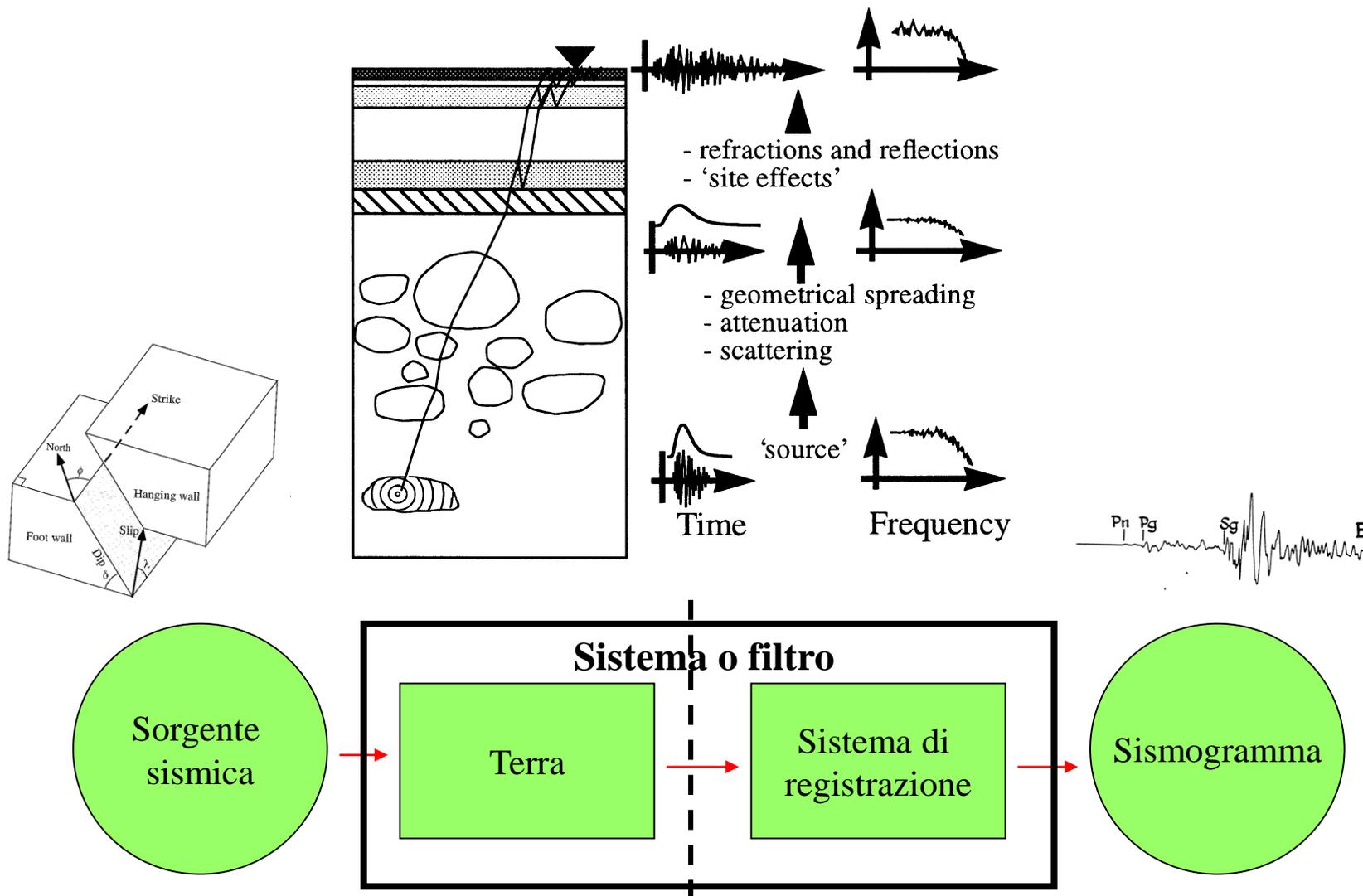
Comprende le caratteristiche dei sismografi, la loro calibrazione, la loro installazione e l'interpretazione quantitativa dei sismogrammi in termini di movimento del terreno.

Dicesi sismometro qualunque strumento che misuri la dipendenza temporale dello spostamento del terreno

Un sismografo fondamentale è costituito da uno o più sismometri, un orologio od un ricevitore del segnale del tempo ed un acquirente.

Sismografo







Programma 2017-2018 (48 ore)

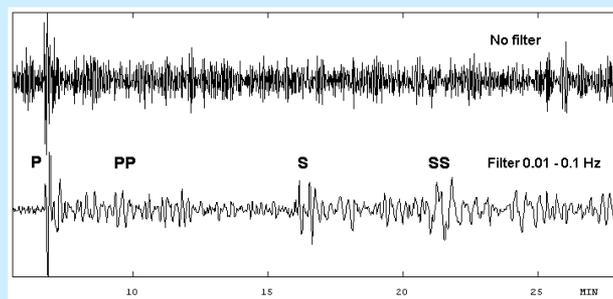
Diversi tipi di sismografi
L'evoluzione dei sismografi
Richiami di teoria
Come sono fatti i sismografi
Rappresentazione matematica della risposta strumentale
Processo di campionamento
Conversione analogico-digitale
Filtri digitali anti-alias
Sismografi a controreazione
Selezione dei siti
Installazione
Test di linearità e rumore
Calibrazione
Preprocessamento dati
Monitoraggio sismico

IASPEI

New Manual of Seismological Observatory Practice

(NMSOP)

Volume 1



Editor

Peter Bormann

GeoForschungsZentrum Potsdam

2002

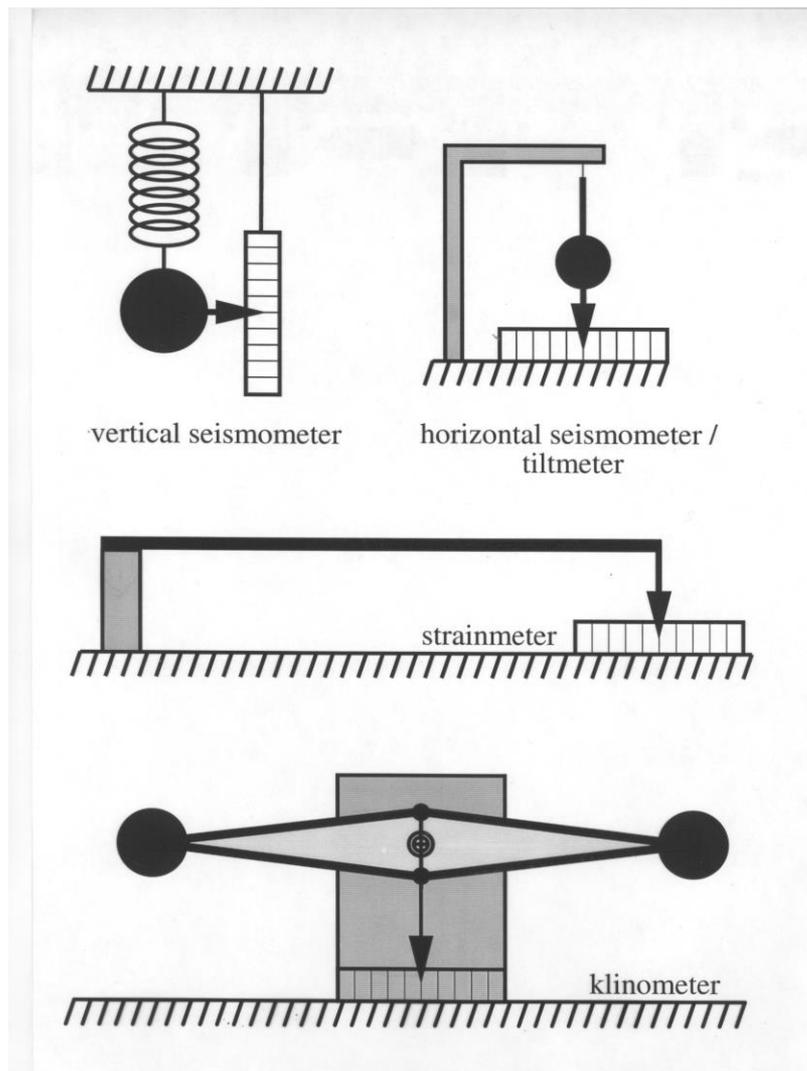
Registrazioni sismologiche di alta qualità

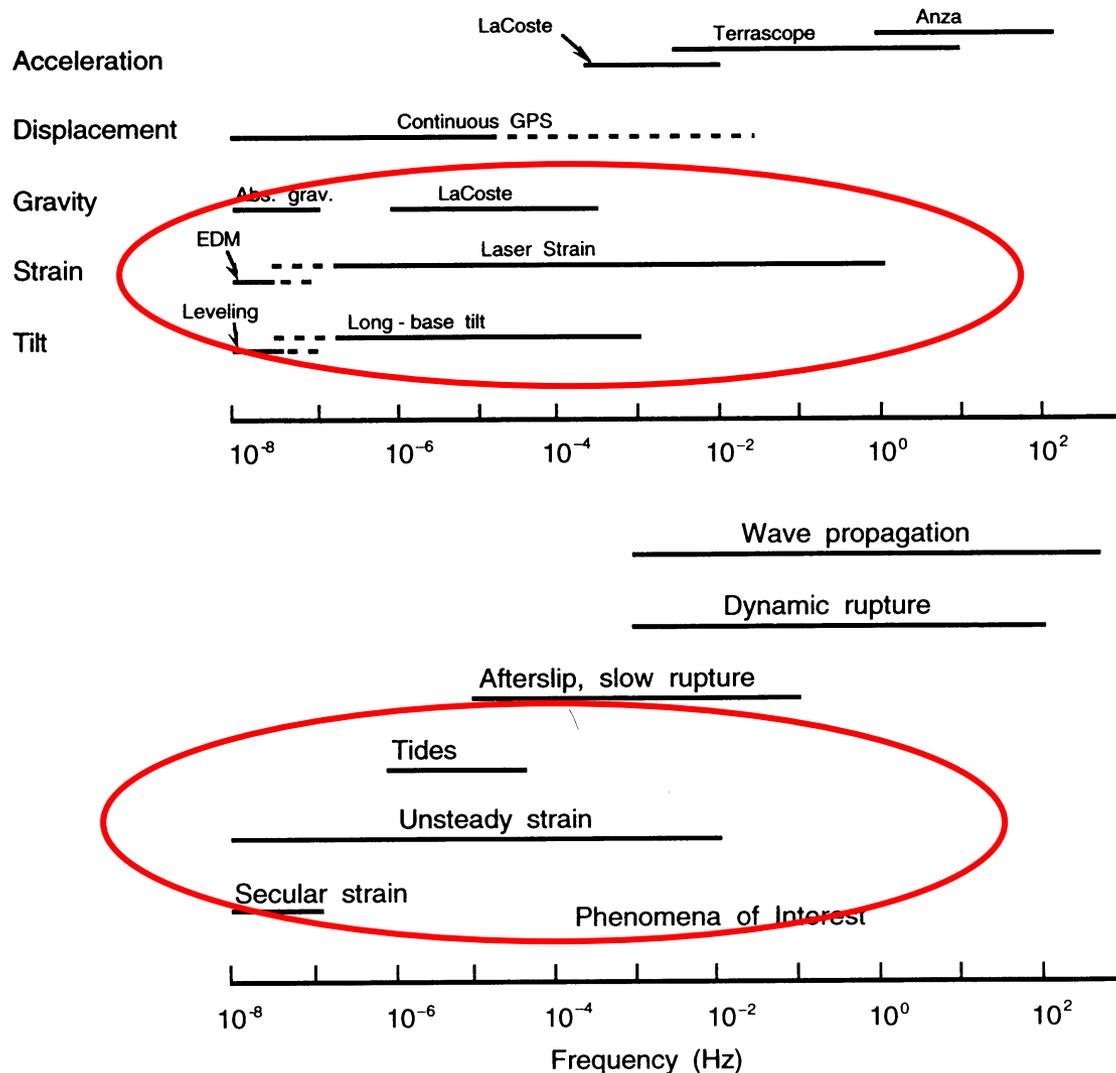
- 1) **Alta “percezione”** (capacità dell’installazione di registrare quanti più eventi possibile).
- 2) **Completezza del data set** (registrazioni continue e stabili nello spazio e nel tempo)
- 3) **Alta fedeltà** delle registrazioni al movimento del terreno.
- 4) **Rappresentatività** dei dati rispetto alle finalità della rete.

2 tipi di sensori sismici:

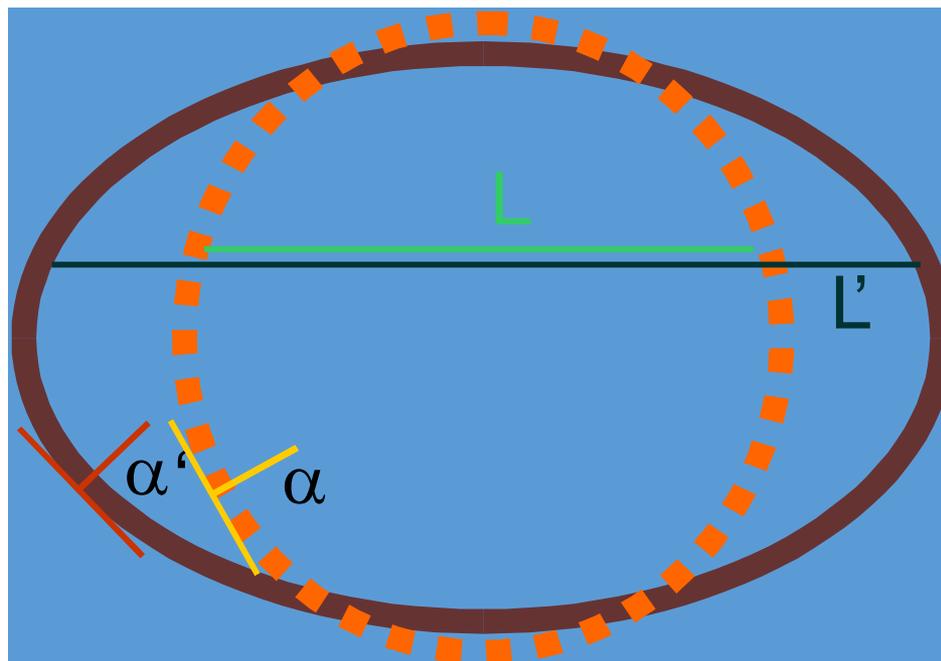
Estensimetri e clinometri. Misurano il moto relativo di un punto rispetto ad un secondo punto

Inerziali. Misurano il moto del suolo relativo ad una massa sospesa

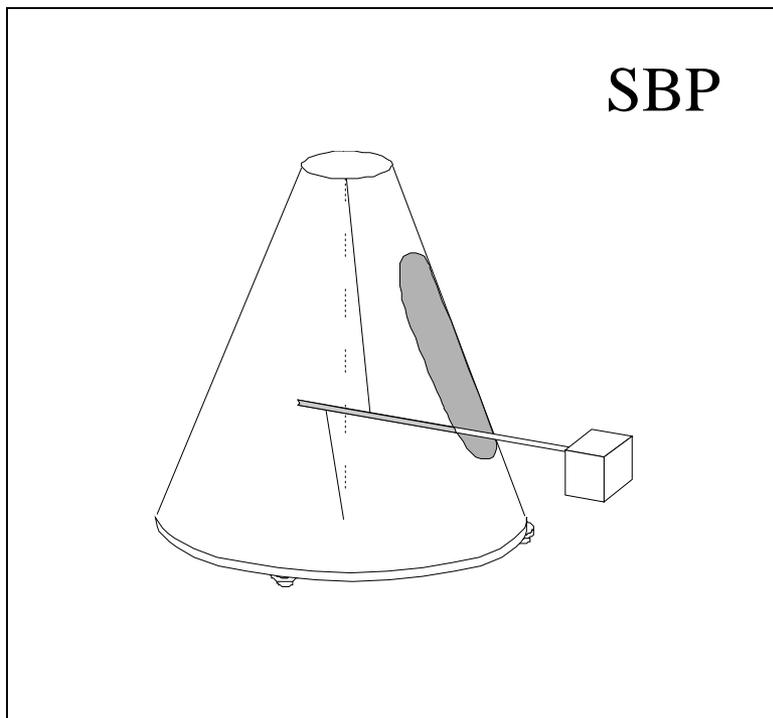




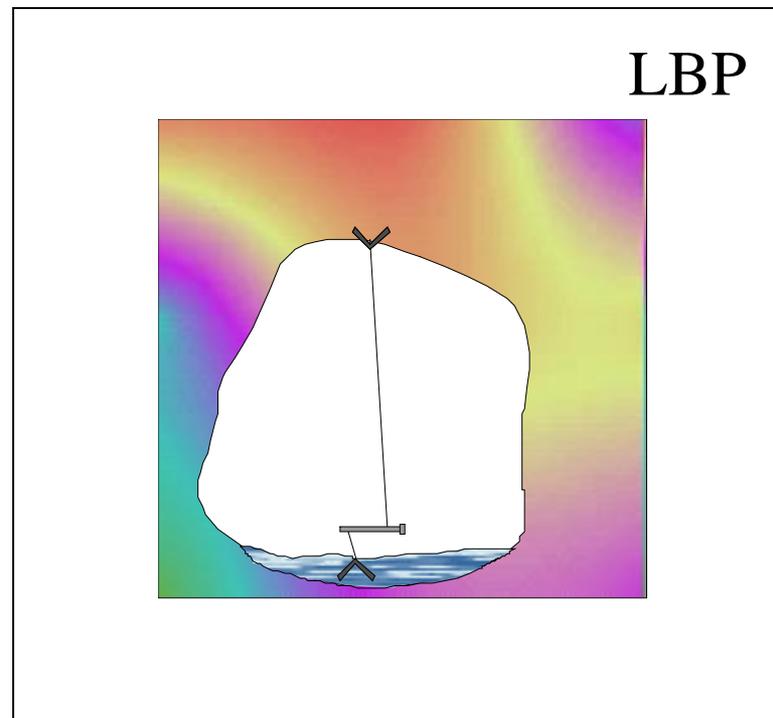
Estensimetri e clinometri



Clinometri

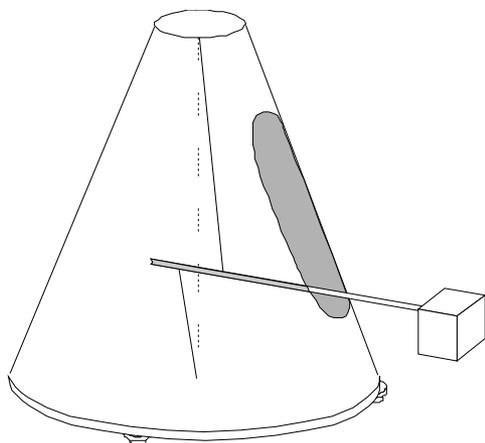


Pendoli Grotta Gigante

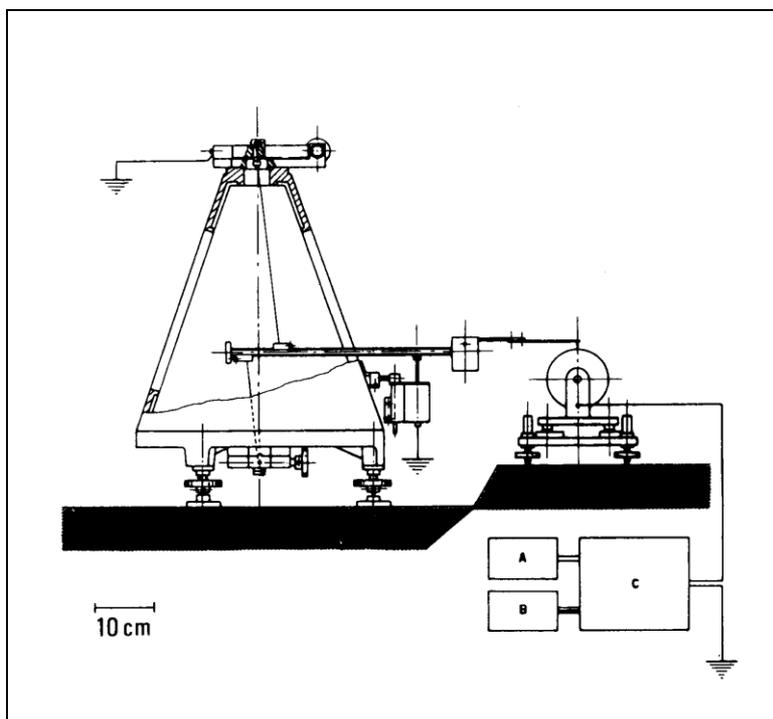


Clinometri

SBP



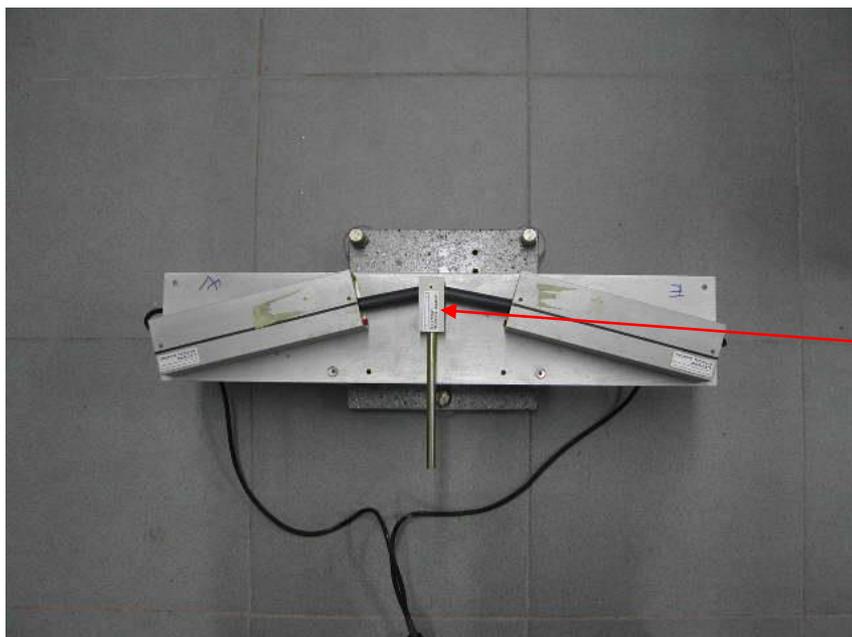
Clinometri



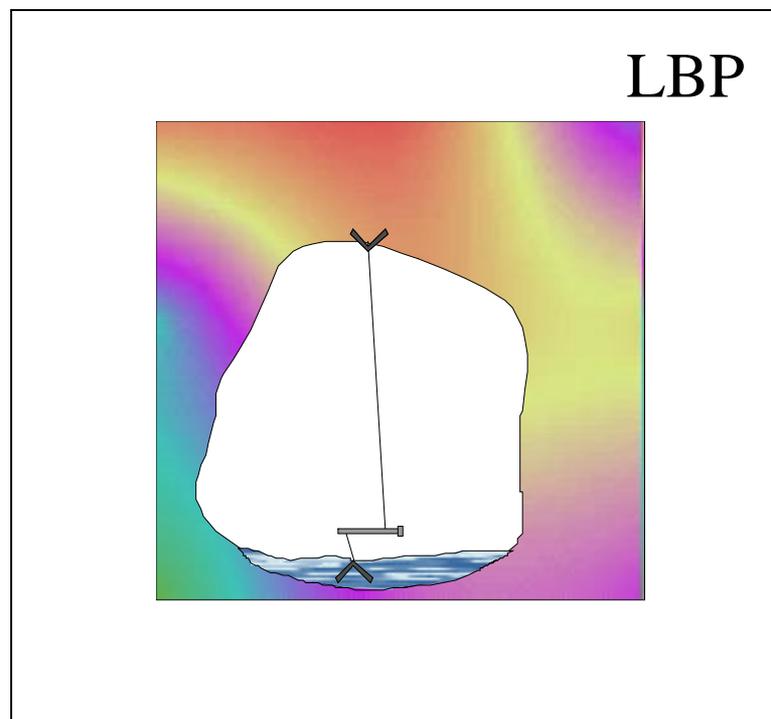
Clinometri



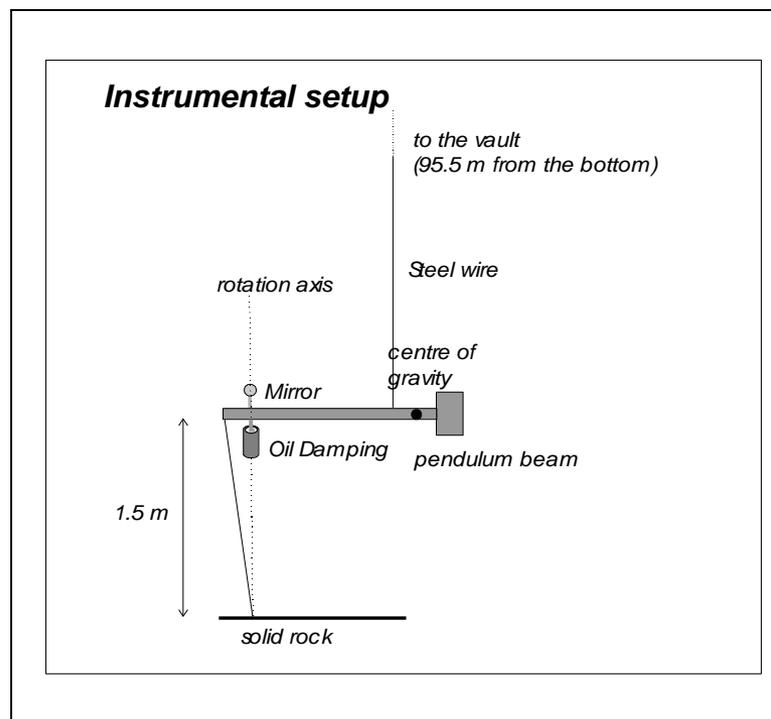
Clinometri



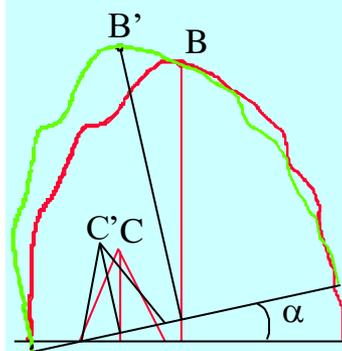
Pendoli di Grotta Gigante



Pendoli di Grotta Gigante

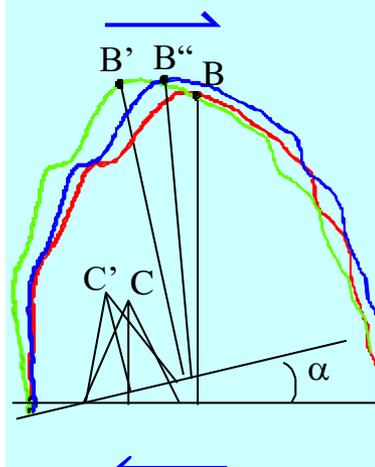


Rotation

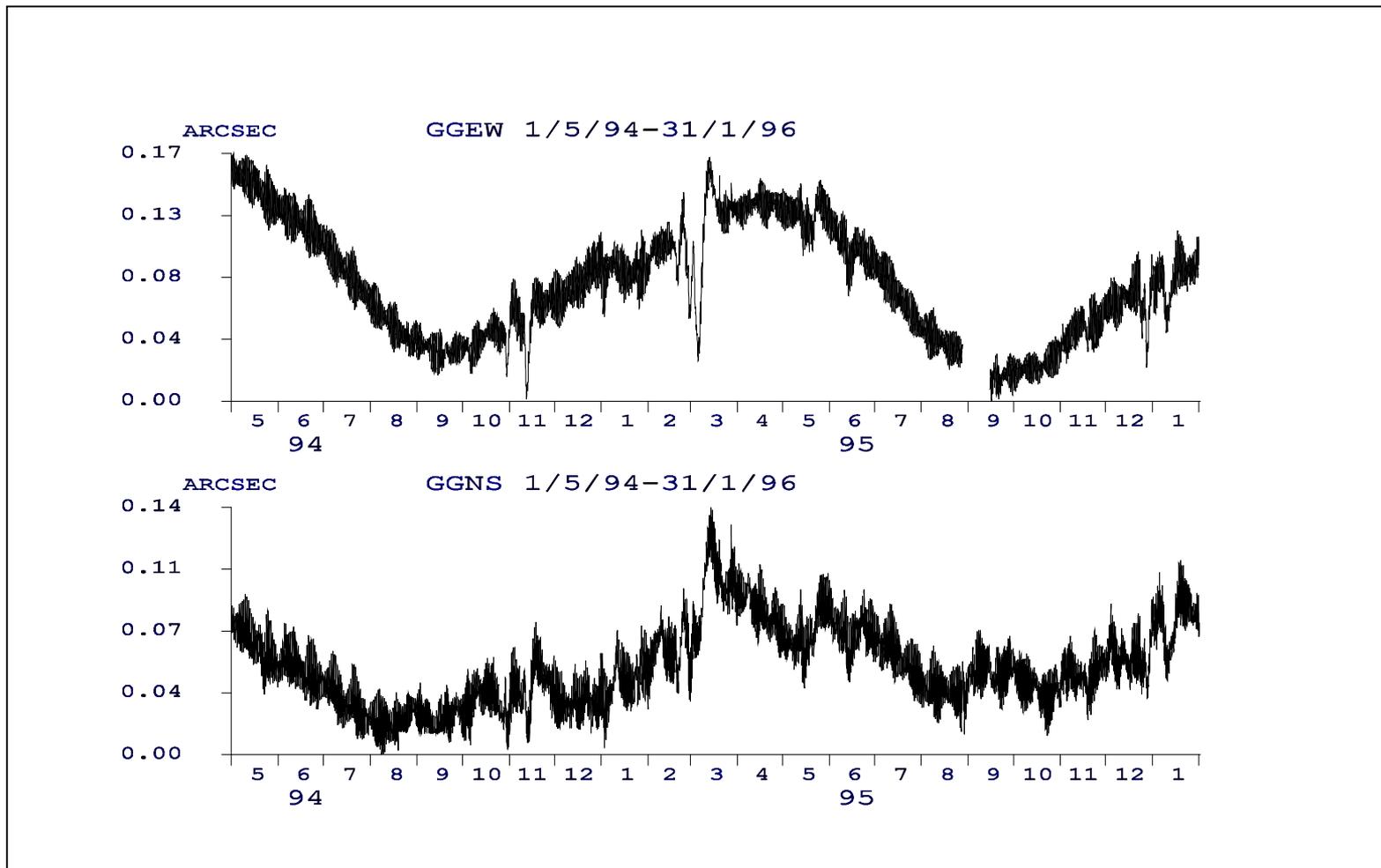


B, C initial positions
B', C' after rotation

Rotation and shear



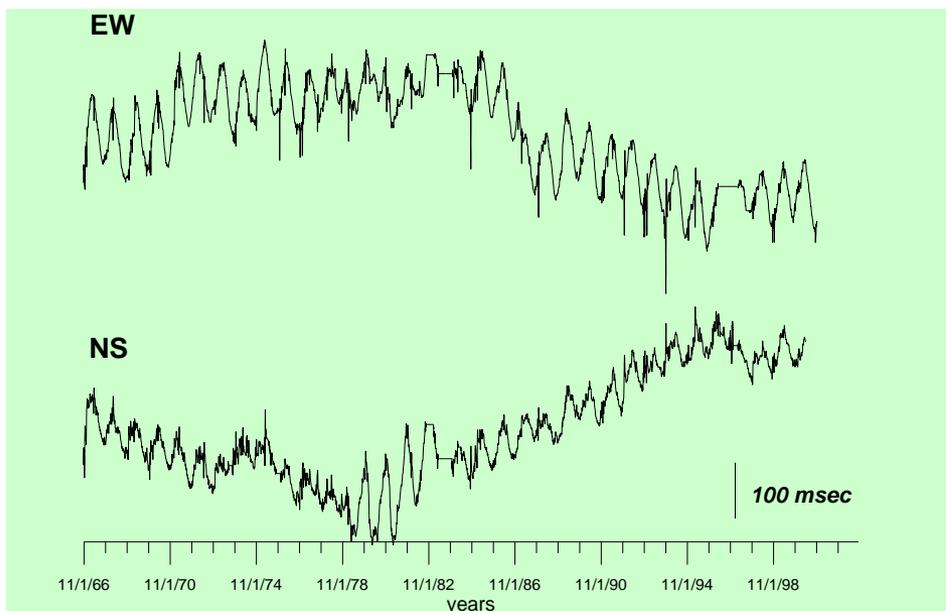
B, C initial positions
B', C' after rotation
B'' after shear



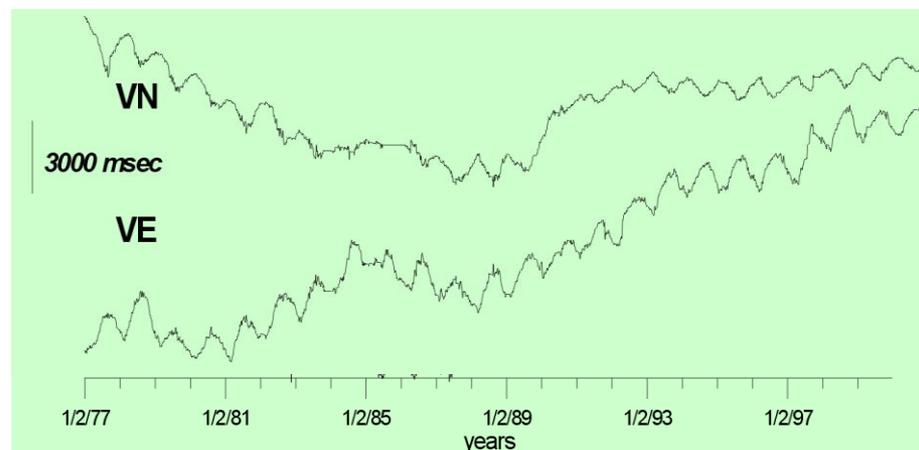
Esempio di registrazioni LBP.

Sono visibili: effetti annuali (effetti termoelastici degli strati della crosta superiore); la marea; alcuni effetti dovuti alle piene del fiume sotterraneo Timavo.

LBP – Grotta Gigante



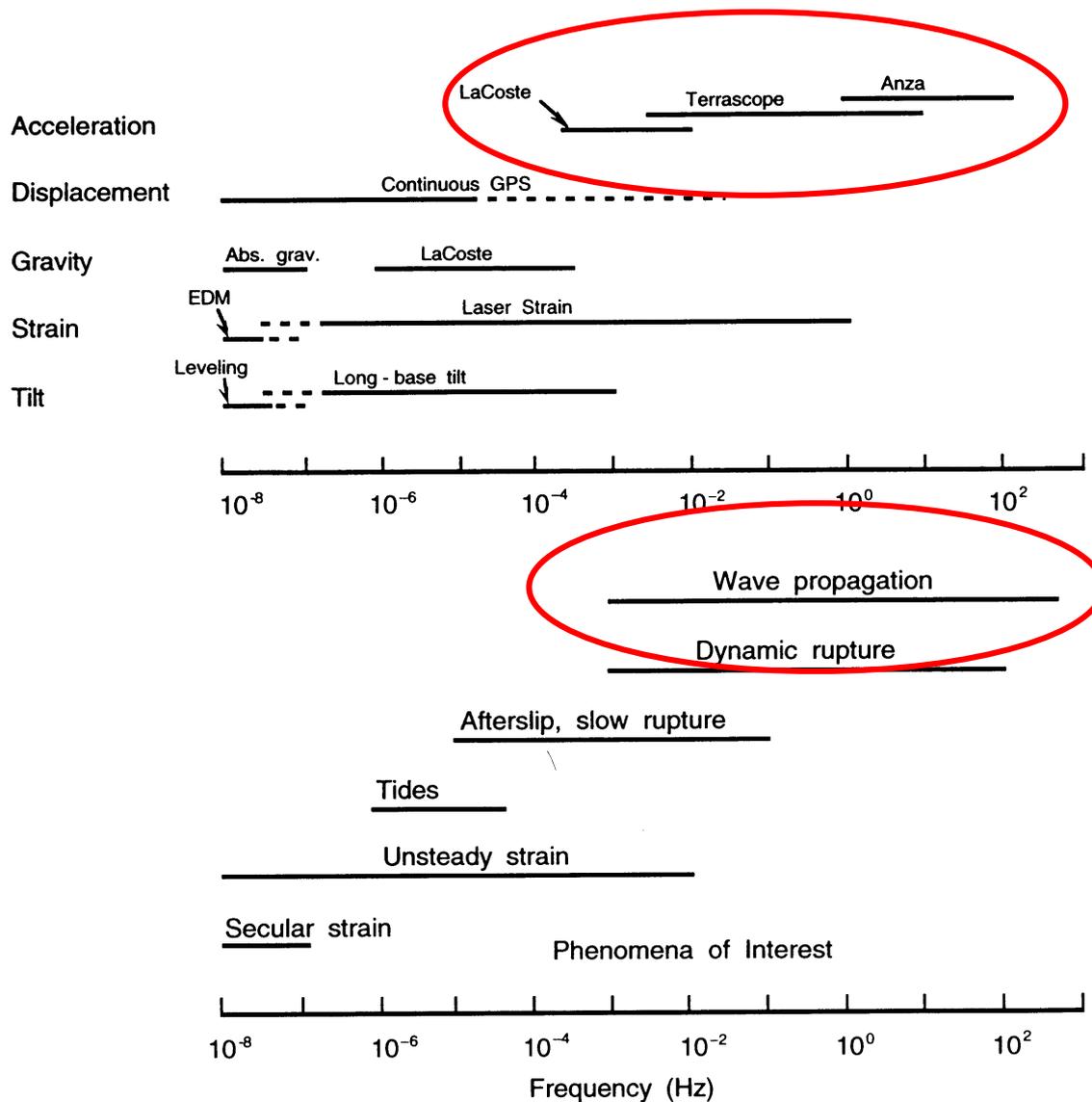
SBP – Grotta di Villanova

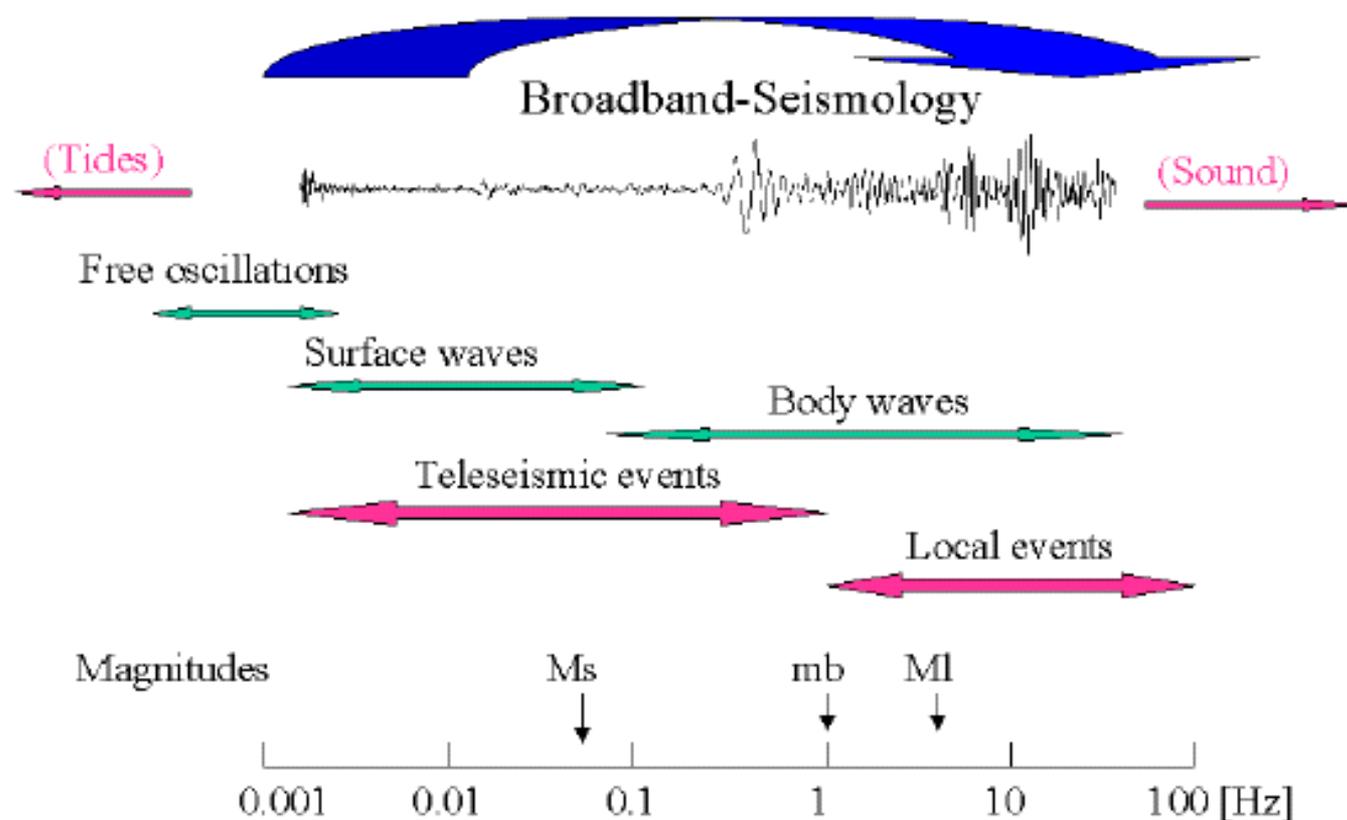


di sensori sismici:

Estensimetri e clinometri. Misurano il moto relativo di un punto rispetto ad un secondo punto

Inerziali. Misurano il moto del suolo relativo ad una massa sospesa

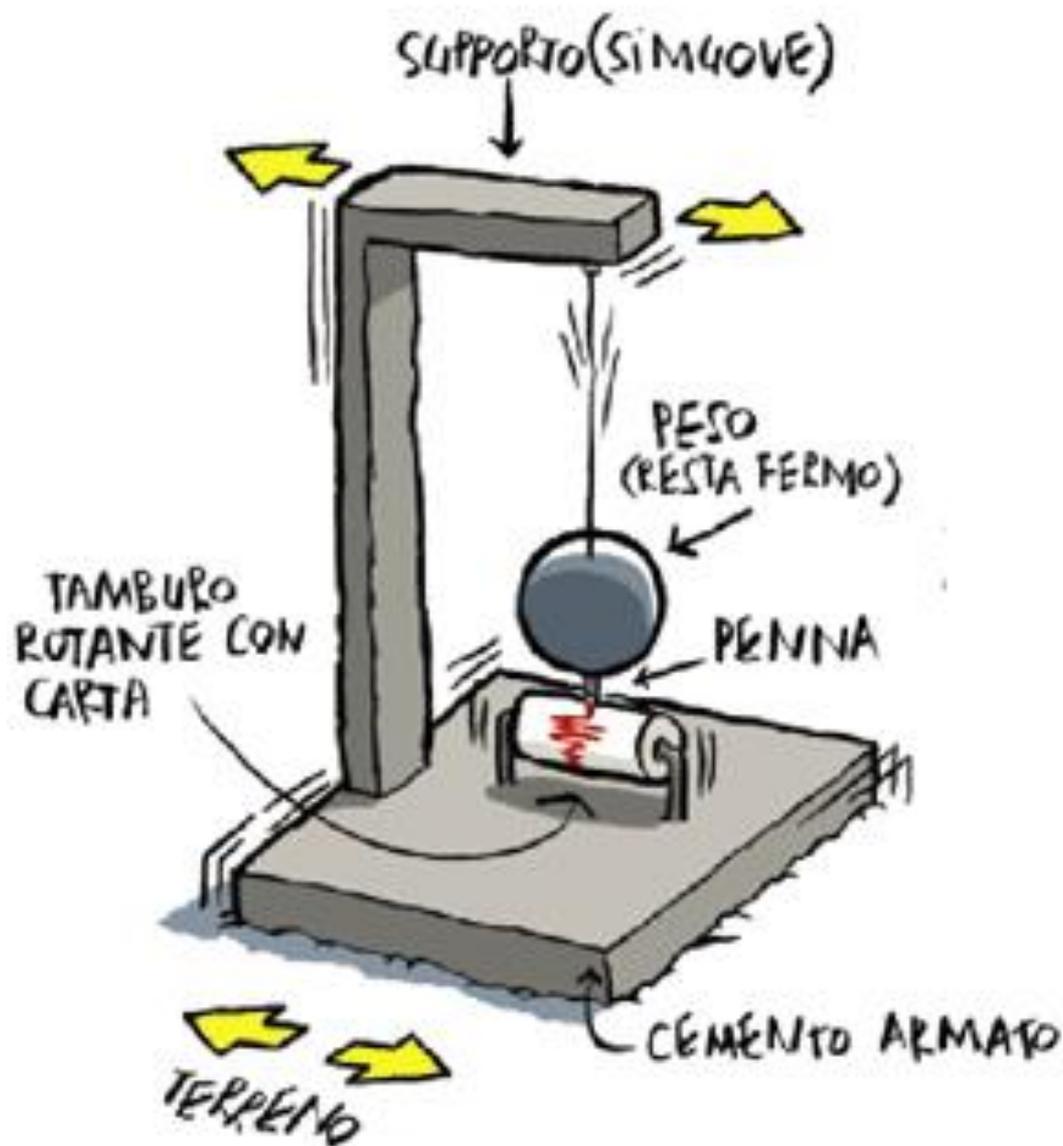


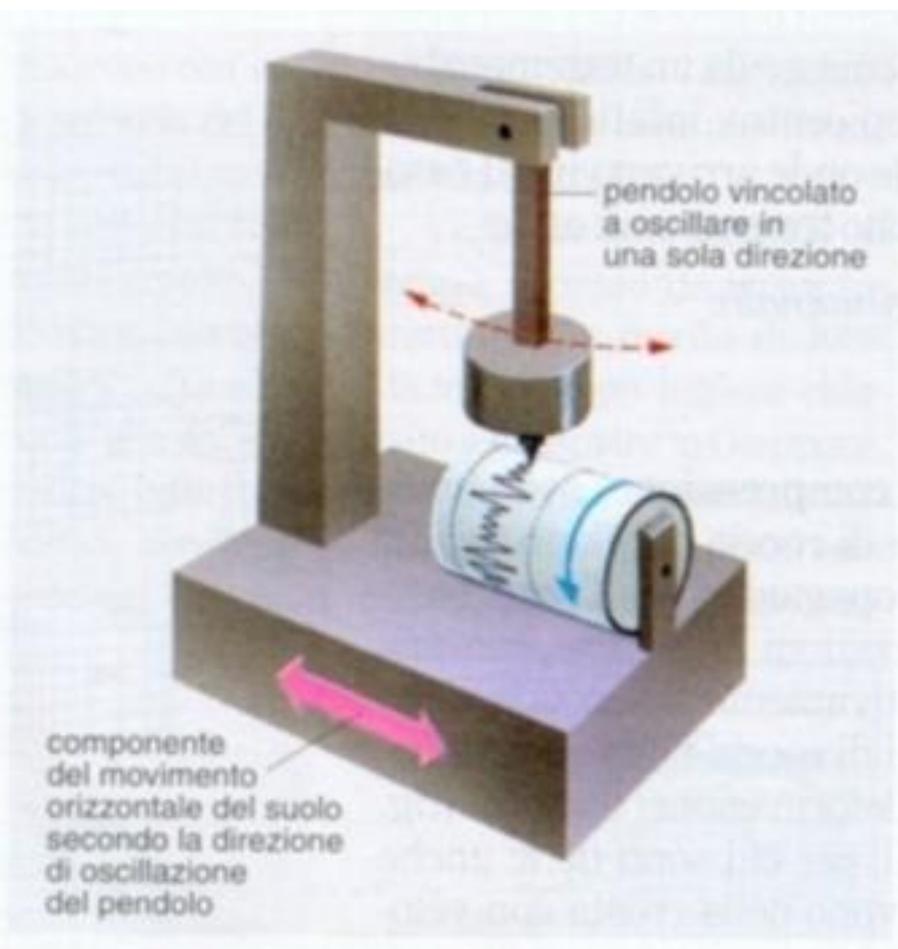
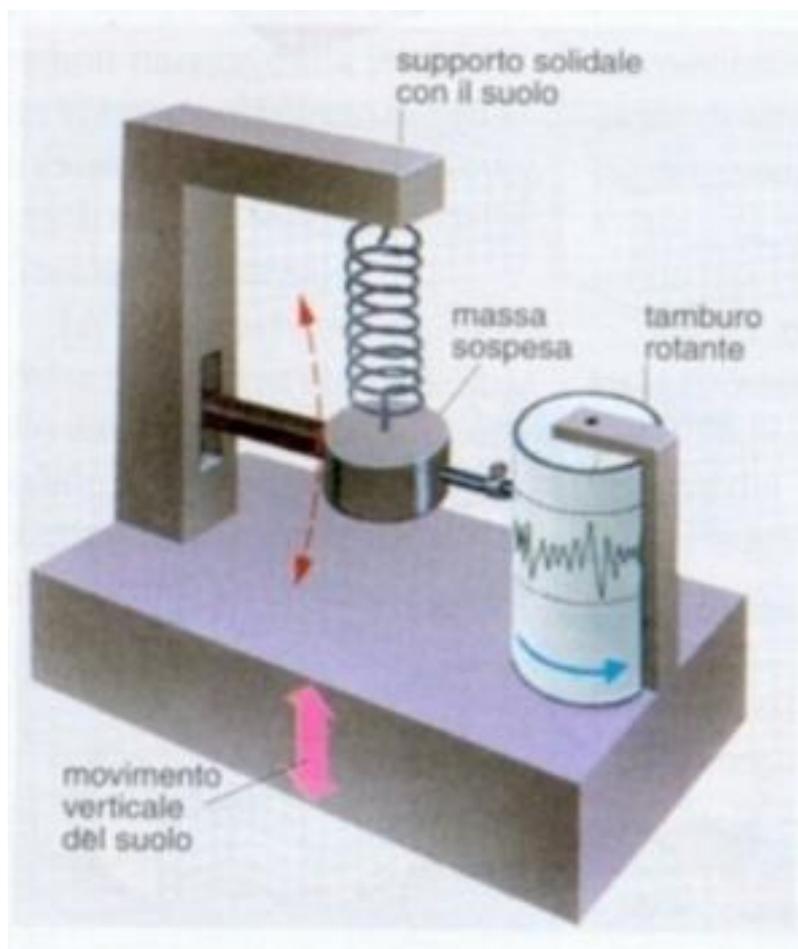


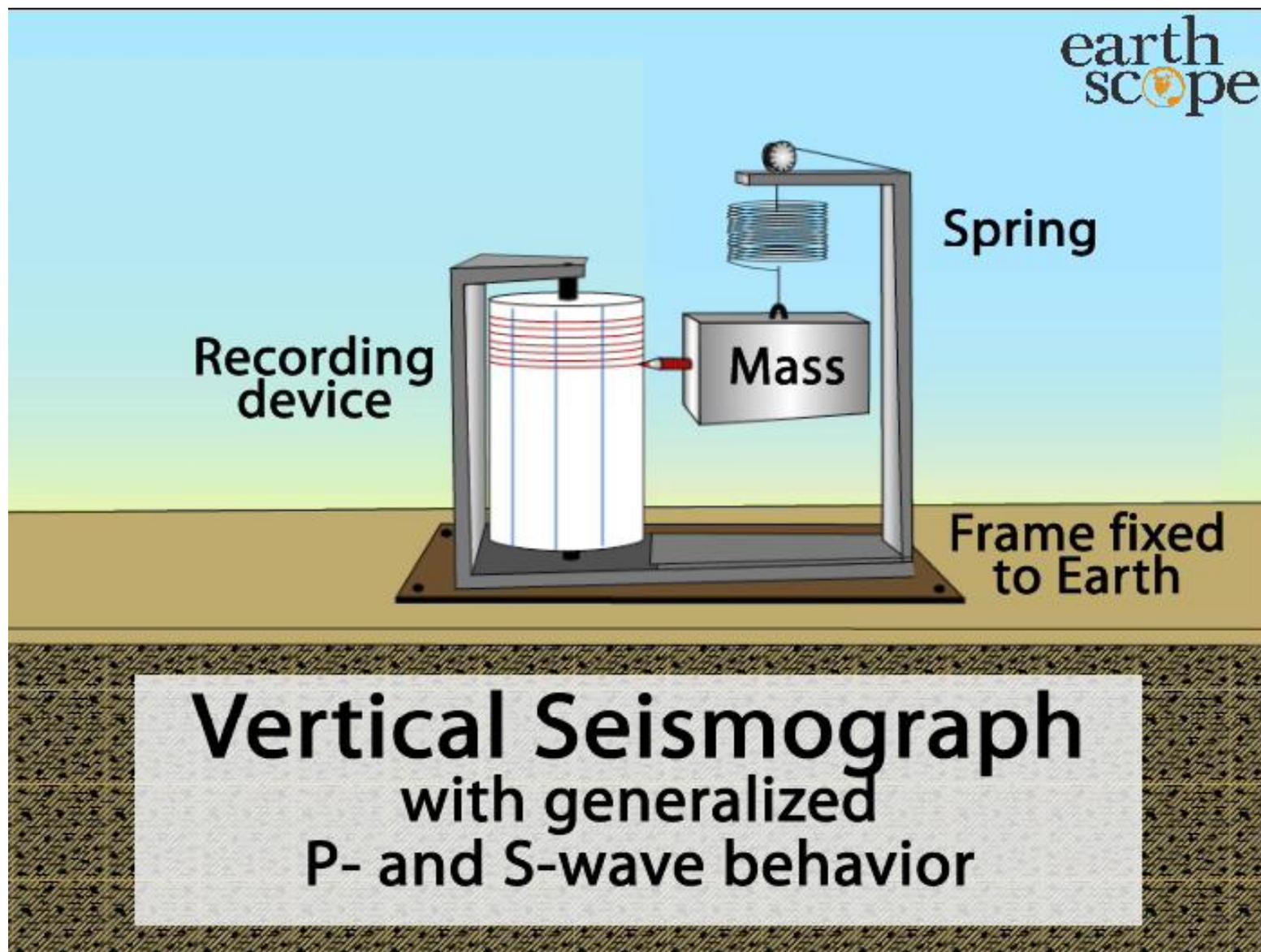
Per misurare lo spostamento del terreno su cui lo strumento poggia si utilizza il

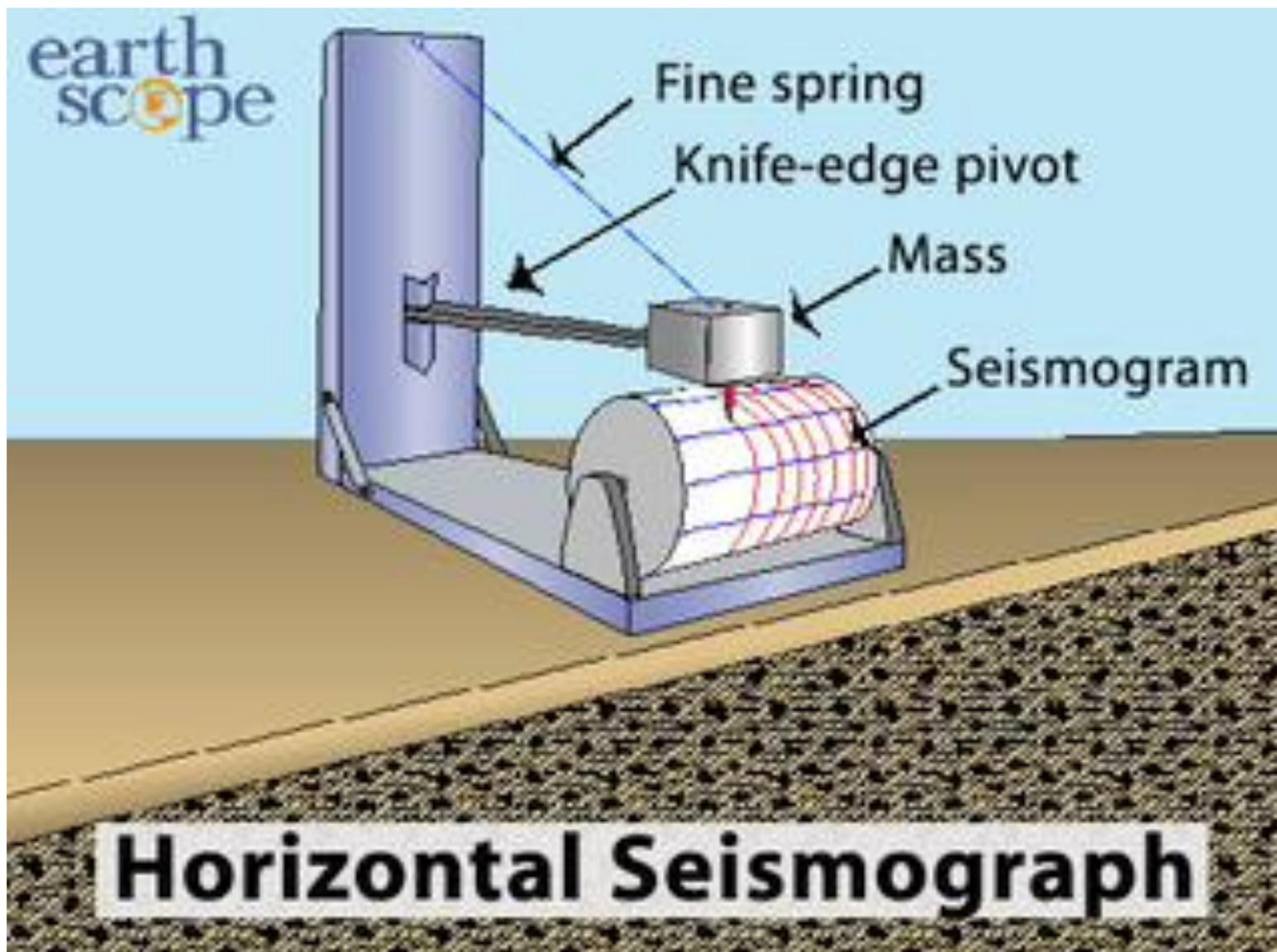
principio d'inerzia:

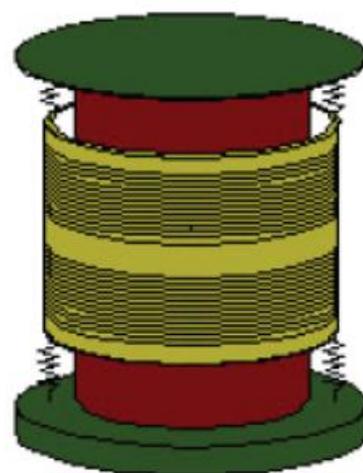
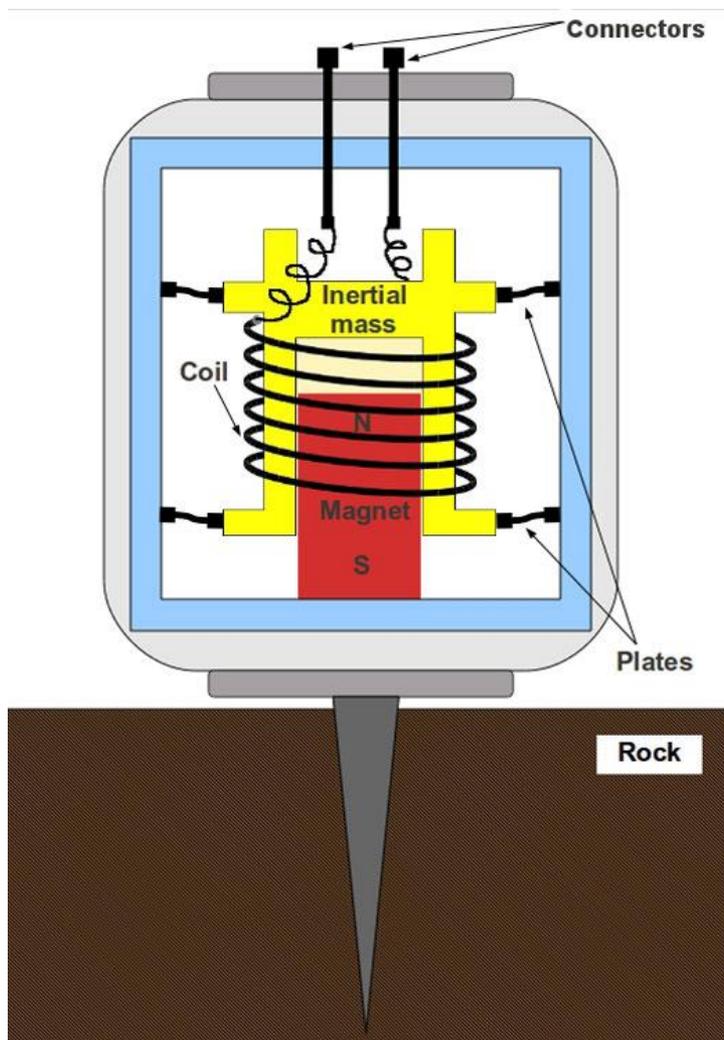
per un moto del terreno sufficientemente rapido una massa sospesa rimarrà immobile e ci darà un punto di riferimento su cui misurare il moto del suolo.





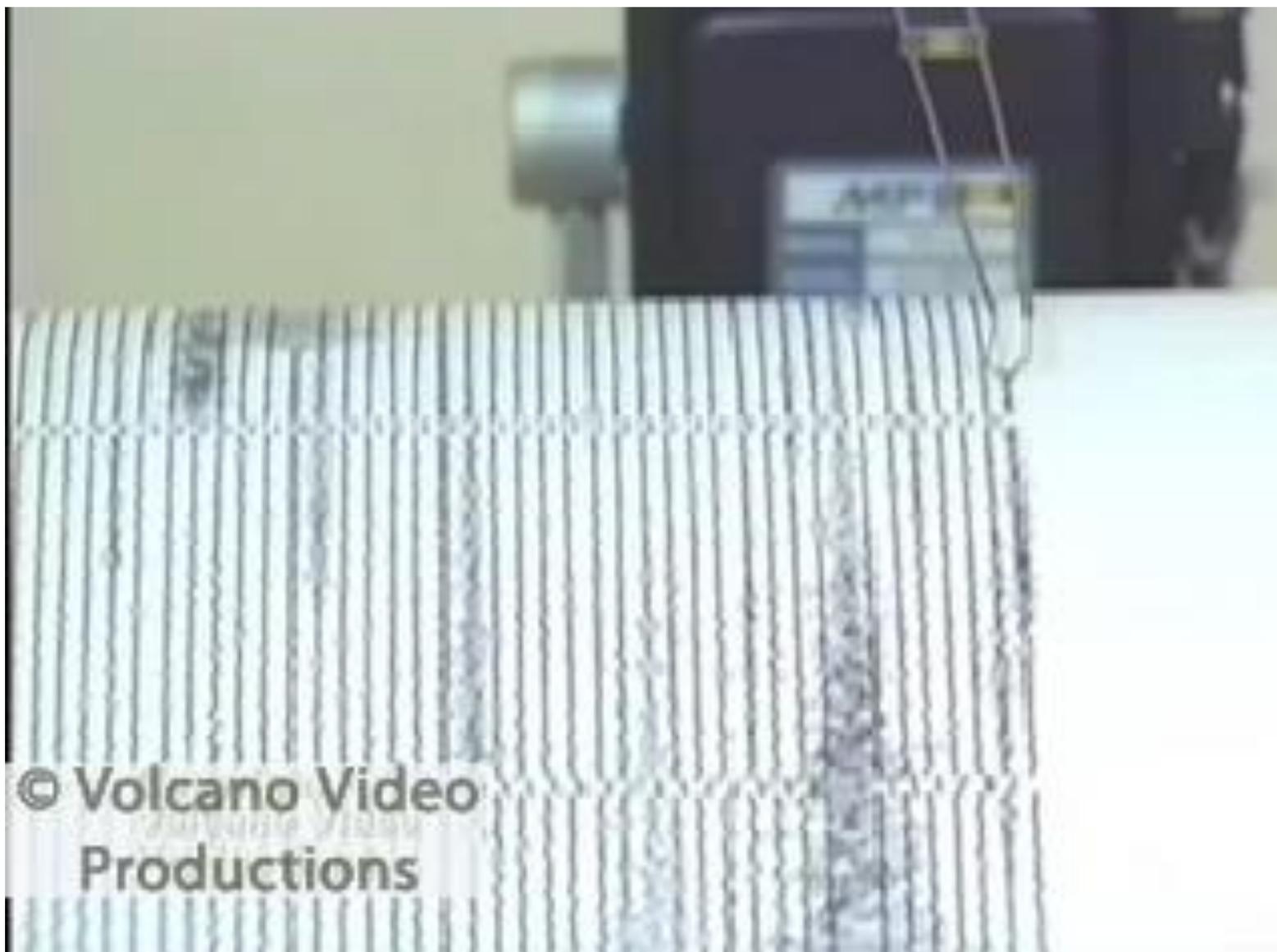






$y(t)$, coil displacement

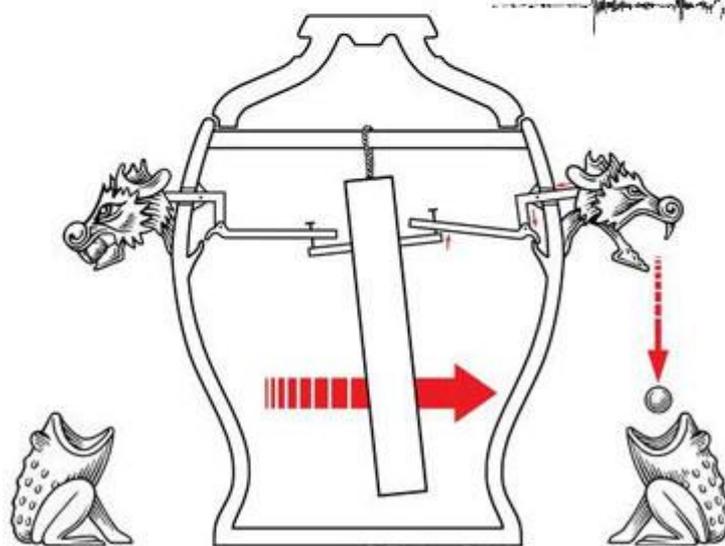
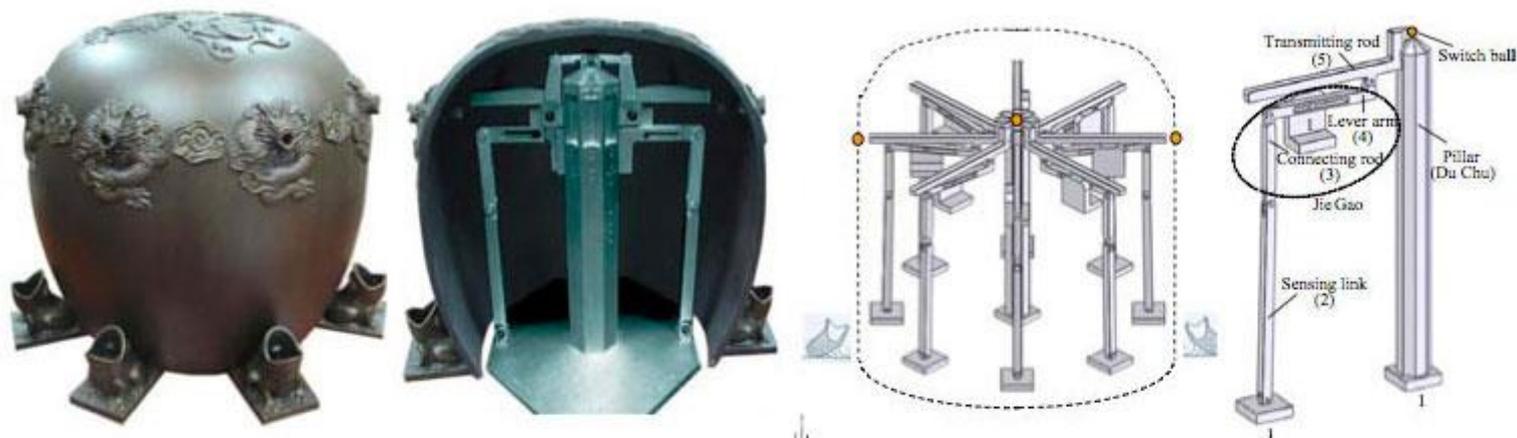
$x(t)$, base displacement



Chang Heng 132 a.c



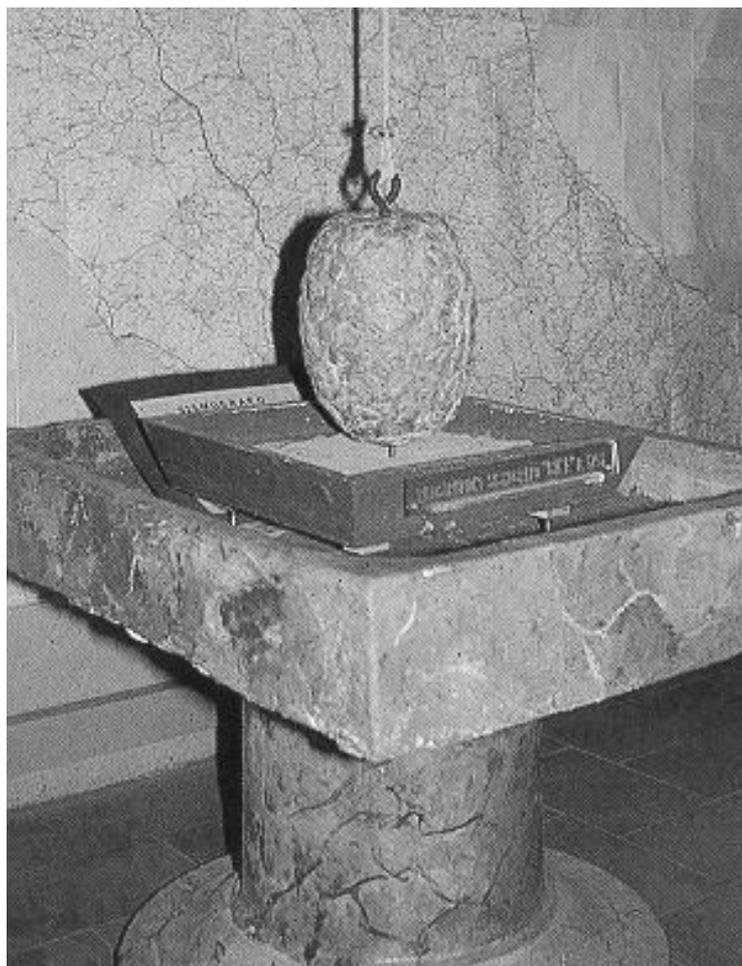
Chang Heng 132 a.c



Chang Heng 132 a.c



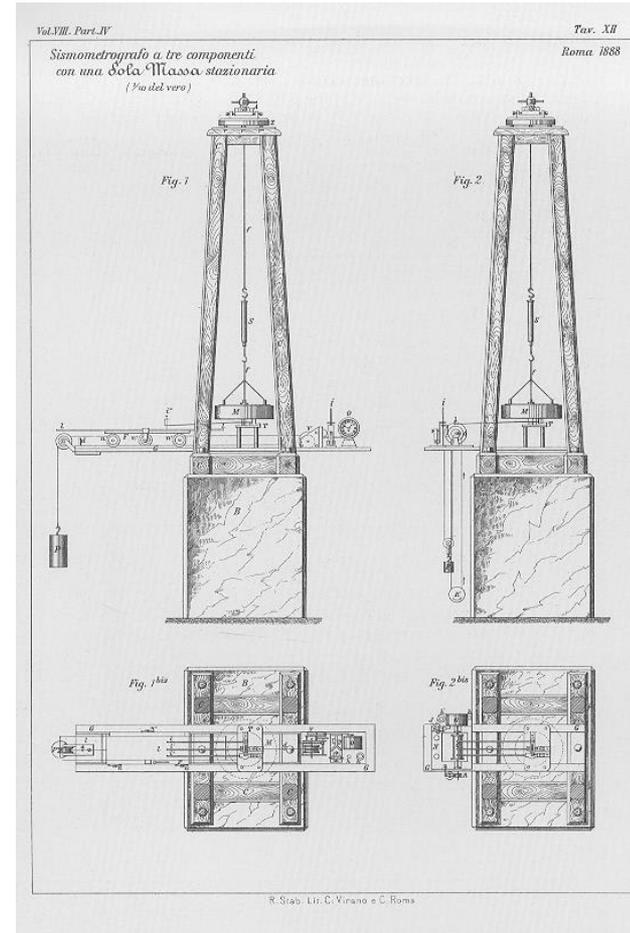
Bina 1751



Cacciatore 1818



Brassart 1888



Palmieri 1807

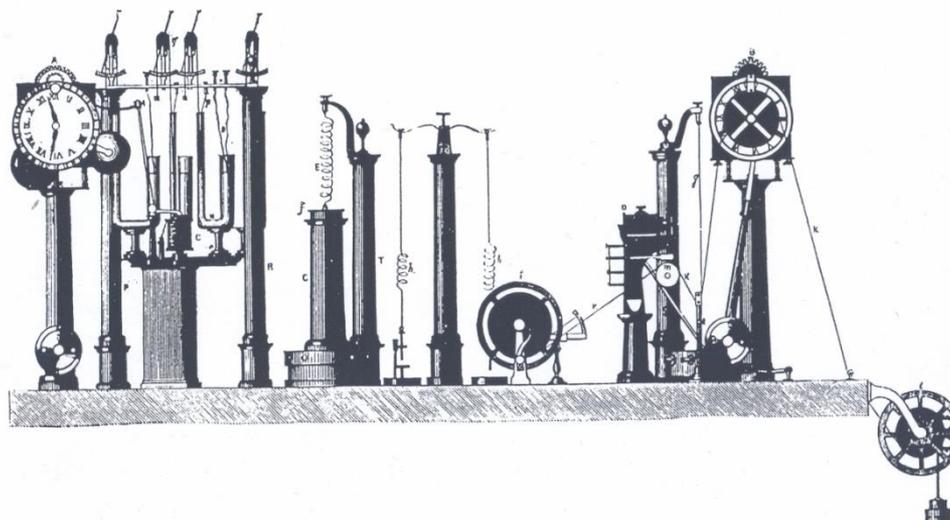
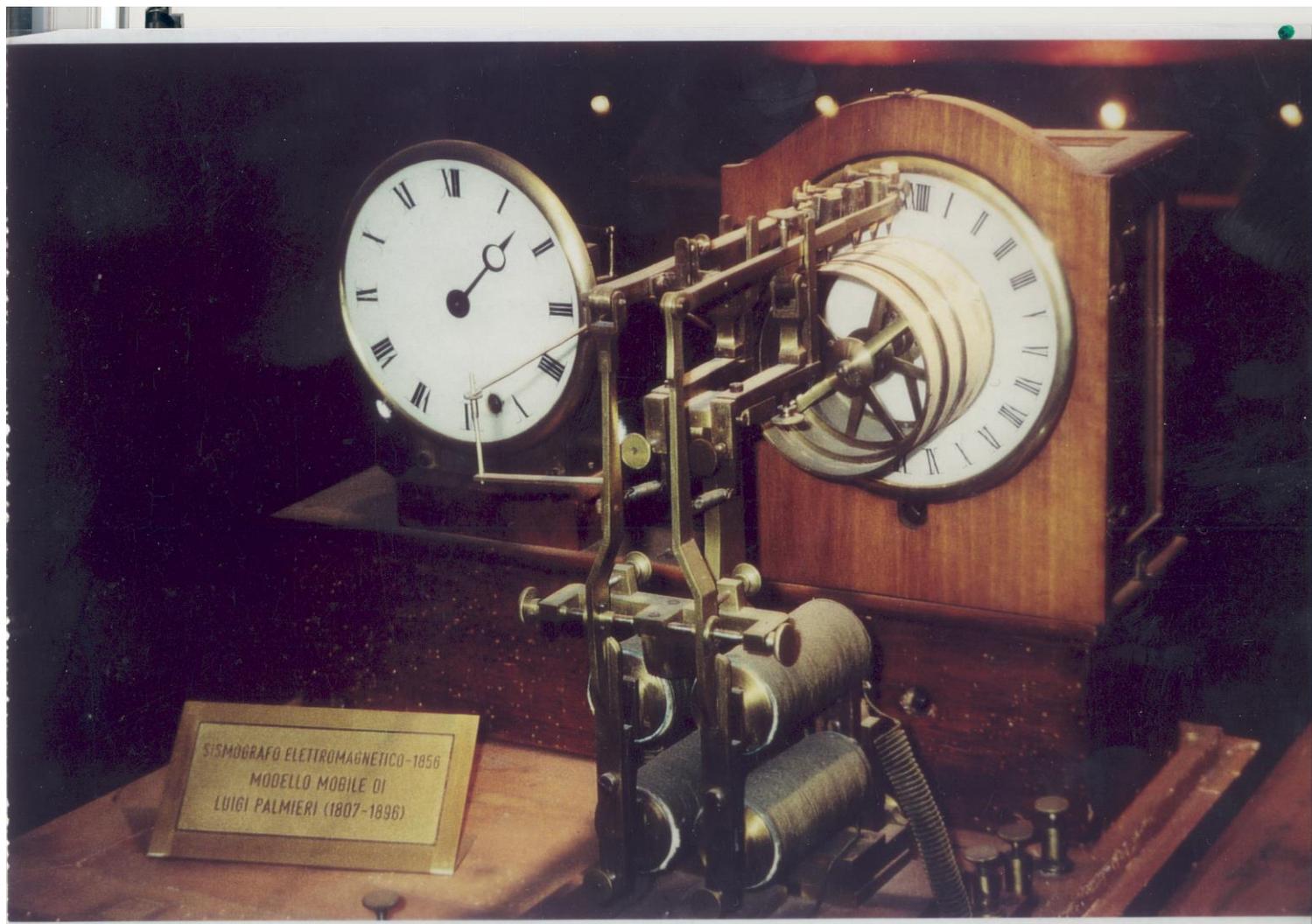
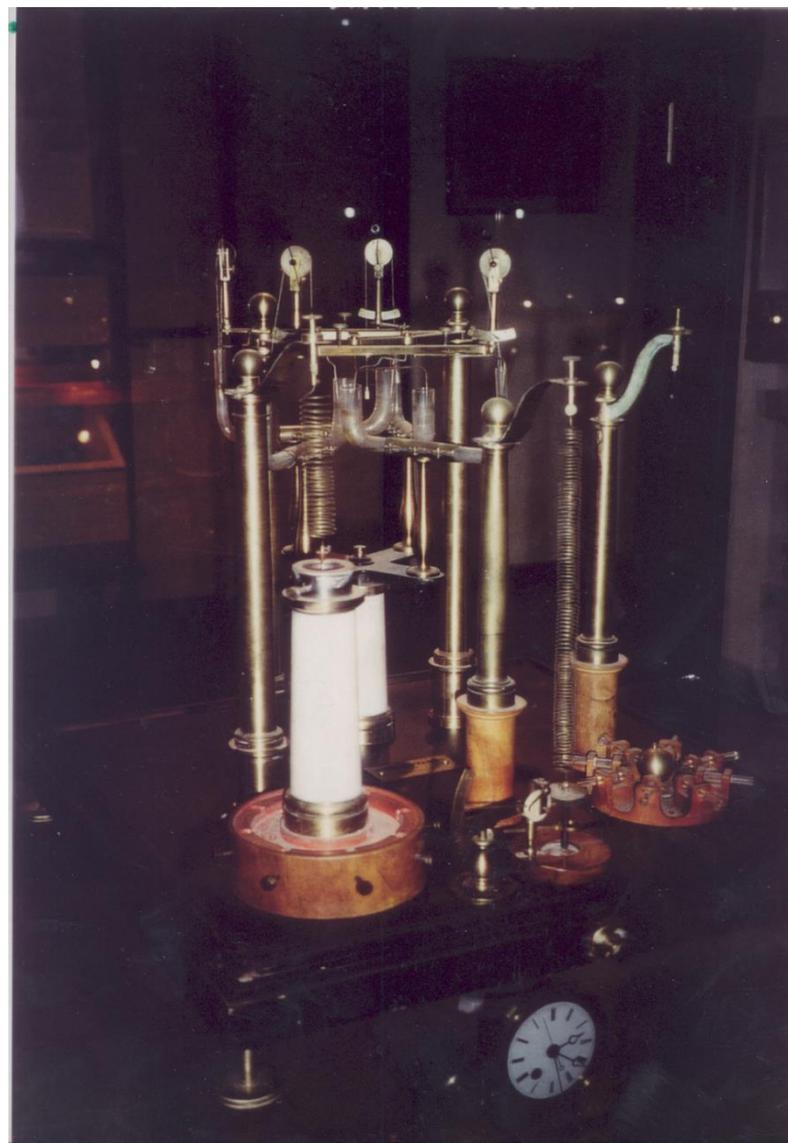


FIG. 4. Palmieri's "sismografo elettro-magnetico" (reproduced from *The Engineer*, 33, 1877, p. 407). Vertical motion is detected by a mass on a spiral spring *E*. The U-tubes *n* detect horizontal motion. Paper is unrolled from the drum *i* and a pencil mark put on the paper at *m*. The speed of the paper is regulated by the clock *B*. The clock *A* is stopped by the earthquake to give the time of the shock.

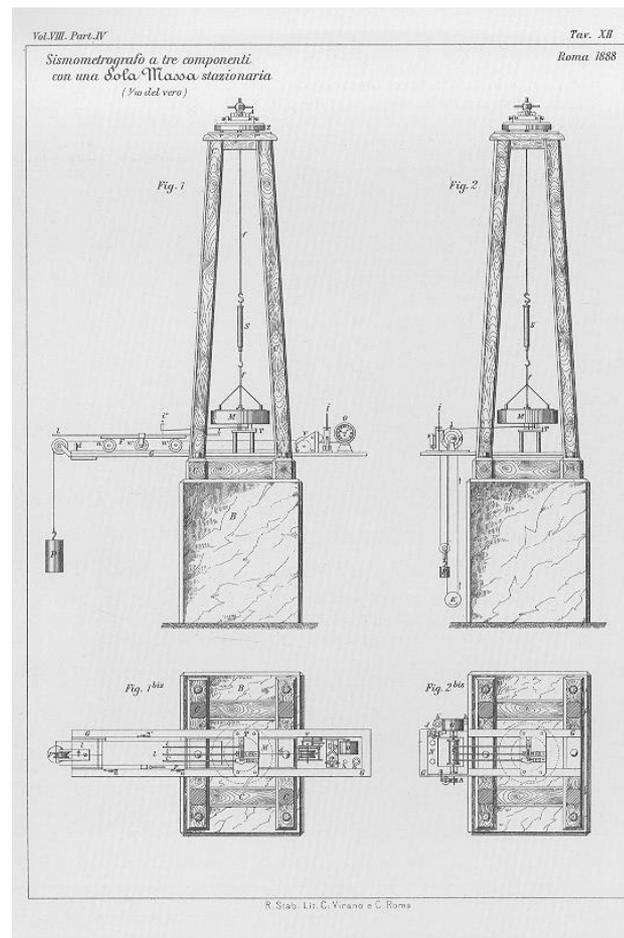
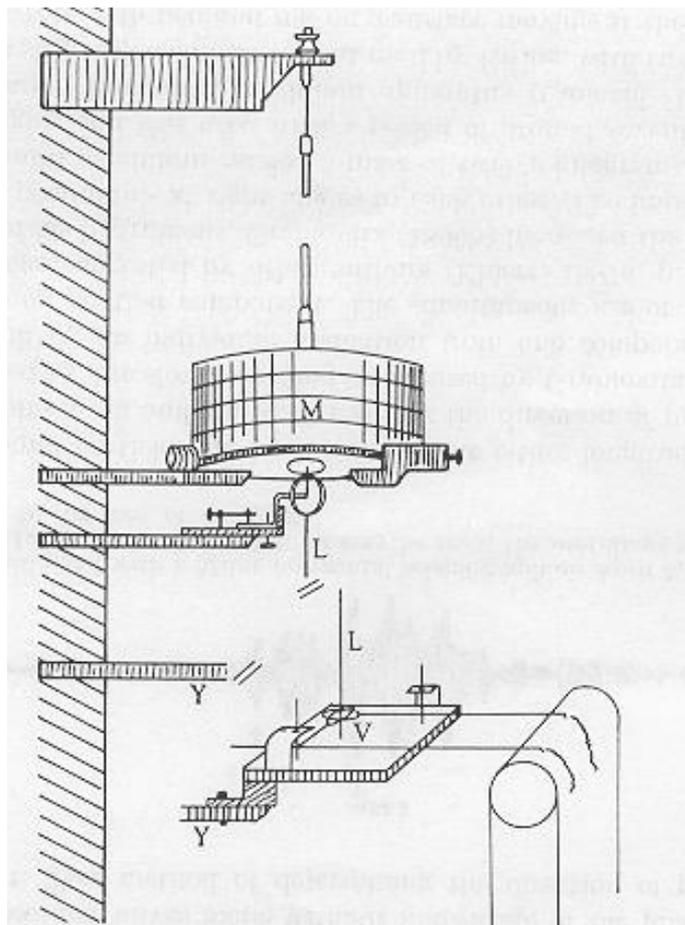
Palmieri 1807



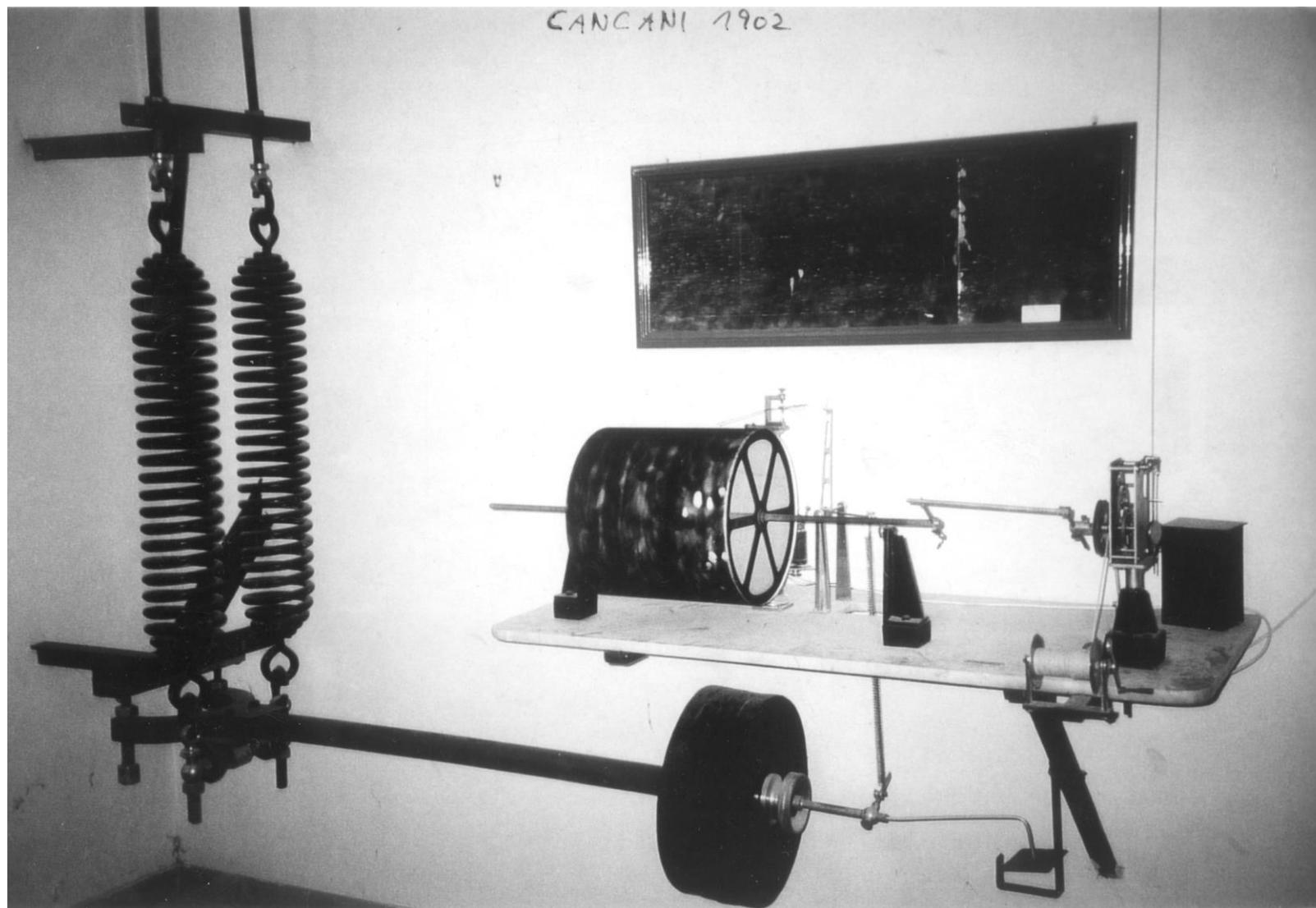
Palmieri 1807



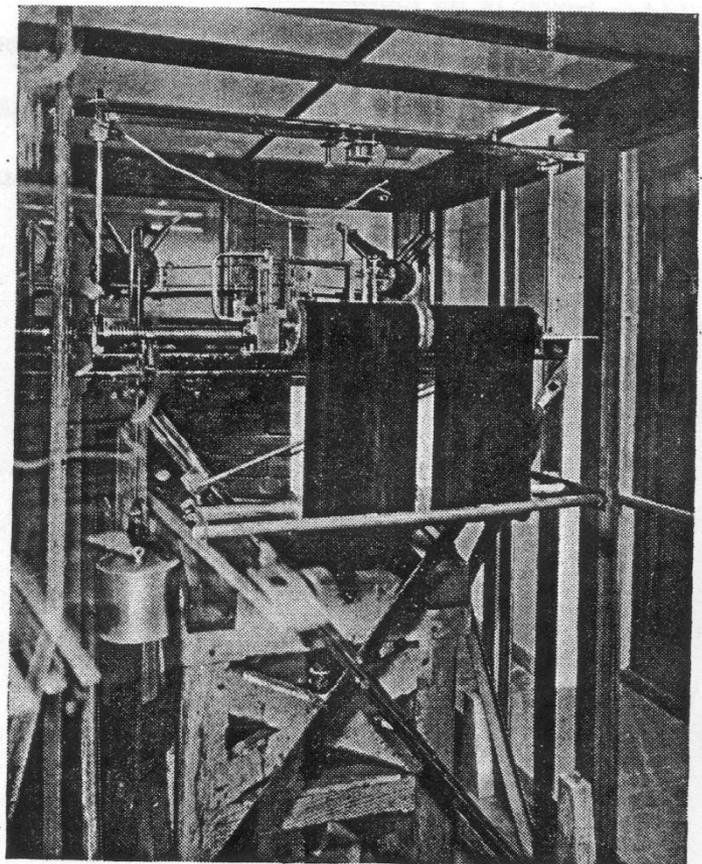
Brassart 1888



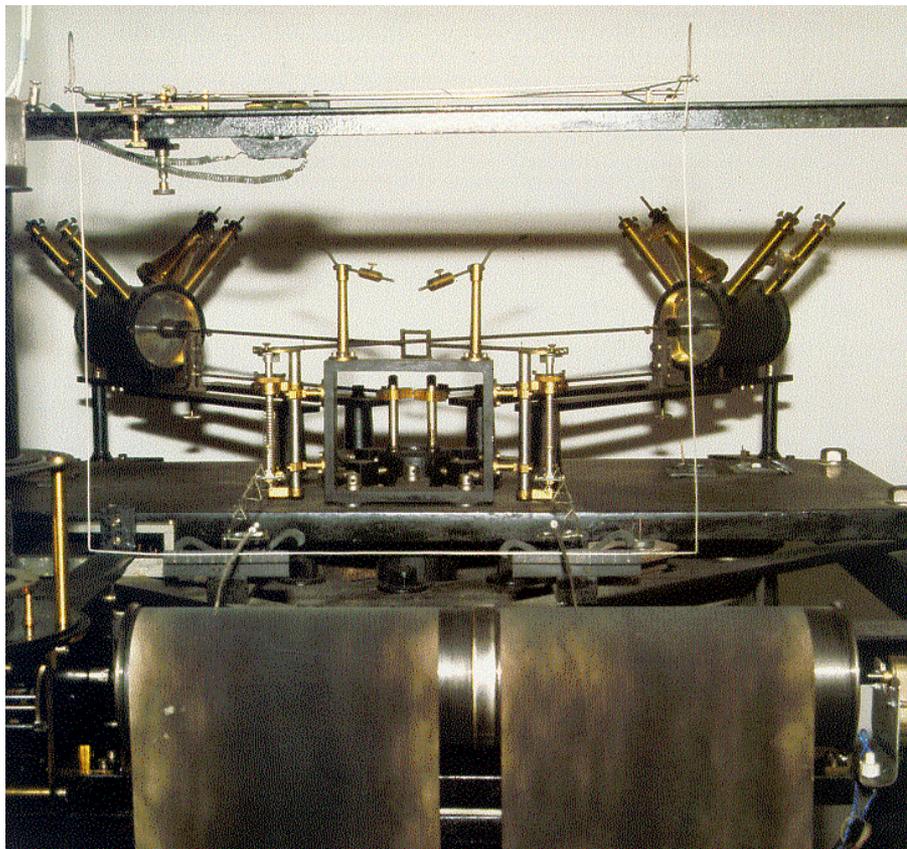
Cancani 1902



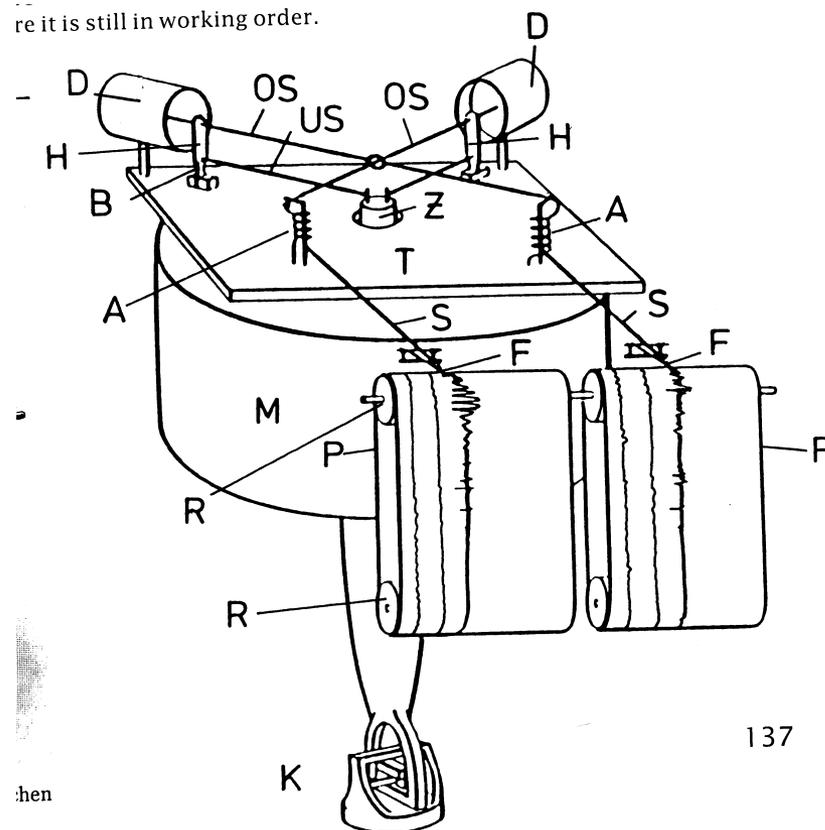
Wiechert 1903



Wiechert 1903



re it is still in working order.

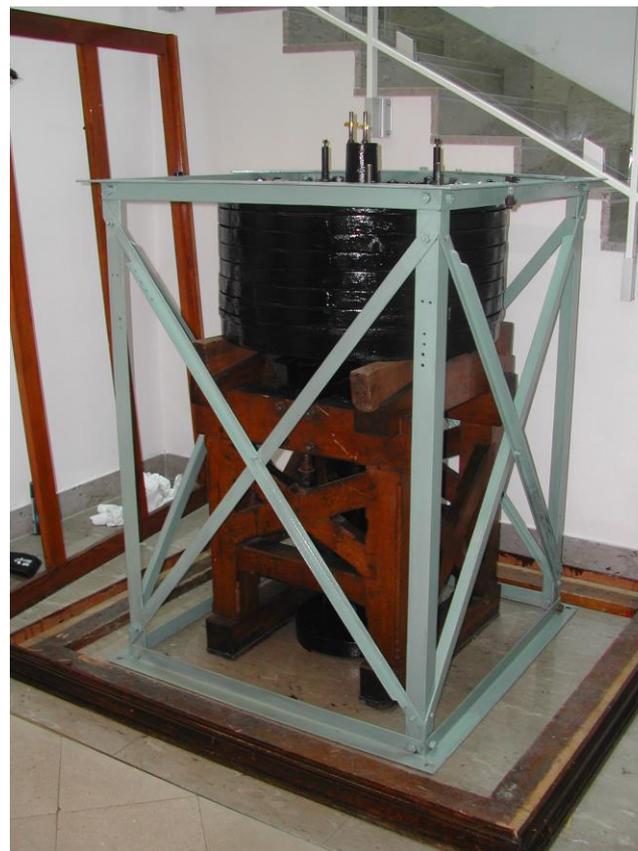


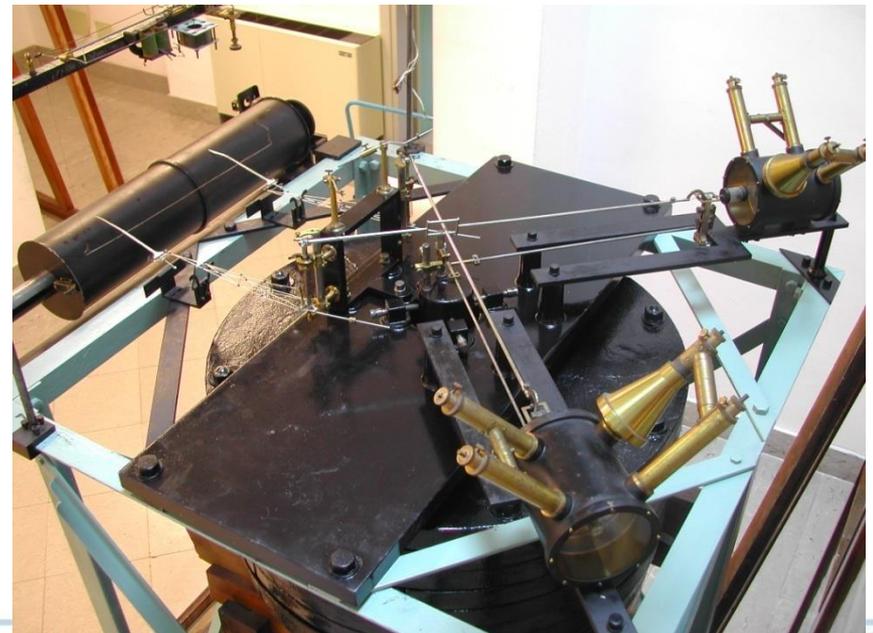
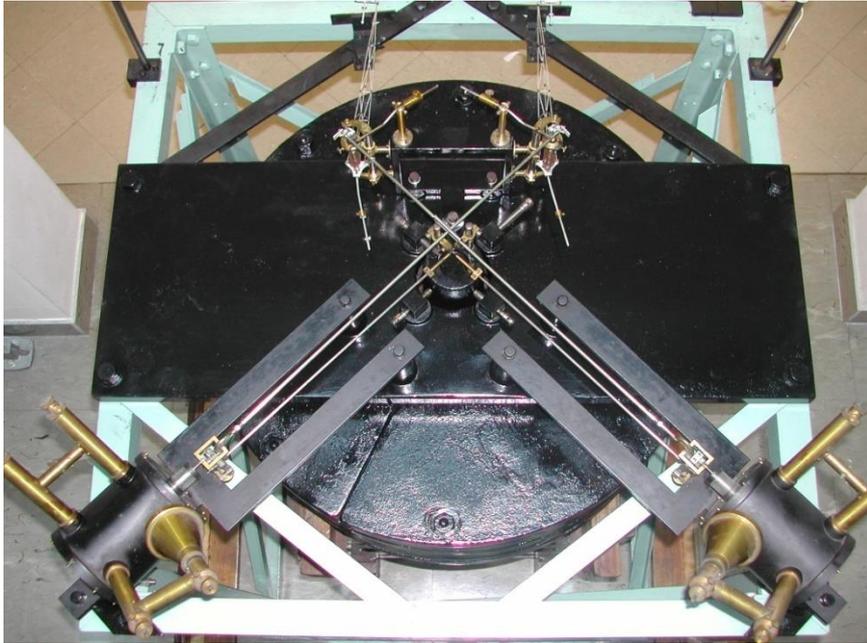
137

hen

1903

Wiechert 1903





Wiechert 1903

Wiechert 1903

202

Viertes Kapitel. Die Hauptprobleme der Seismometrie

punkt der Masse. Die Feder, die einen Zug von 160 kg auszuhalten hat, ist oben an einem Hebel befestigt, der sich auf einen Rost von Zink- und

der "kleine" WIECHERT
(~ 1910, vert.)
mit Temperatur-
Kompensation

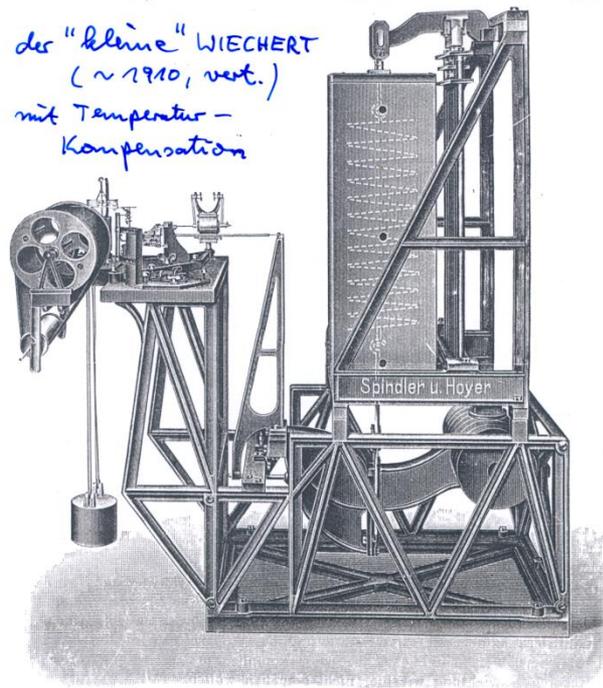
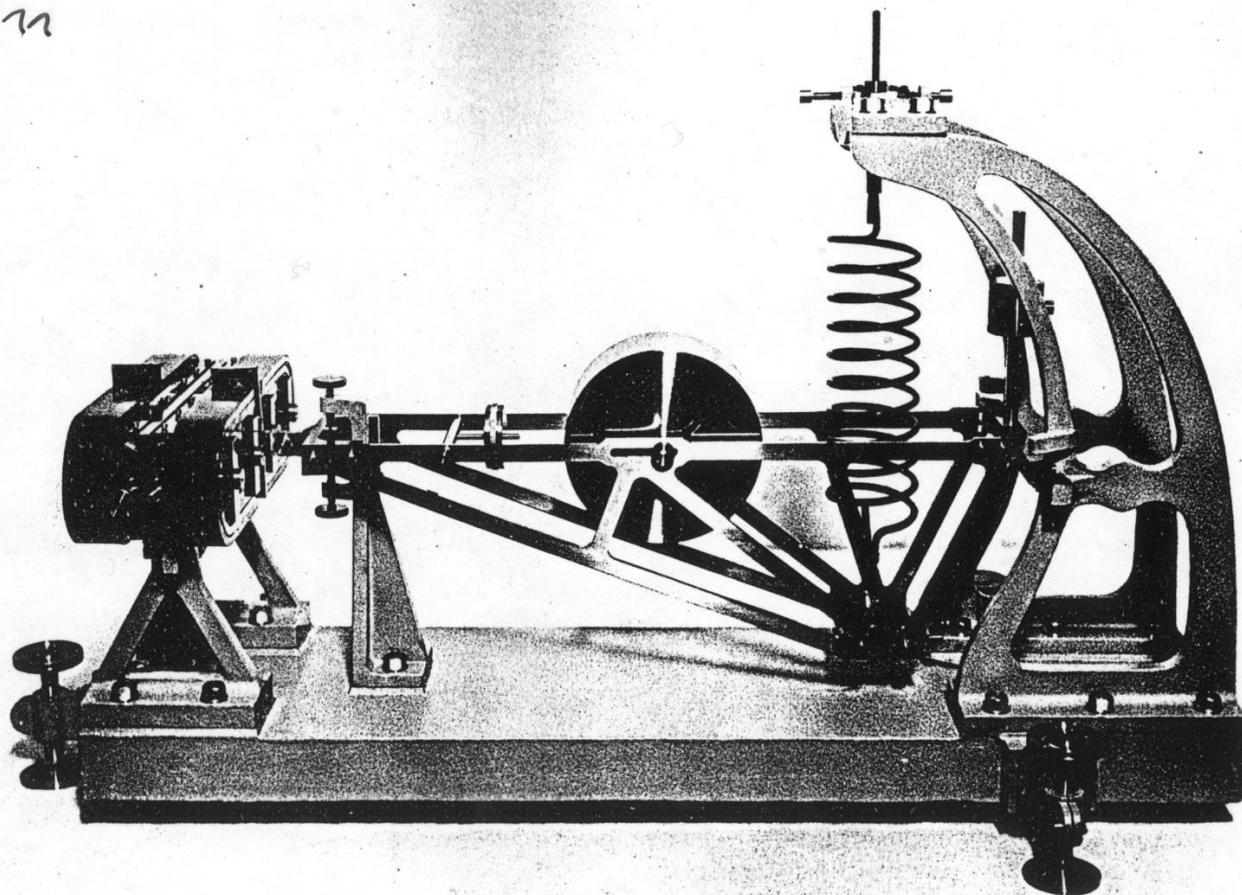


Fig. 74

Eisenstäben stützt. Diese sind so angeordnet, daß sie eine Temperaturkompensation bewirken, die sehr notwendig ist, da schon bei einer Temperaturänderung von $\frac{1}{10}^{\circ}\text{C}$ bei der angewandten Vergrößerung die Schreibfeder einen Ausschlag von 30 mm machen würde. Um die Feder vor Temperaturschwankungen zu schützen, ist sie mit einem dickwandigen Kasten umgeben. Das Instrument, dessen Schwingungsdauer sich etwa bis 8 Sekunden

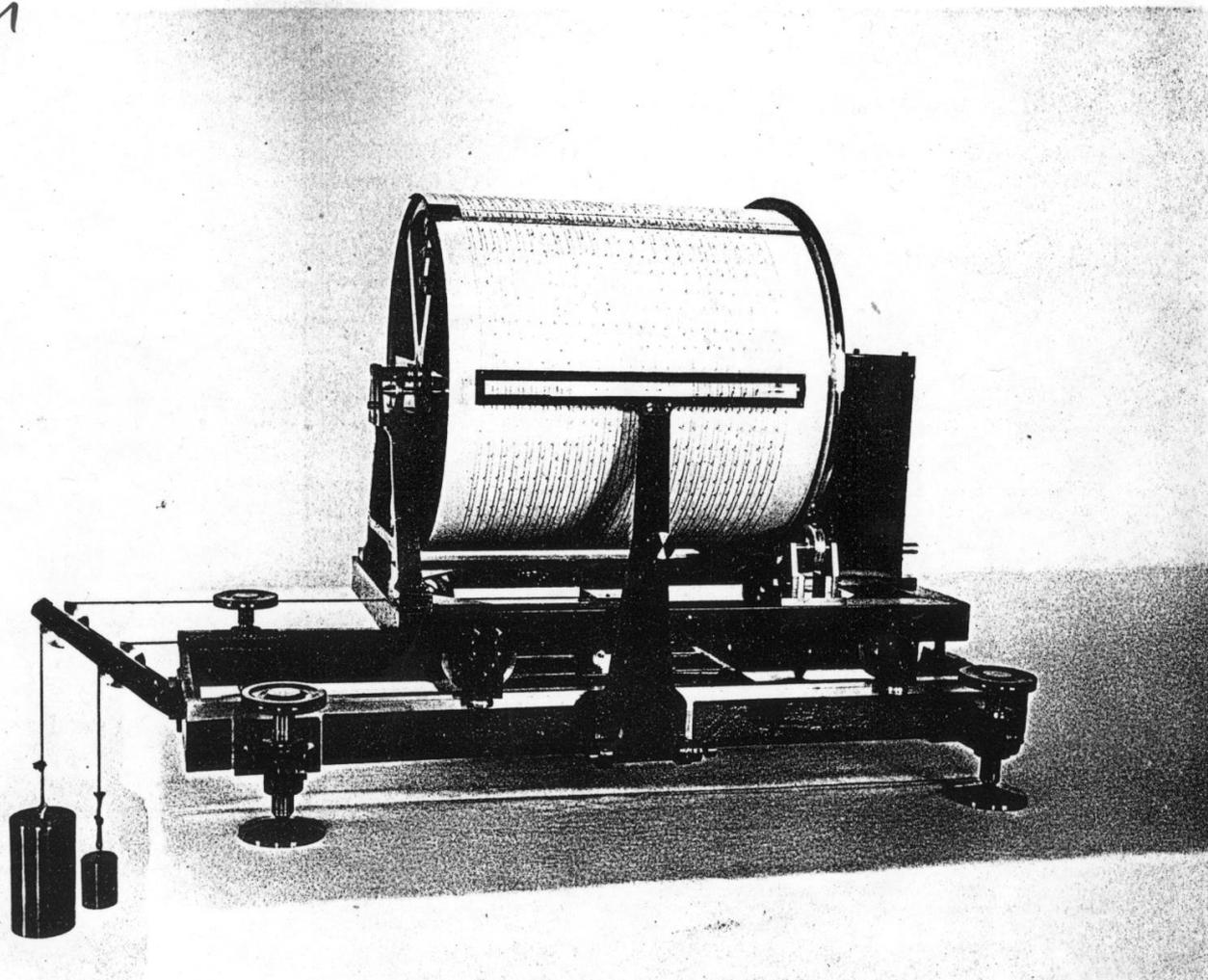
Fig. 84.

GALITZIN
1904-1911



GALITZIN
1904-1911

Fig. 85.



Фигура 85. Дрезден, ССР.

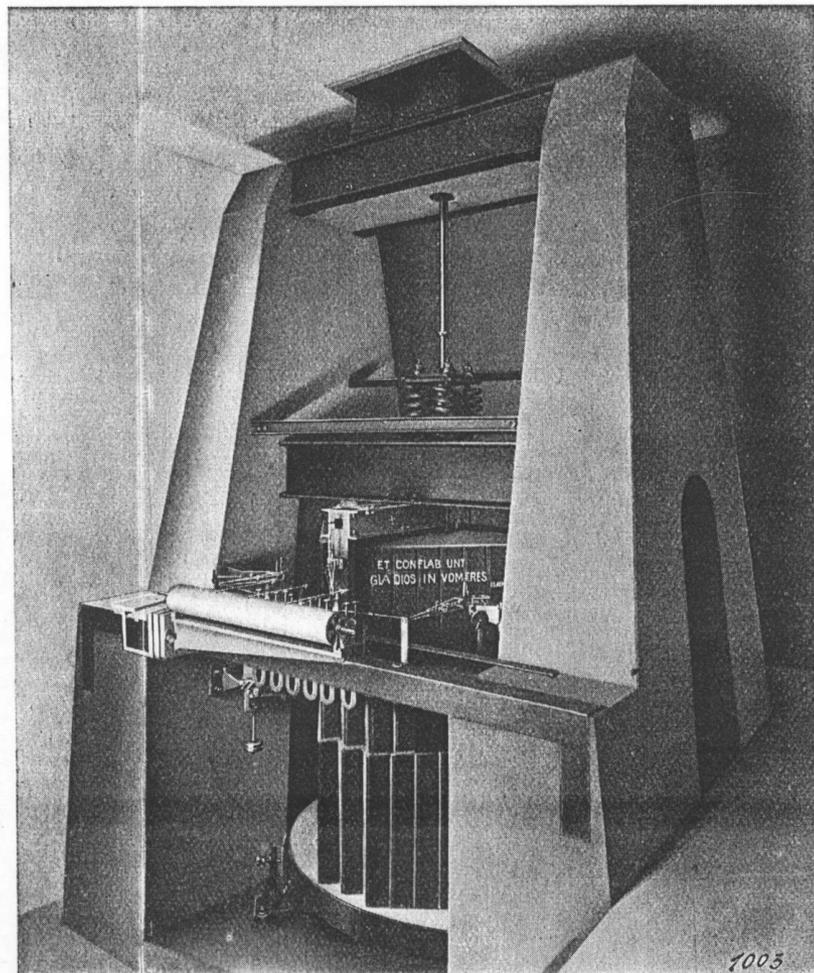
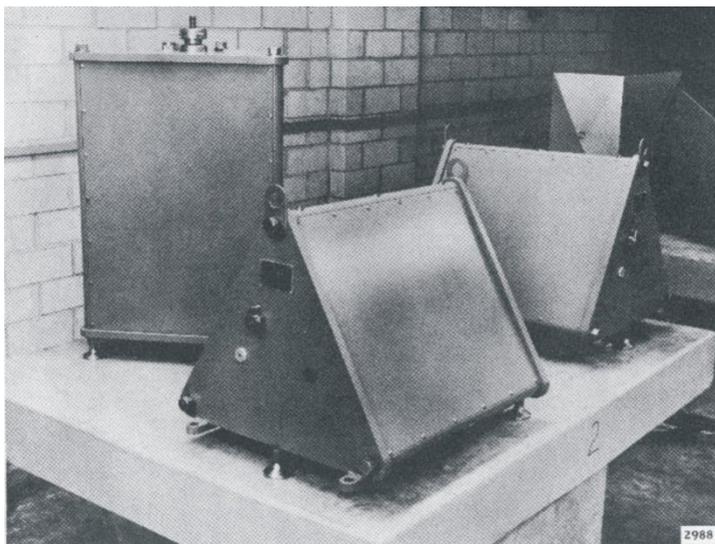


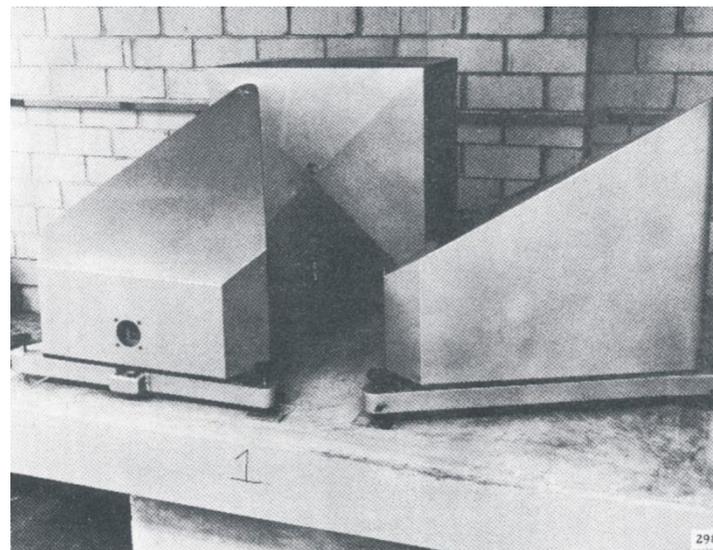
Fig. 4. Rohbau.

de Quevauvill - Piccard (Zürich)
Masse 21 to. Vergr. 2000. 1922-24

The TRI-117 WWSSN Trieste station seismometers



(a)

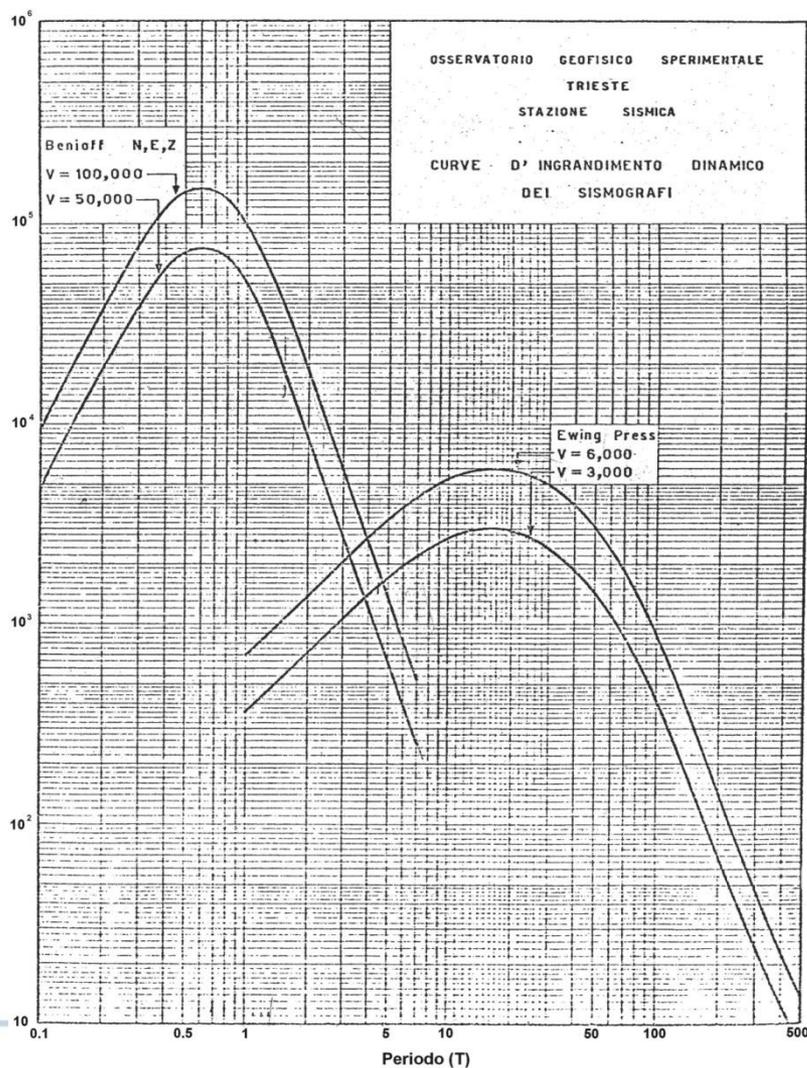


(b)

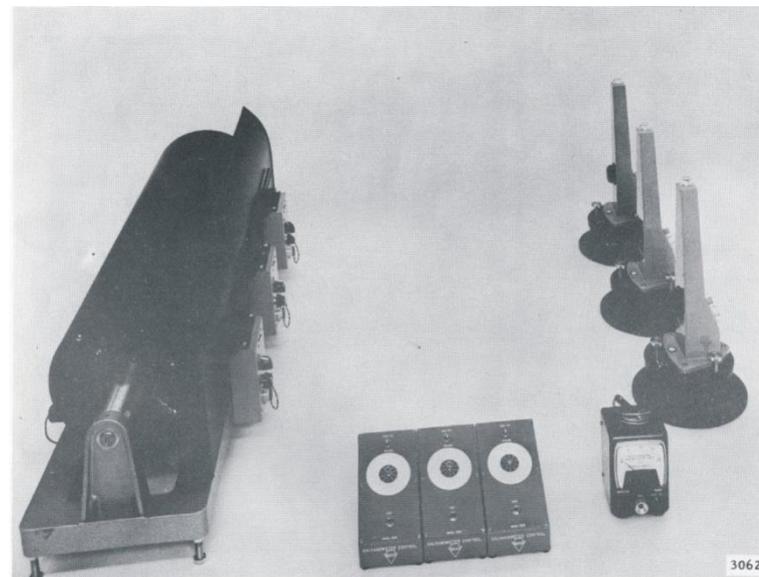
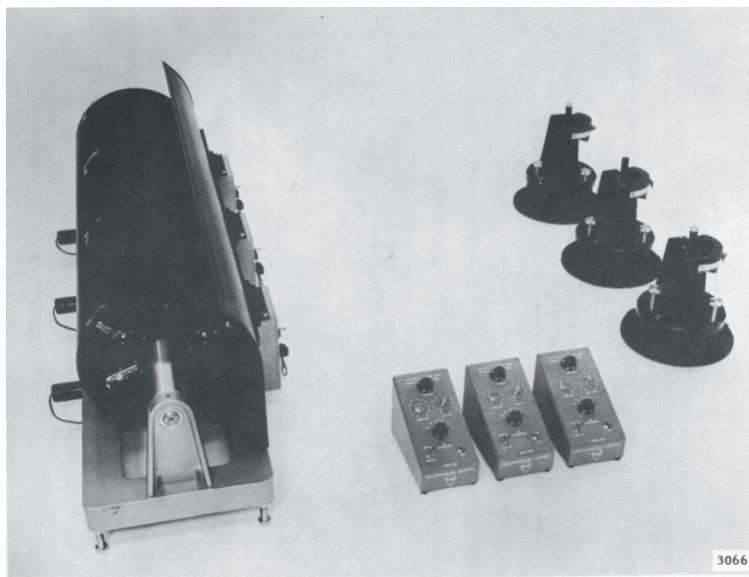
(a): Short period Benioff seismometers; component: Z, N-S, E-W; magnification: 50000; period: 1 s.

(b): Long period Ewing-Press seismometers; component: Z, N-S, E-W; magnification: 3000; period: 15 s.

The dynamic magnification curves of the TRI-117 WWSSN station seismometers



Surface equipment of TRI-117 WWSSN station



Short period (on the left) and long period (on the right) seismograph recording instruments

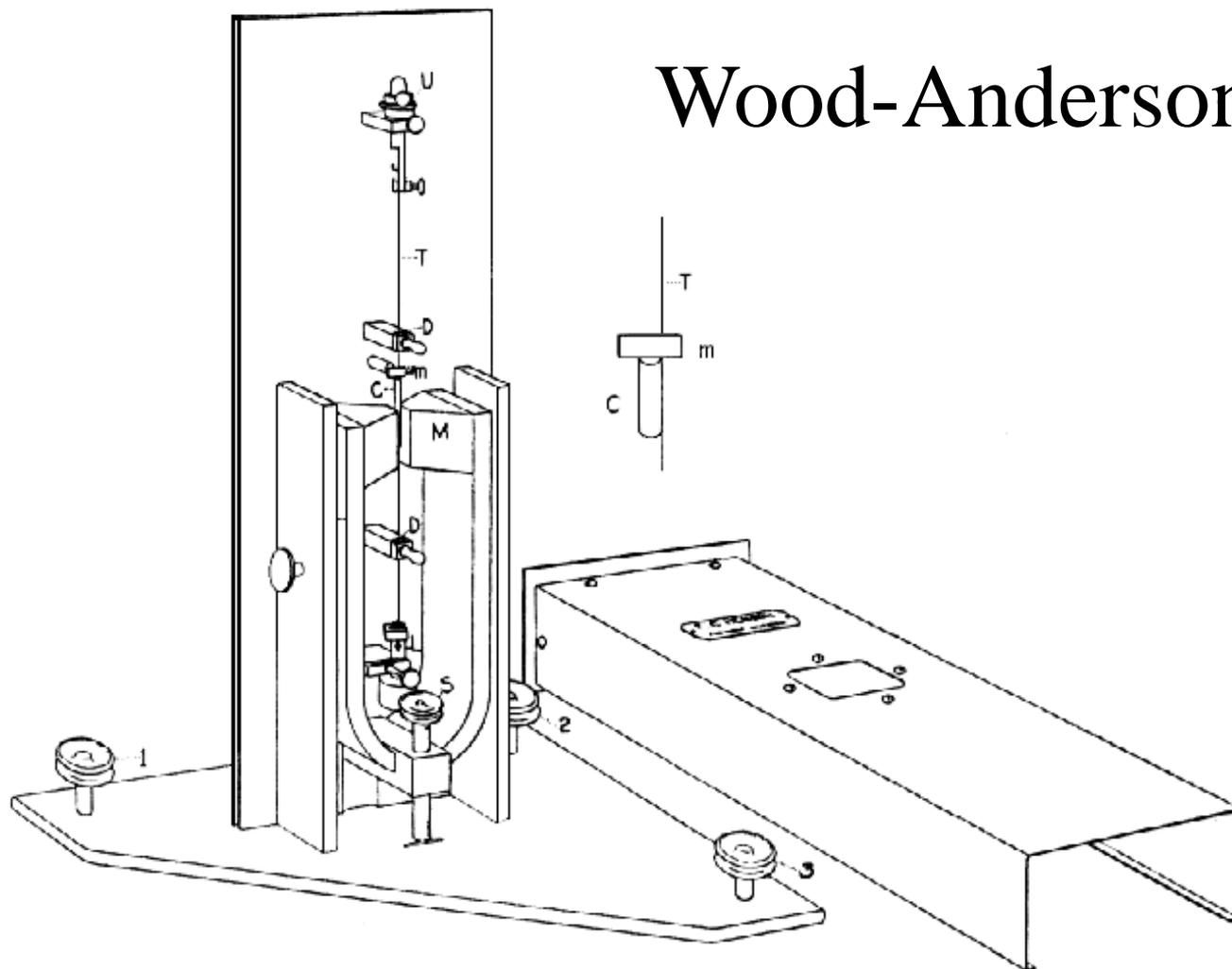
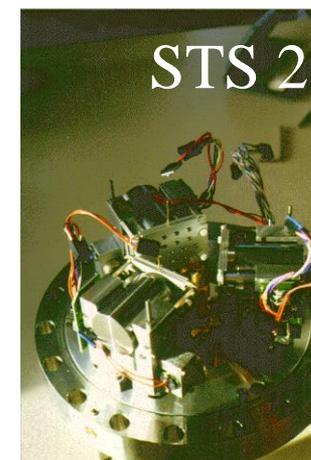
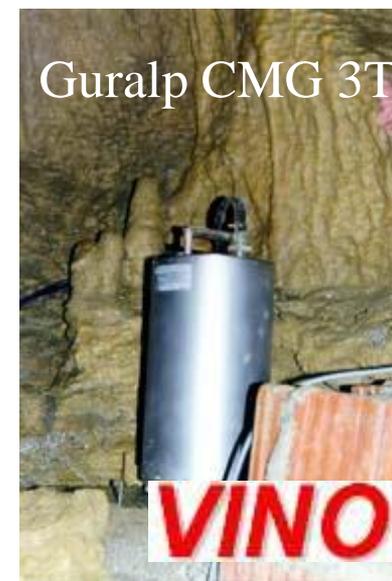
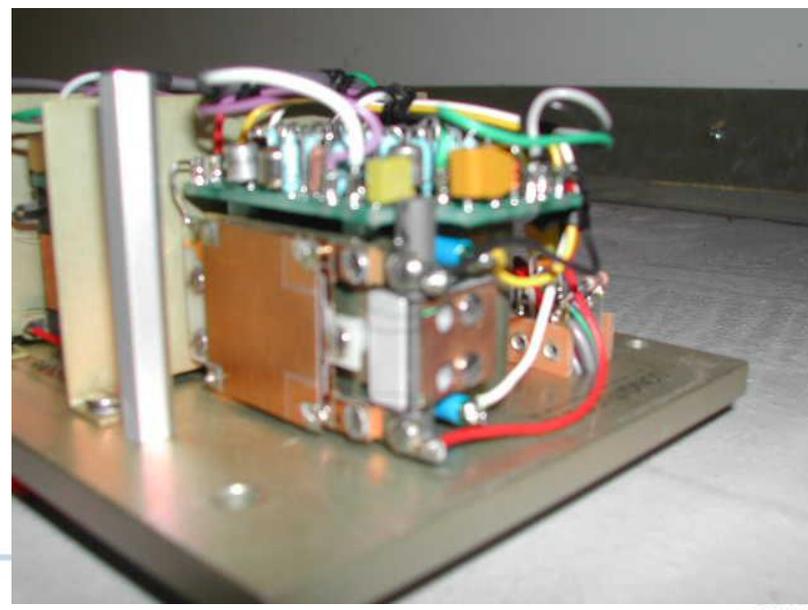
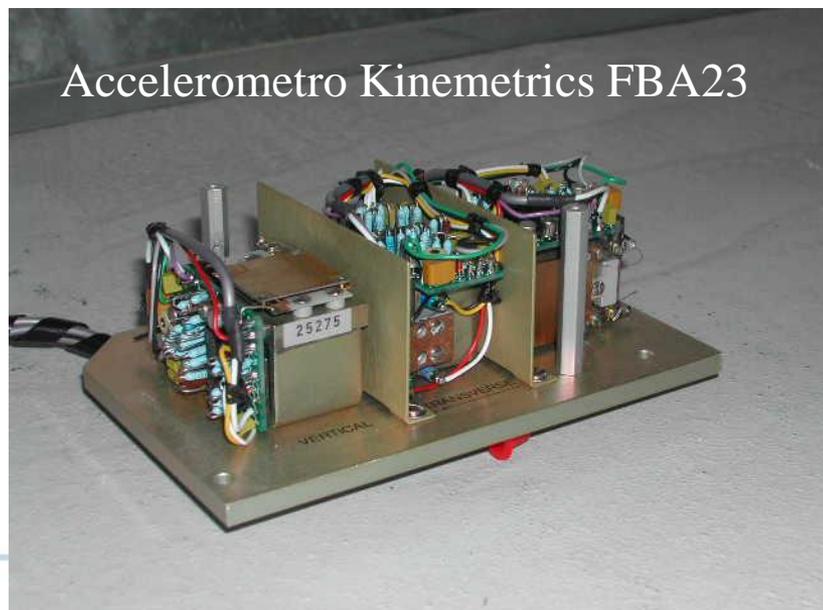


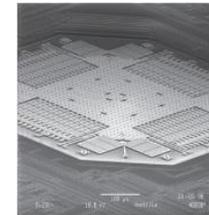
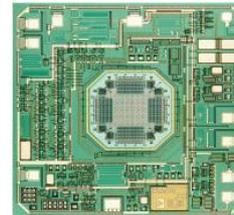
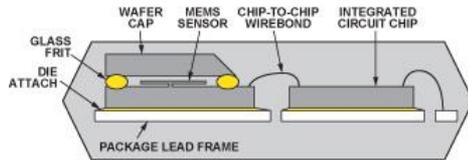
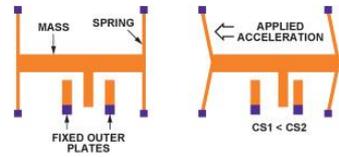
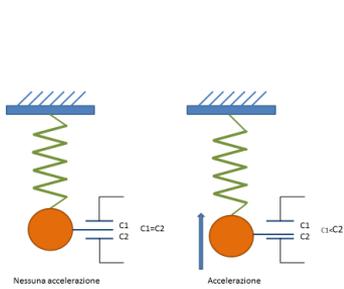
Fig. 2

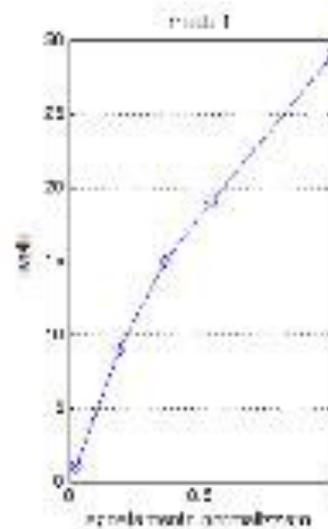
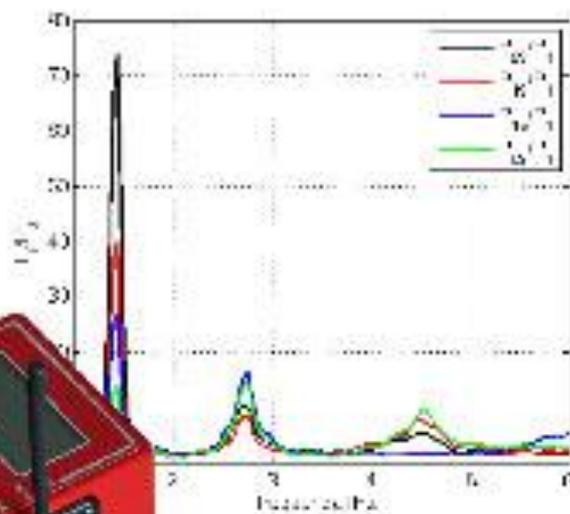




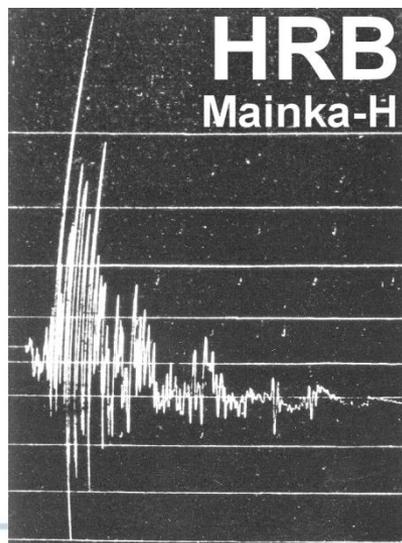
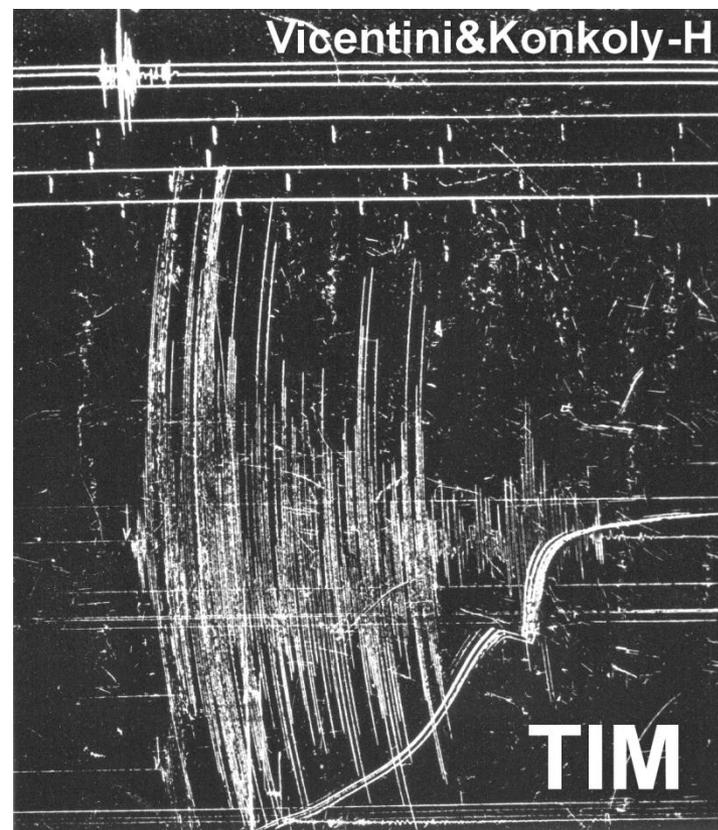


Accelerometri MEMS

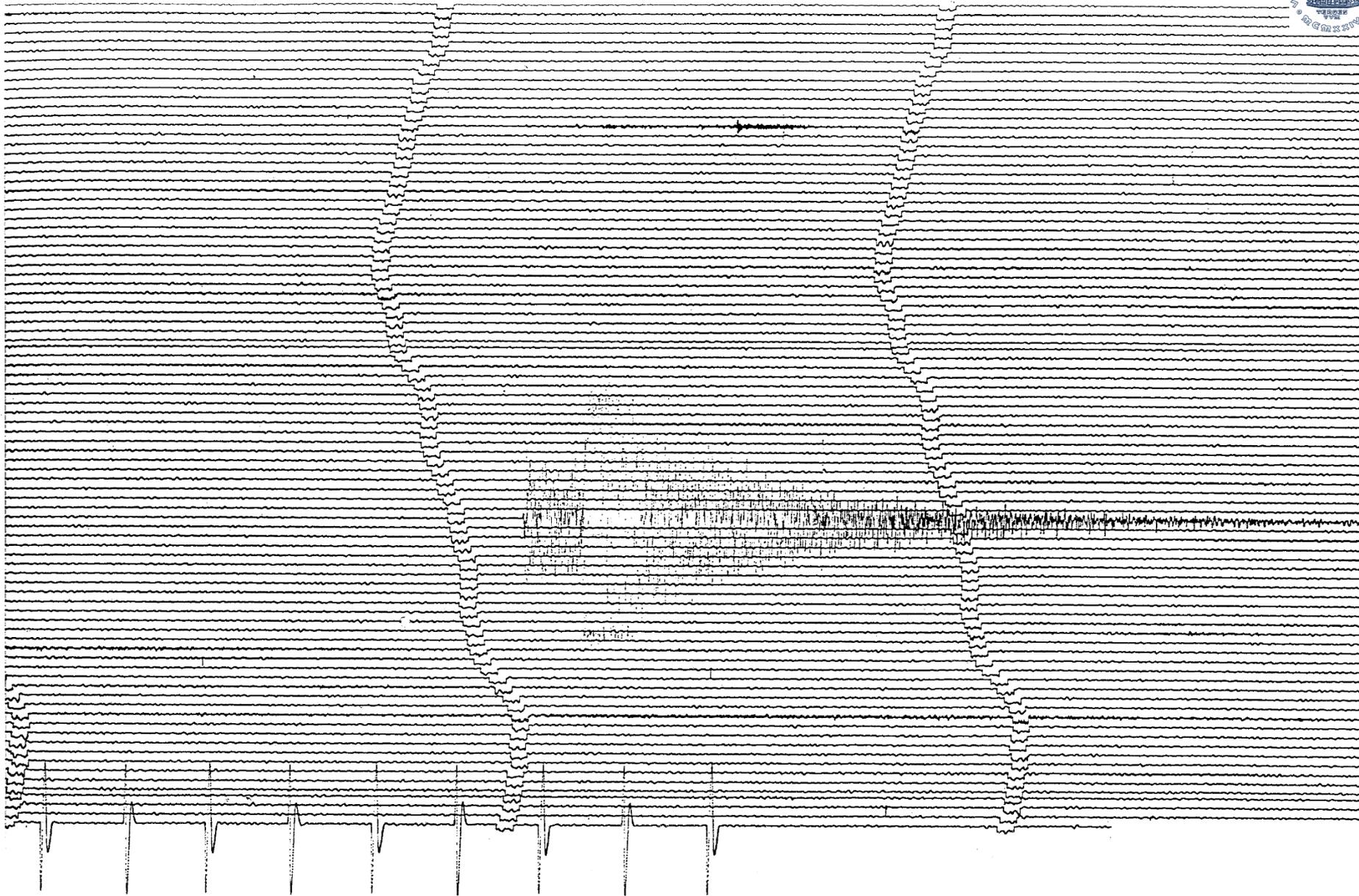






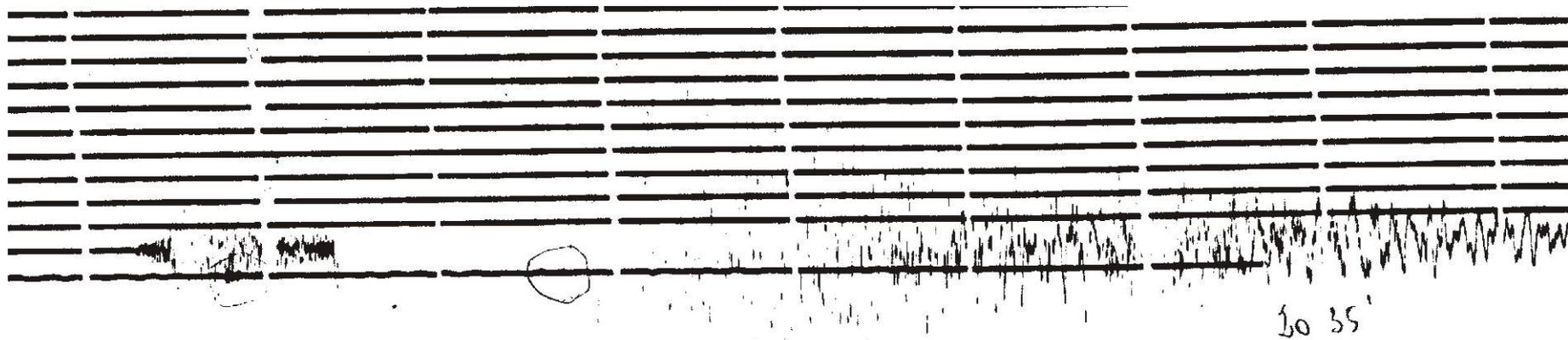


Kecskemét 1911, M 5.6



2011-08-24 10:00:00

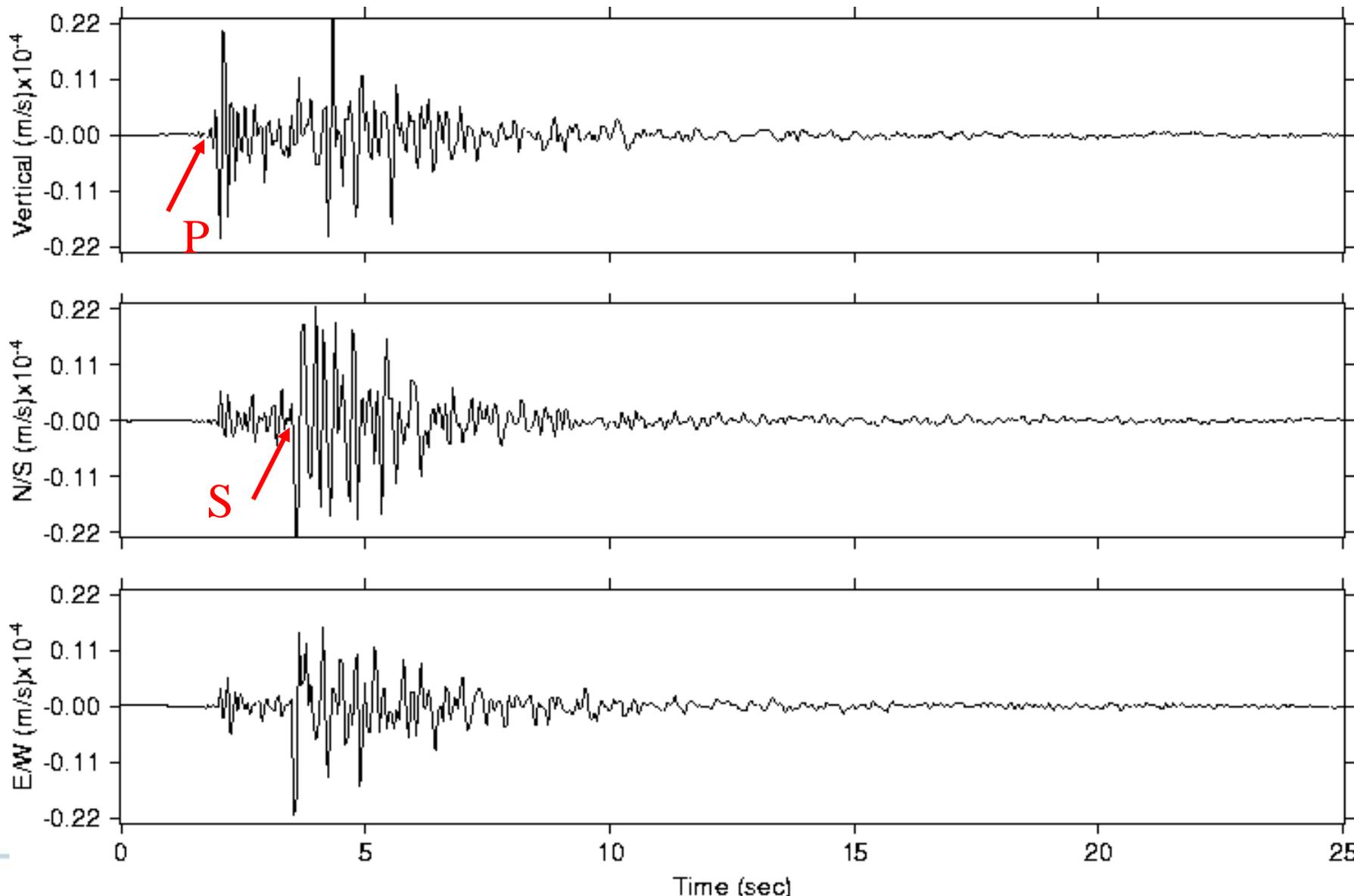
Friuli 1976 MI 6.5 – Wood-Anderson





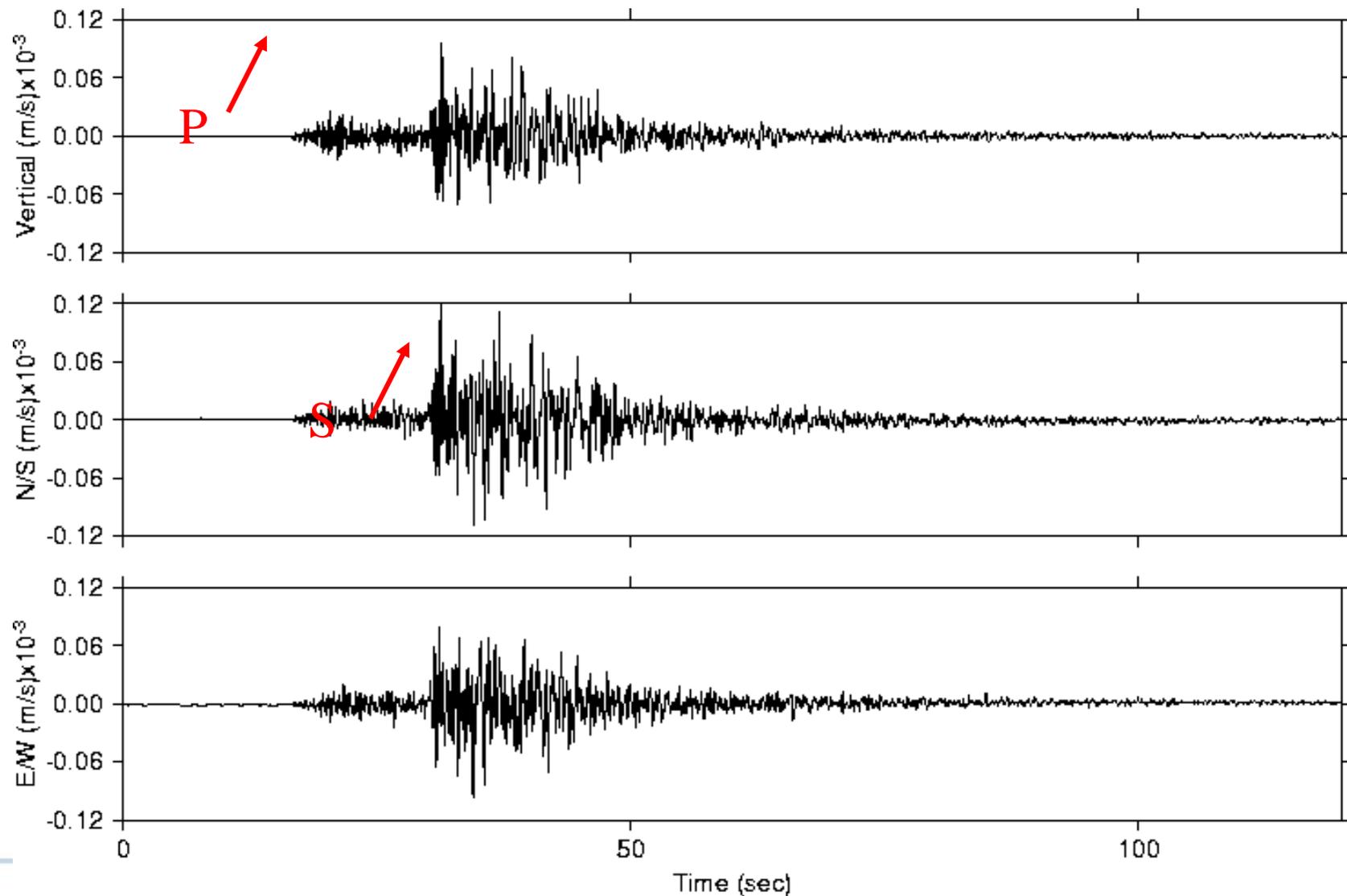
VINO

Evento Lusevera 25 maggio 2002 Md: 2.5 dist.: 4 km



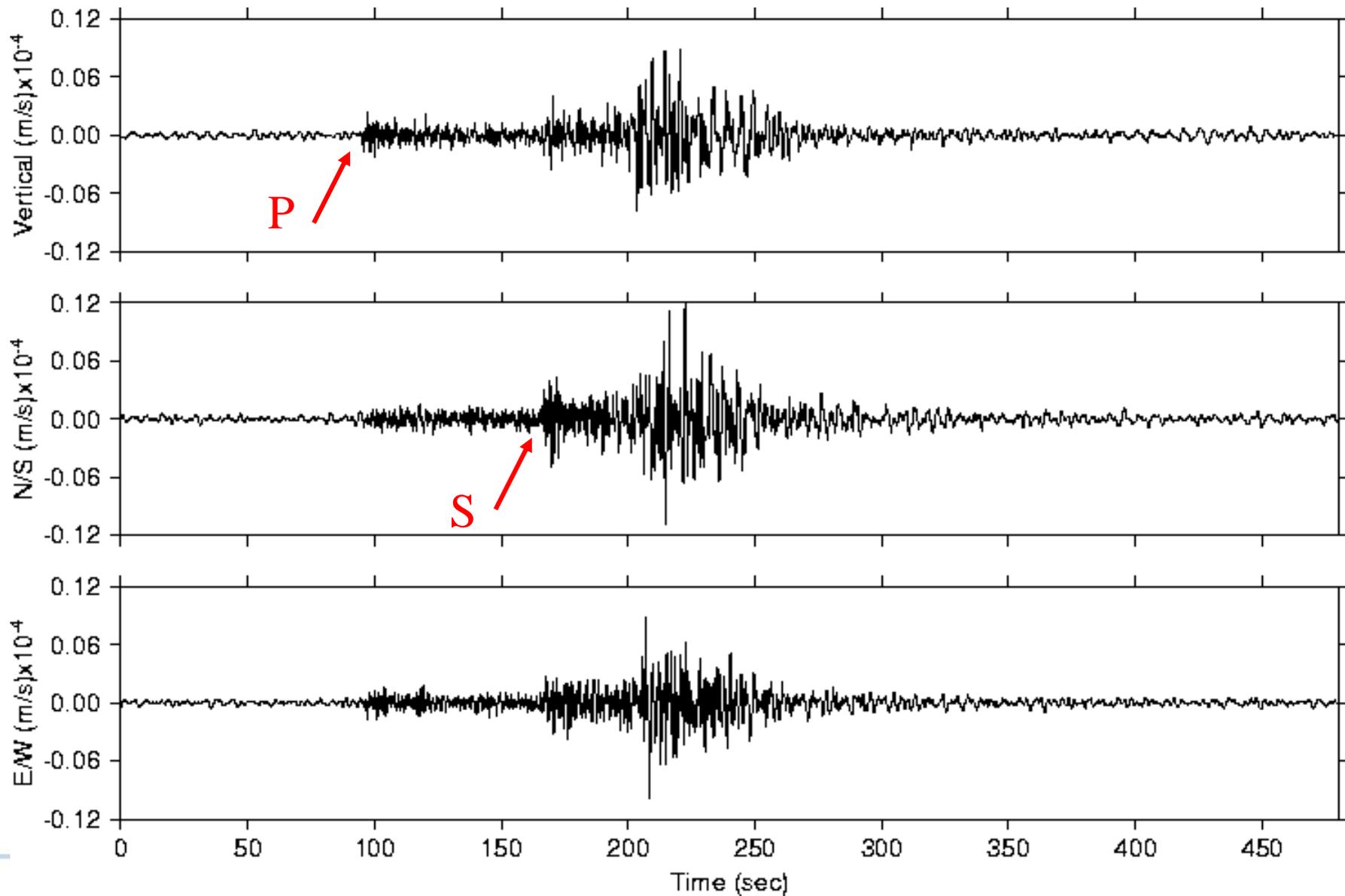
VINO

Evento M. Nevoso 2 giugno 2002 Ml: 3.7 dist.: 101 km



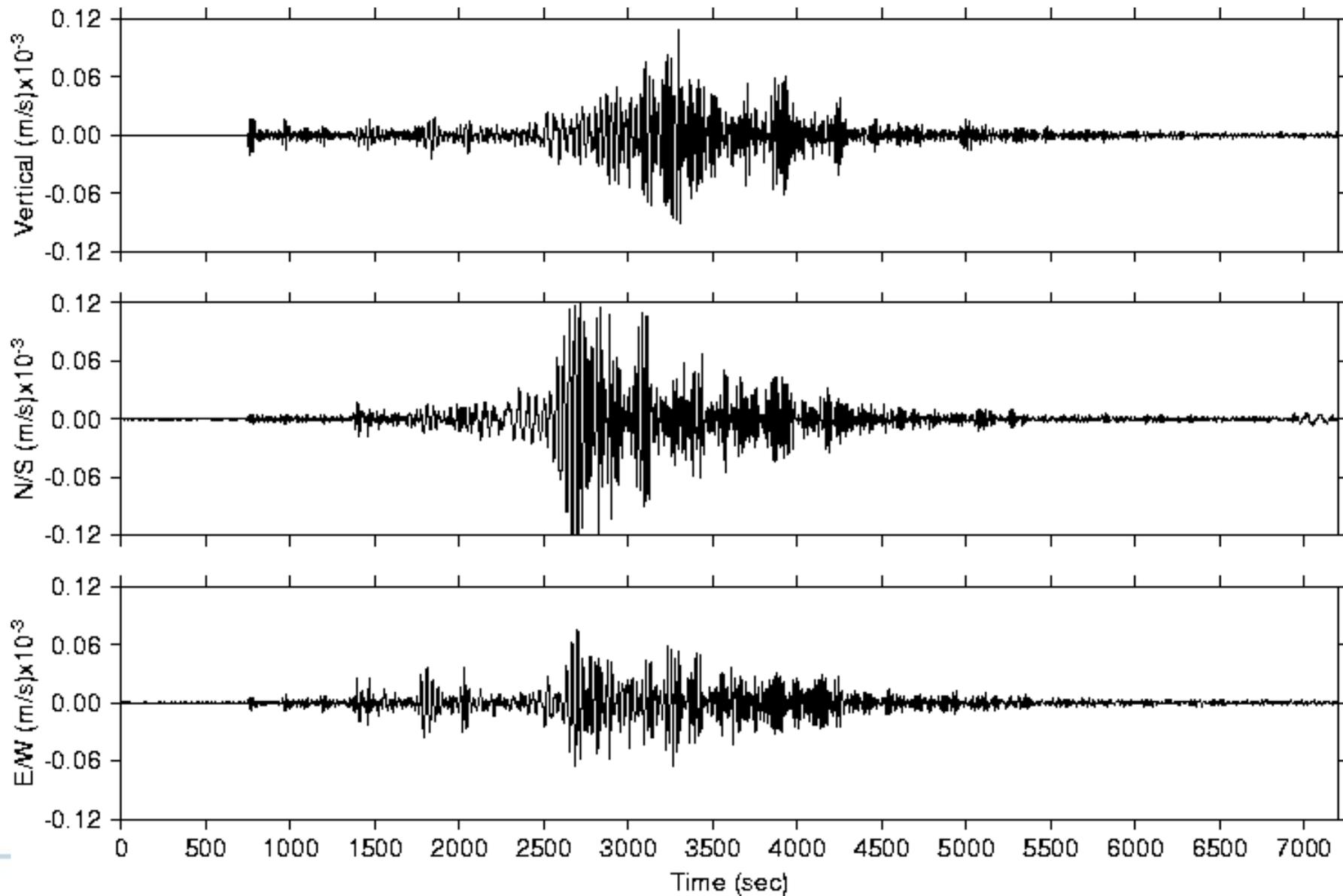
VINO

Evento Albania 28 maggio 2002 Ml: 4.4 dist.: 696 km

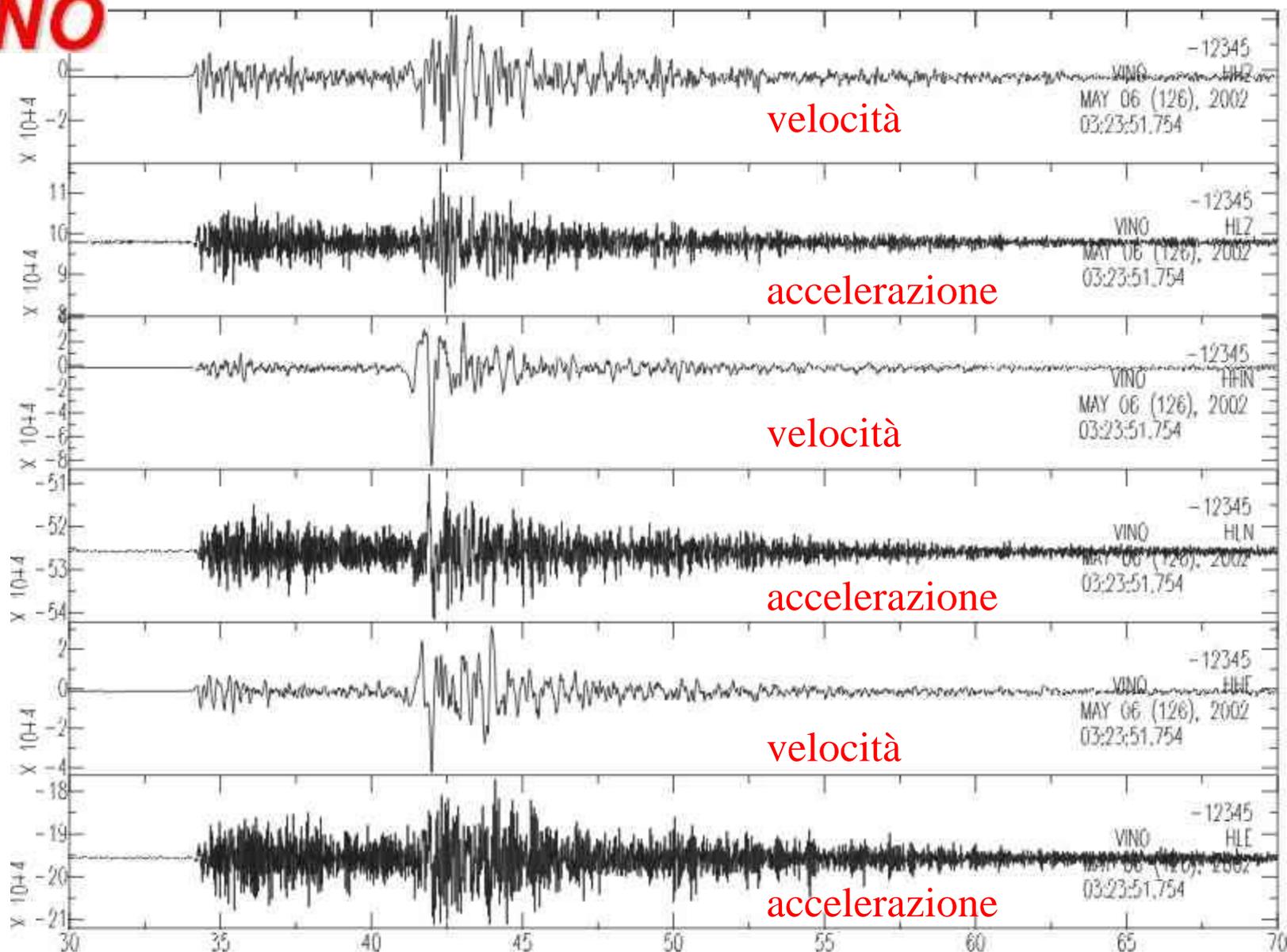


VINO

Evento Taiwan 15 maggio 2002 Ms=6.2 dist.: 9357 km

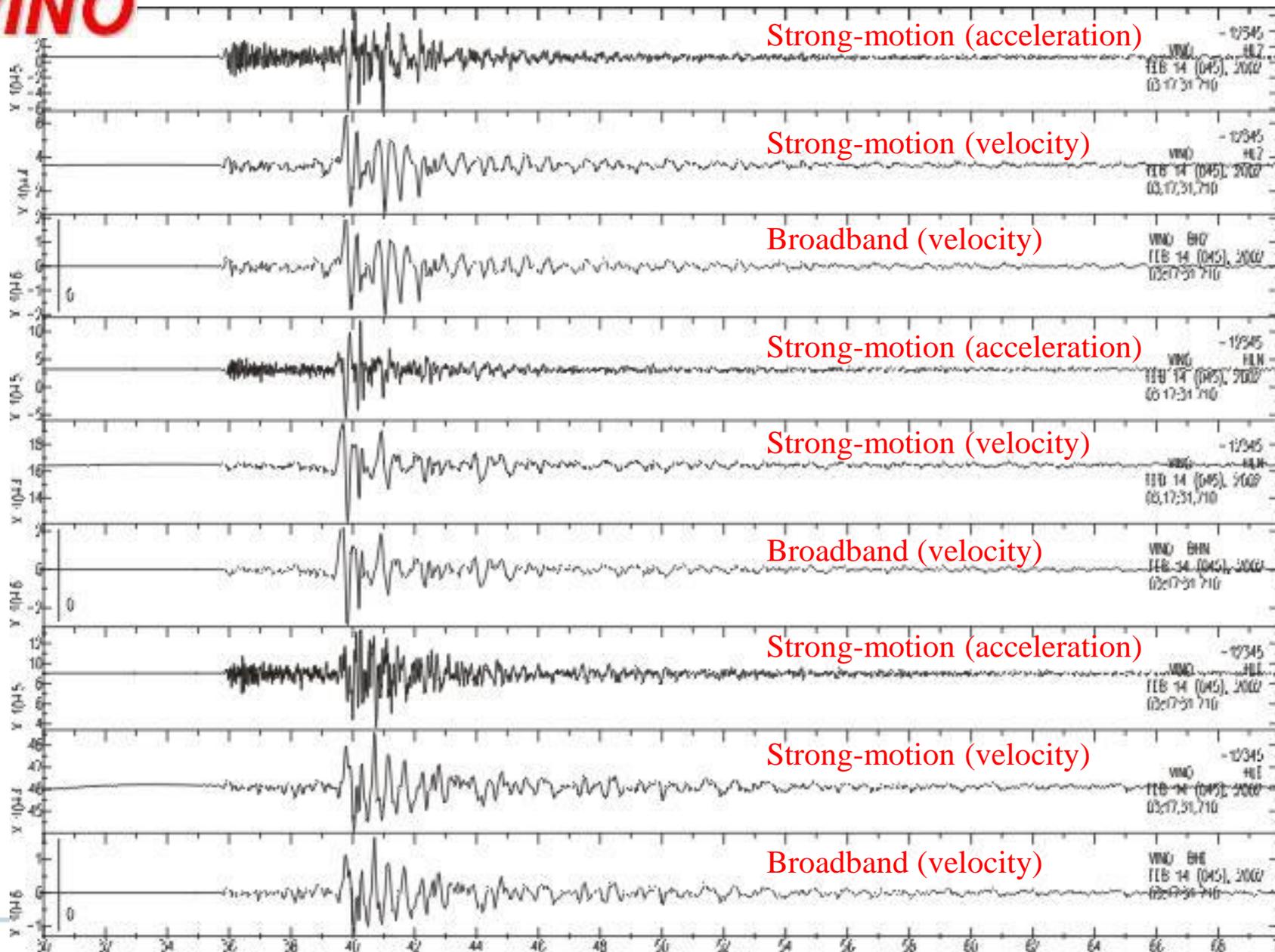


VINO





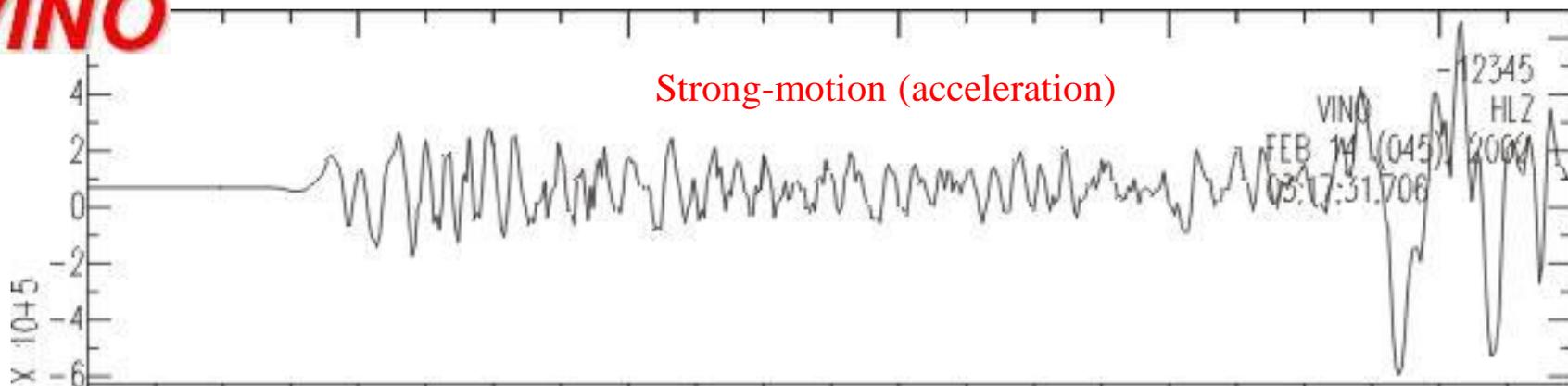
VINO



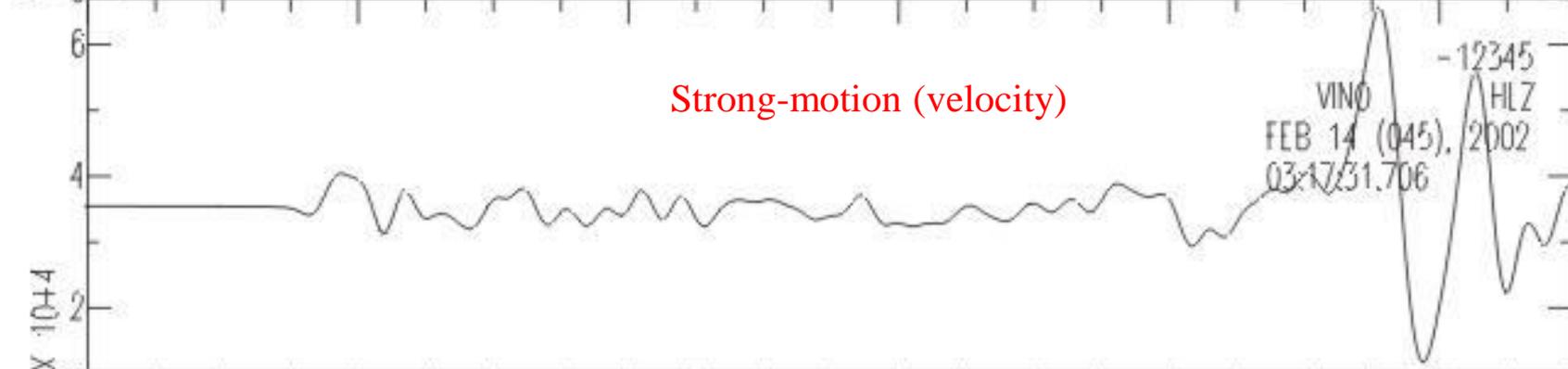


VINO

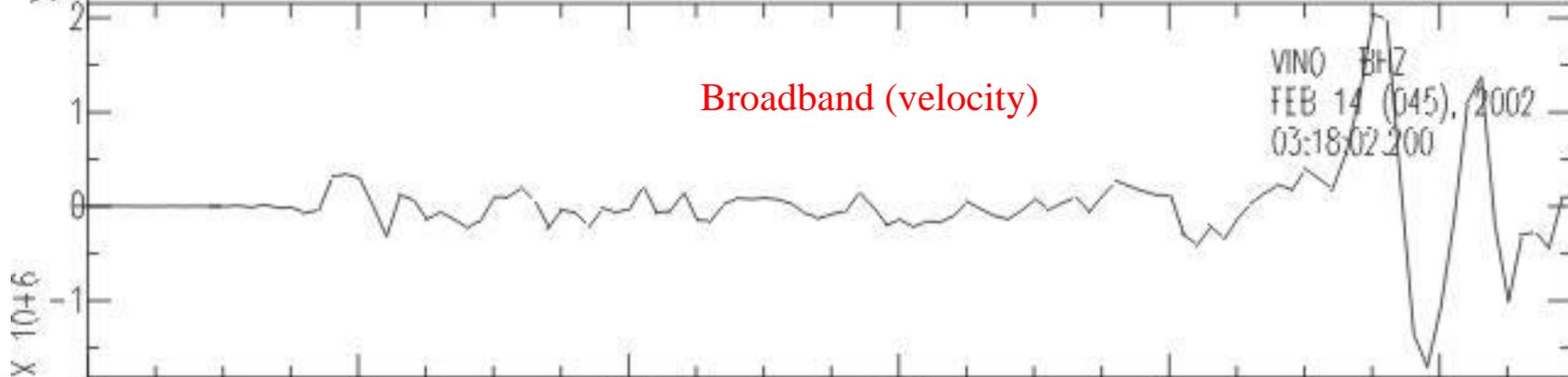
Strong-motion (acceleration)

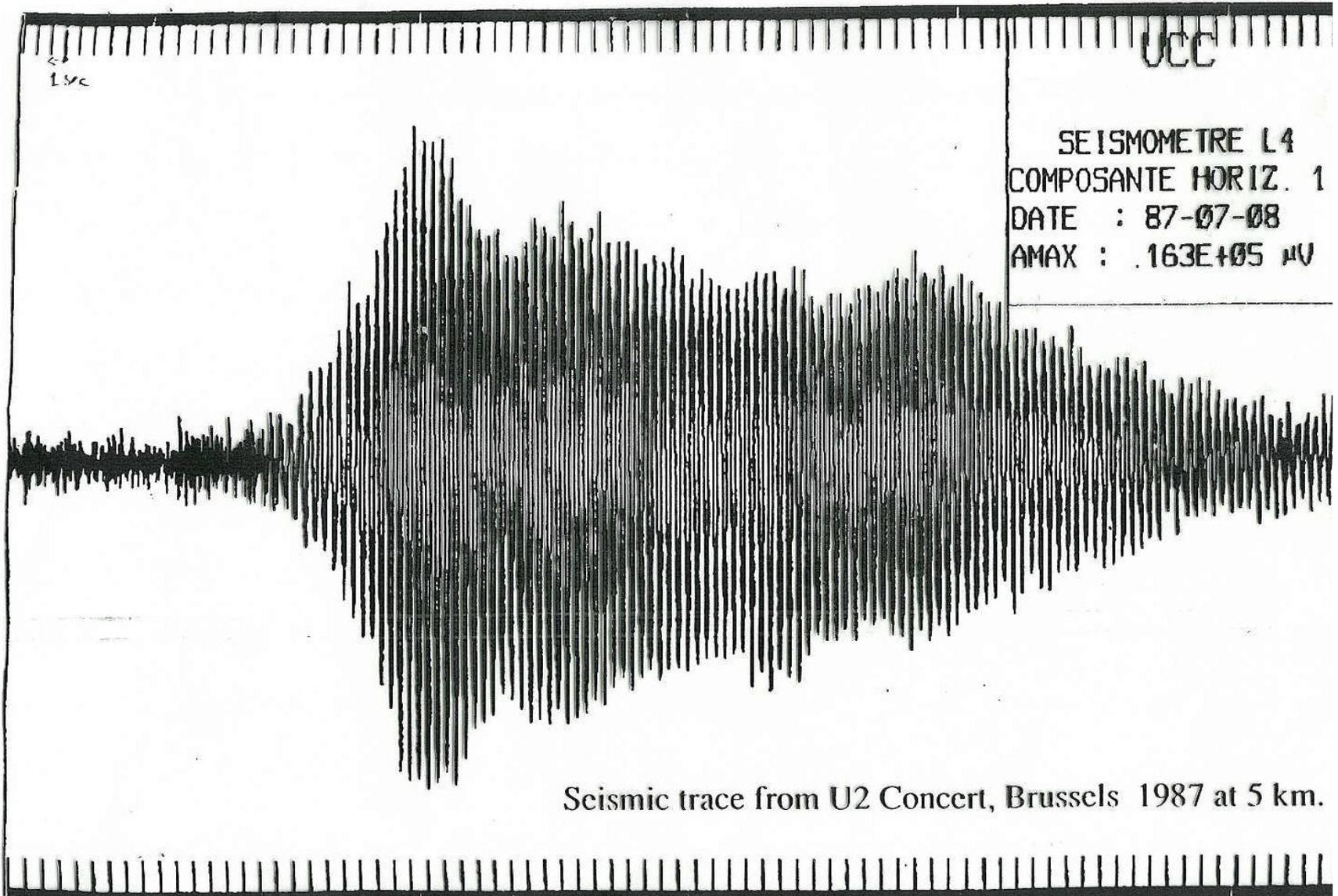


Strong-motion (velocity)

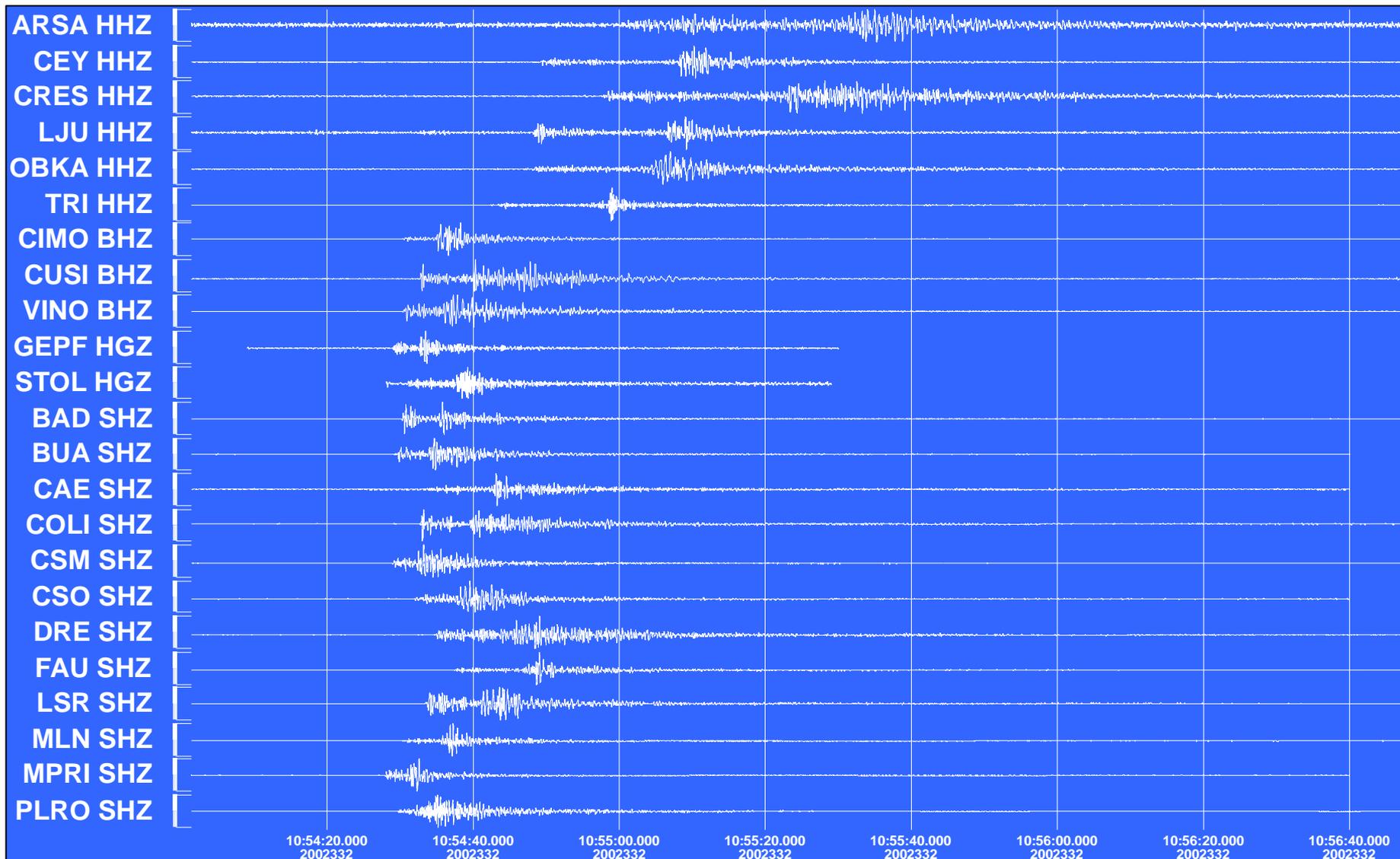


Broadband (velocity)





Seismic trace from U2 Concert, Brussels 1987 at 5 km.



Effetti di sito

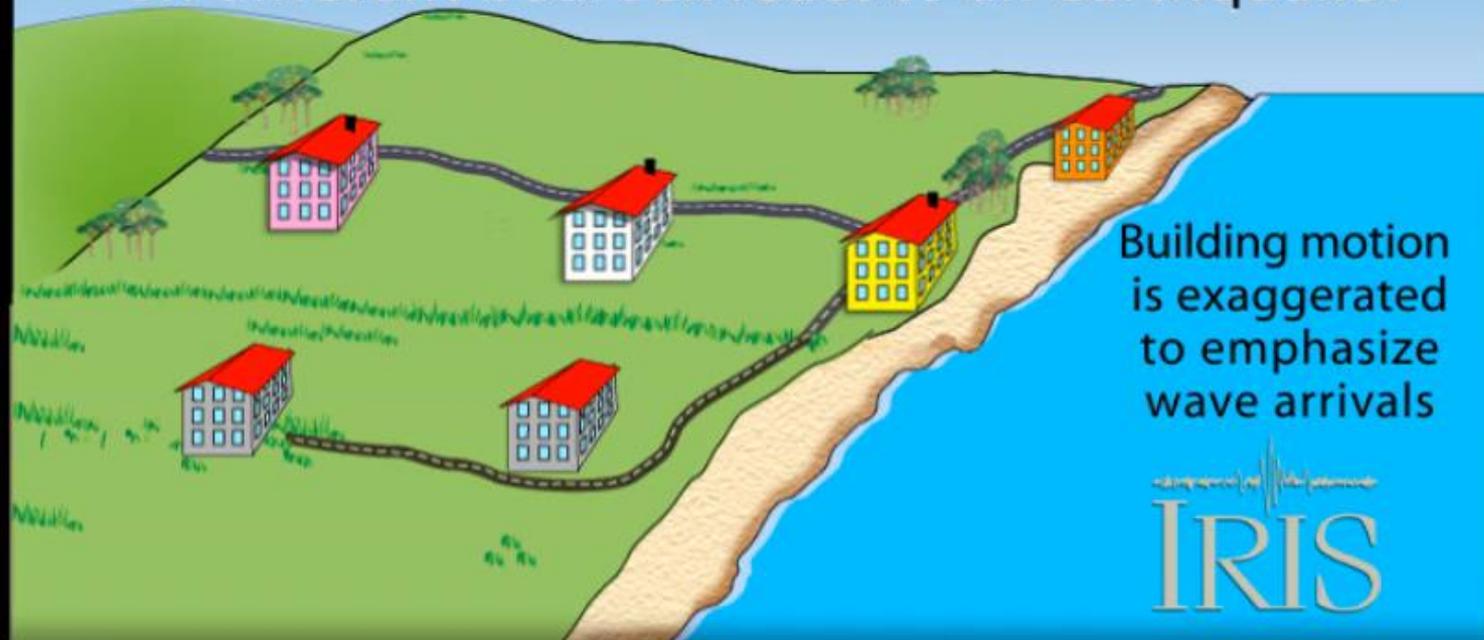


Effetti di sito



Effetti di sito

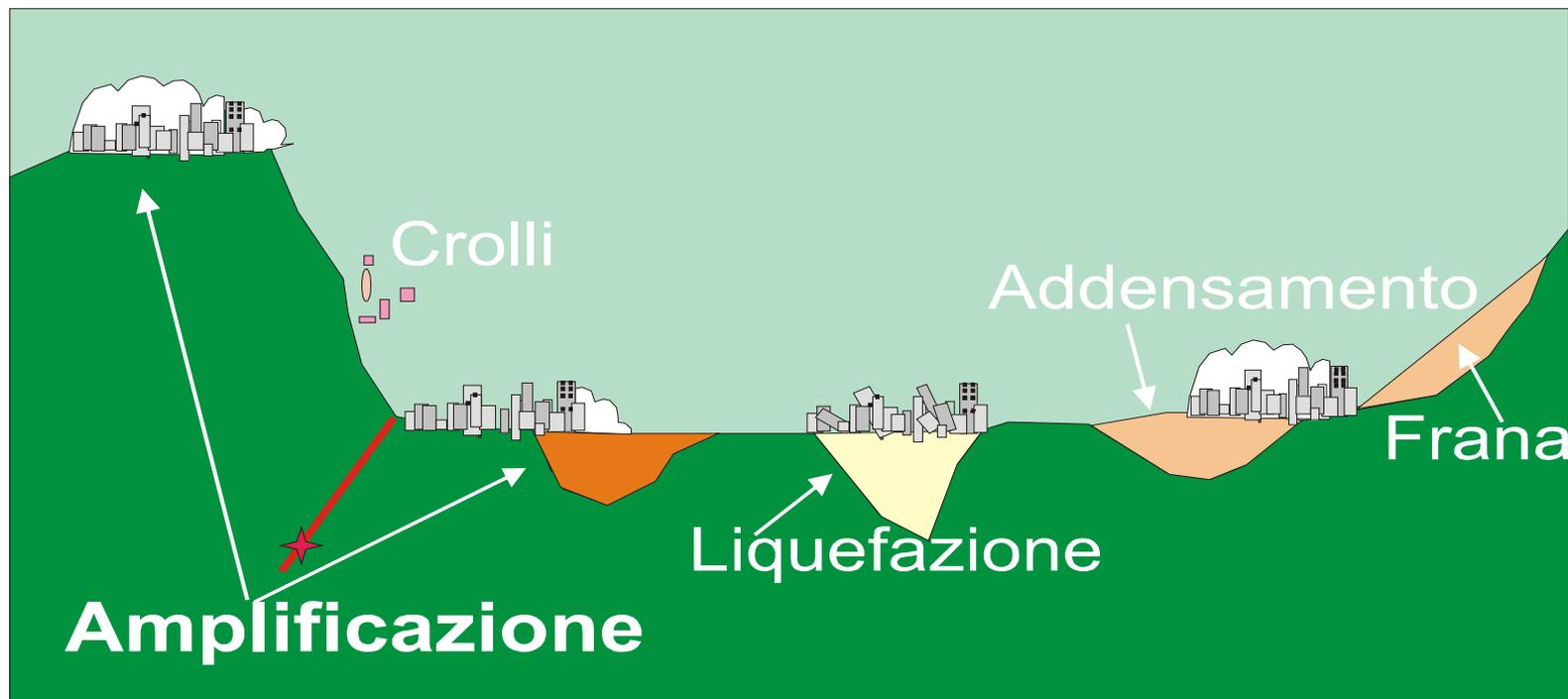
How will 3 buildings, engineered equally, on different bedrock react to an earthquake?



Two variables affect damage during earthquake:

- 1) Intensity of shaking (*felt motion, not magnitude*)
- 2) Engineering

EFFETTI LOCALI INDOTTI DA UN EVENTO SISMICO



EFFETTI LOCALI INDOTTI DA UN EVENTO SISMICO



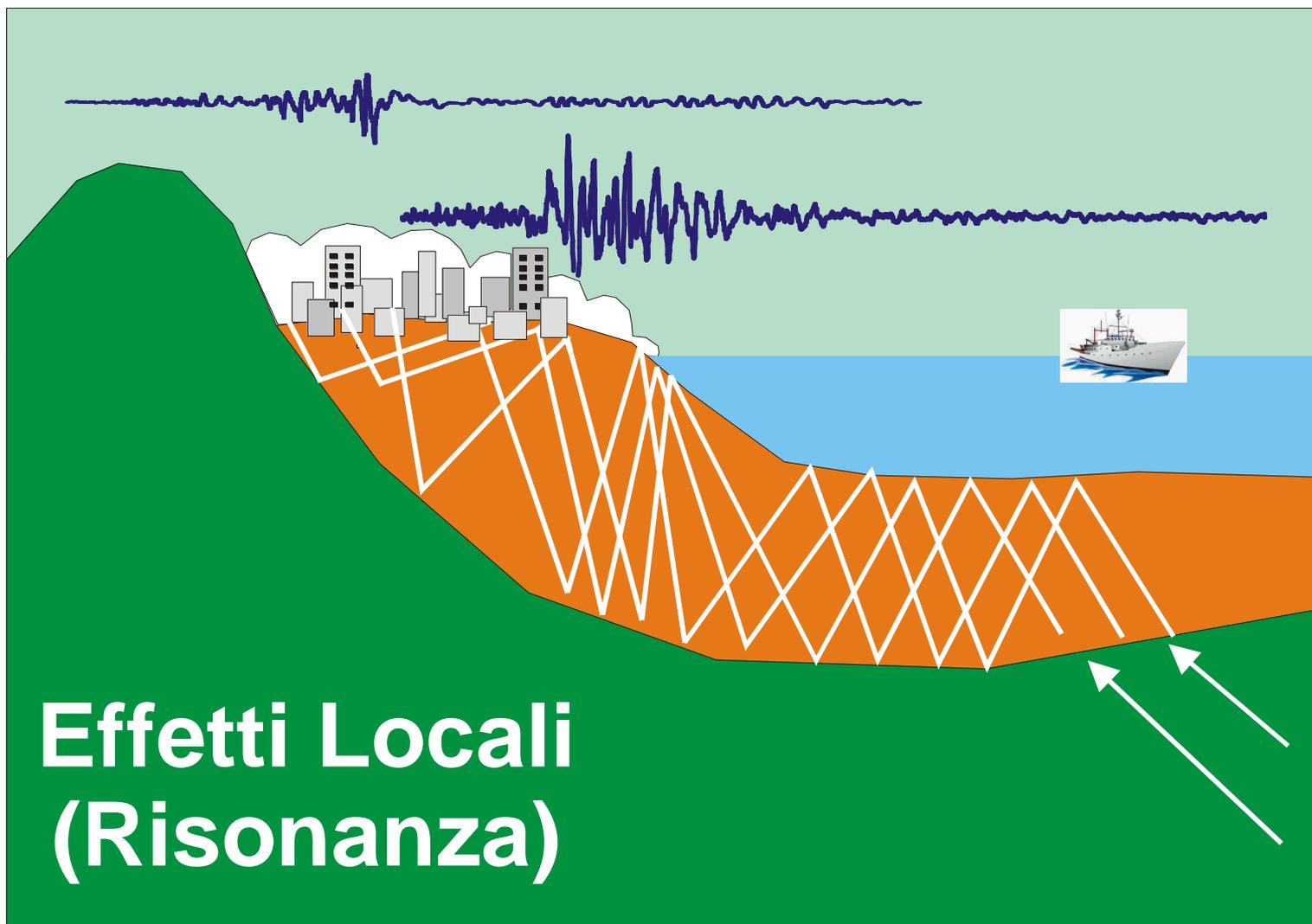
Emilia

20 maggio 2012 ore 04:03

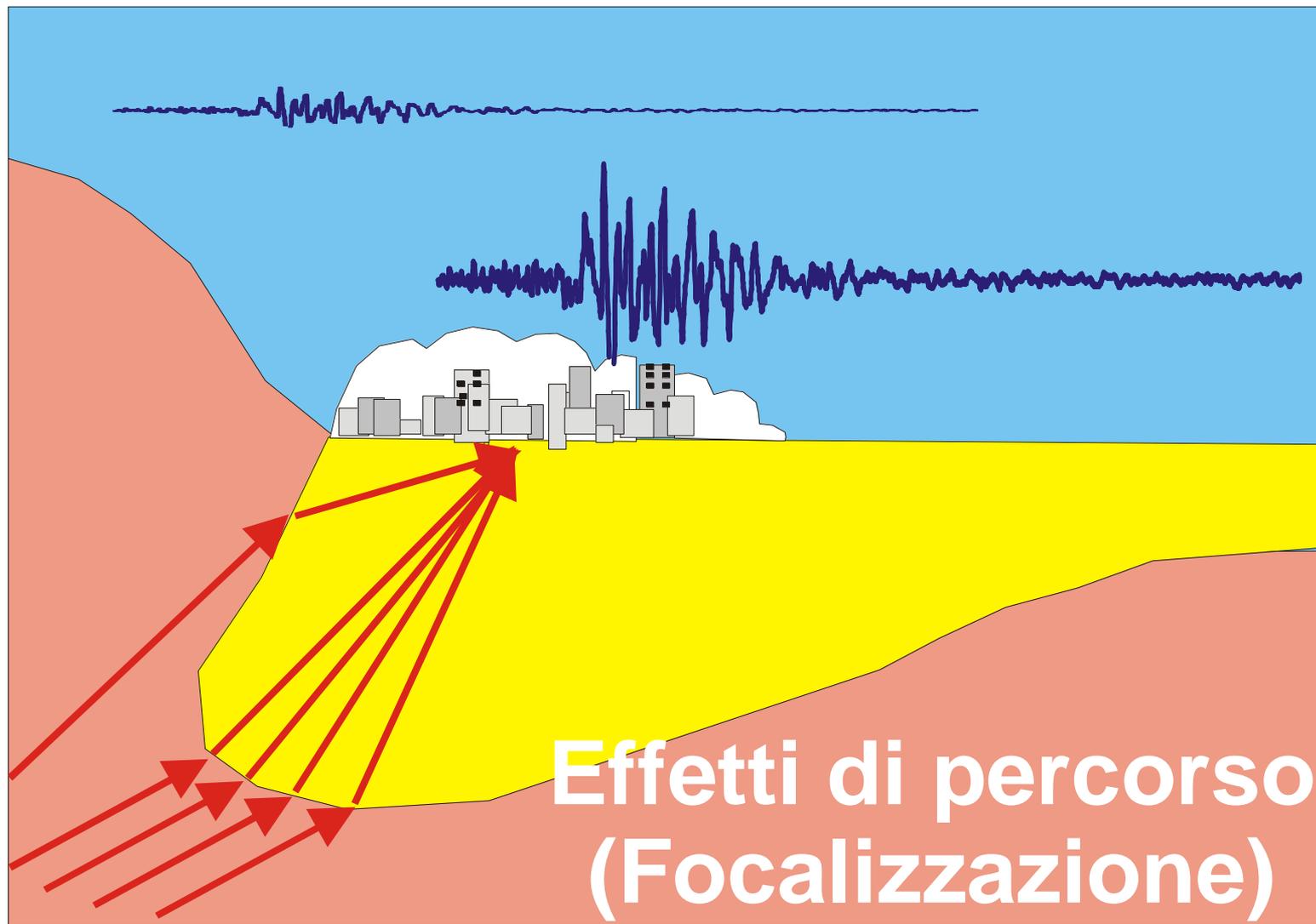
M=5.9



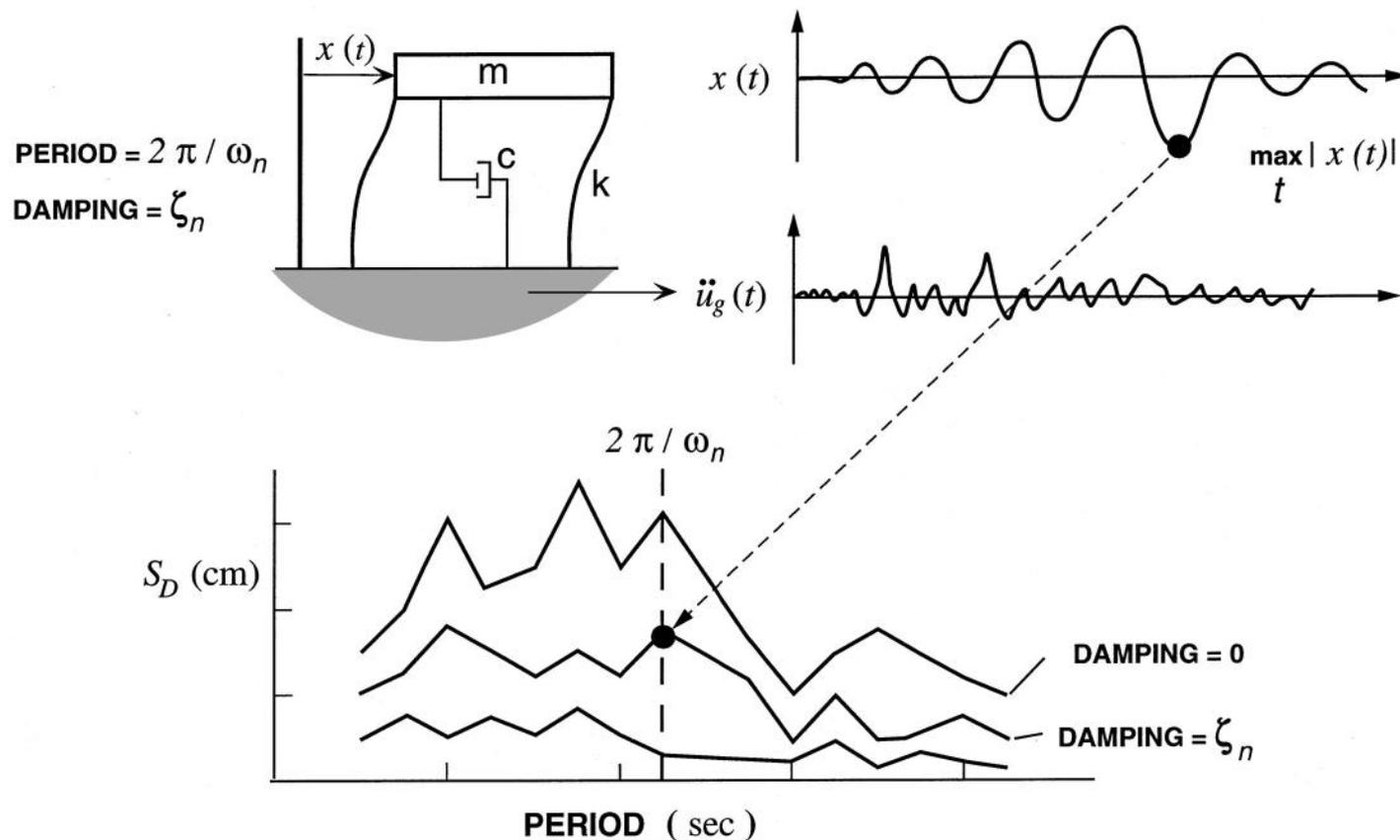
EFFETTI LOCALI INDOTTI DA UN EVENTO SISMICO

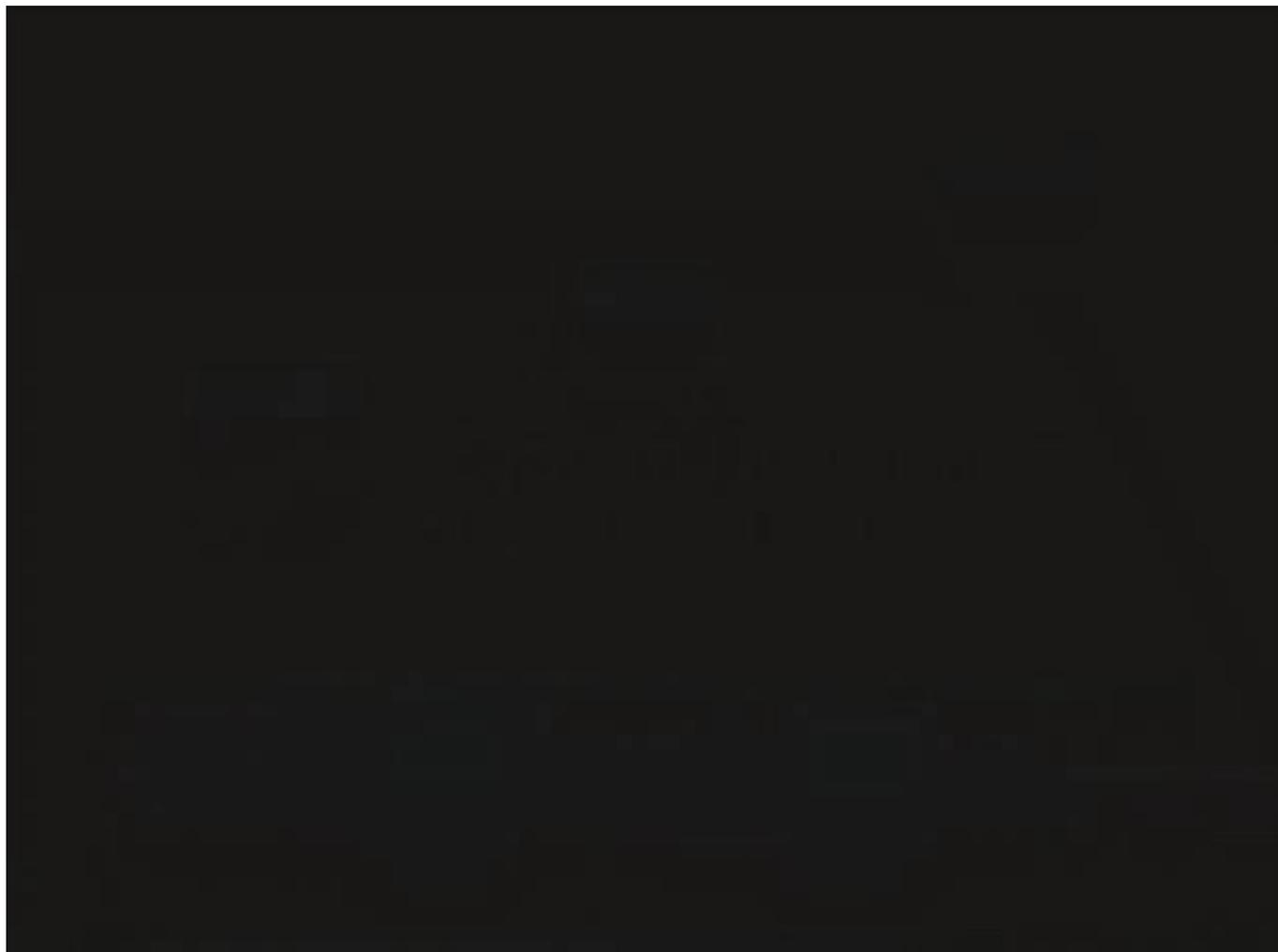


EFFETTI LOCALI INDOTTI DA UN EVENTO SISMICO



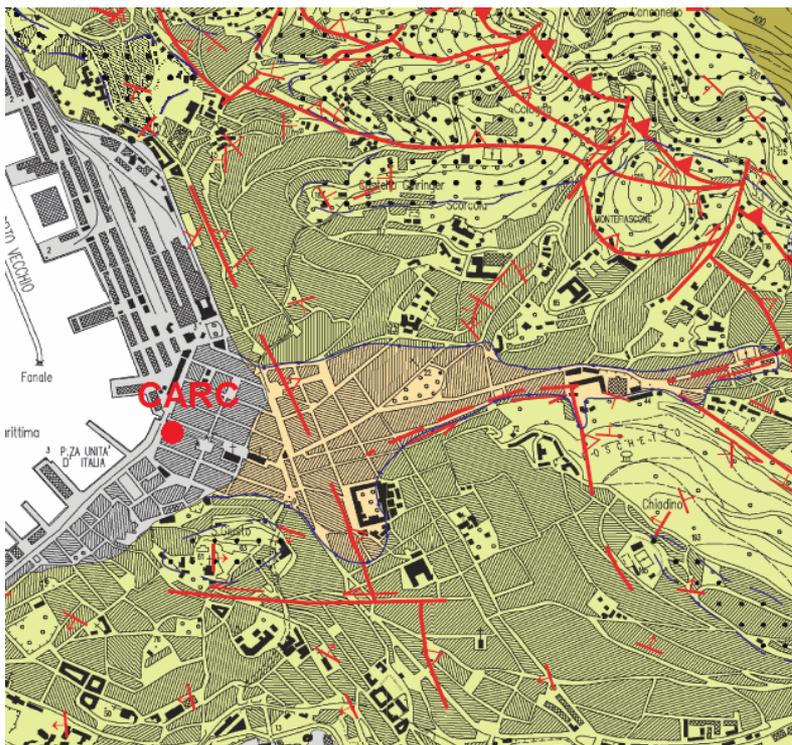
SPETTRI DI RISPOSTA





Il terremoto, a 40 anni dall'evento del Friuli

Palazzo Carciotti, Borgo Teresiano, Trieste



(Cucchi et al., 2013)



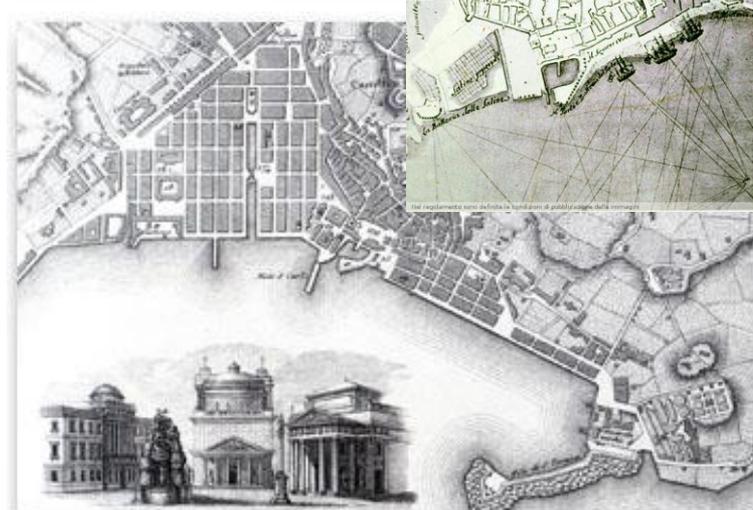
Antropico (Attuale)

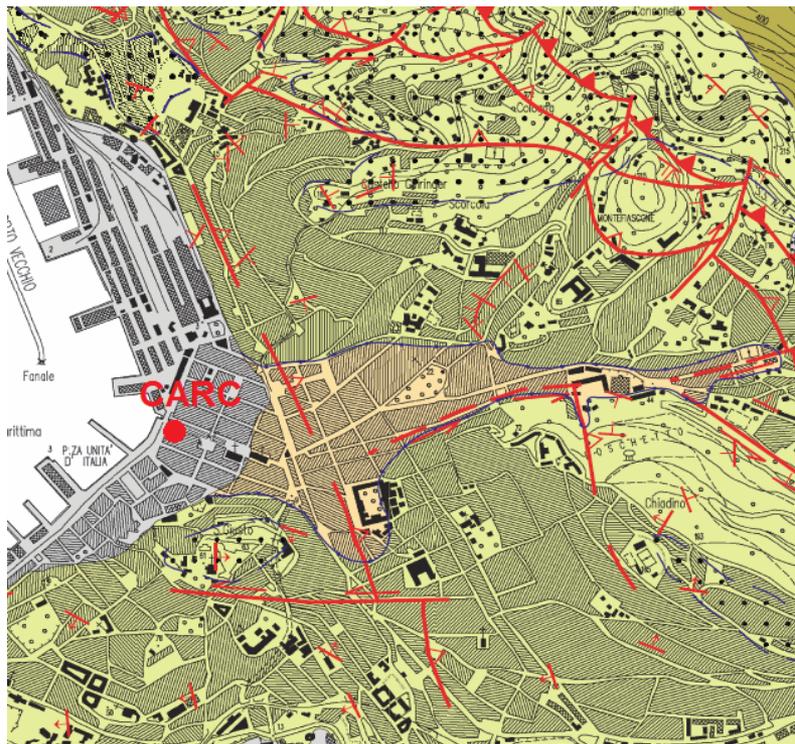


Unità dei depositi ubiquitari (Pleistocene sup. - Attuale) - UIN



Flysch di Trieste (Luteziano sup.) - FT





(Cucchi et al., 2013)

-  Antropico (Attuale)
-  Unità dei depositi ubiquitari (Pleistocene sup. - Attuale) - UIN
-  Flysch di Trieste (Luteziano sup.) - FT

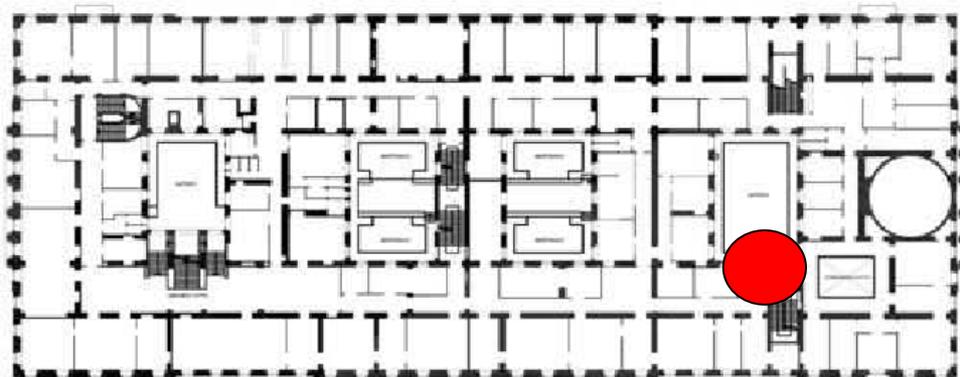


Argille e silts 27 m

Arenarie e Marne
Flysch – (Eocene) 770 m

Calcari (Mesozoico)

Palazzo Carciotti, Borgo Teresiano, Trieste



CARC

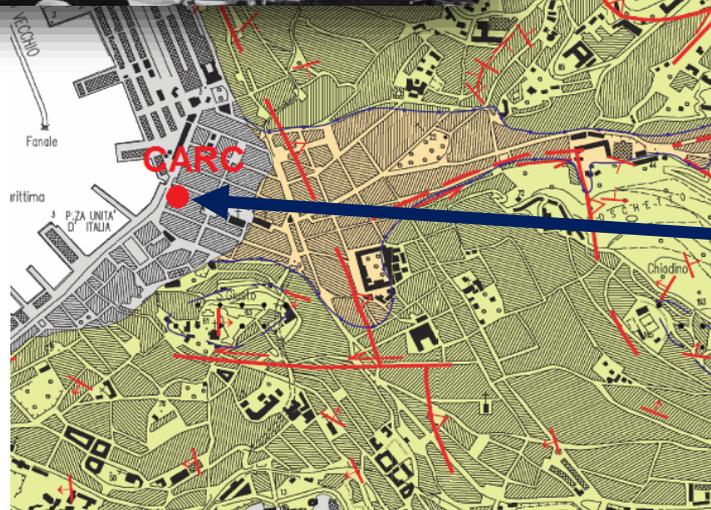
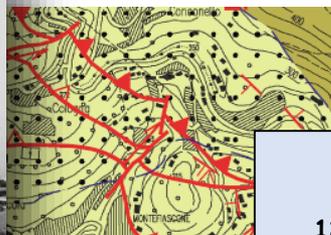


Argille e silts 27 m

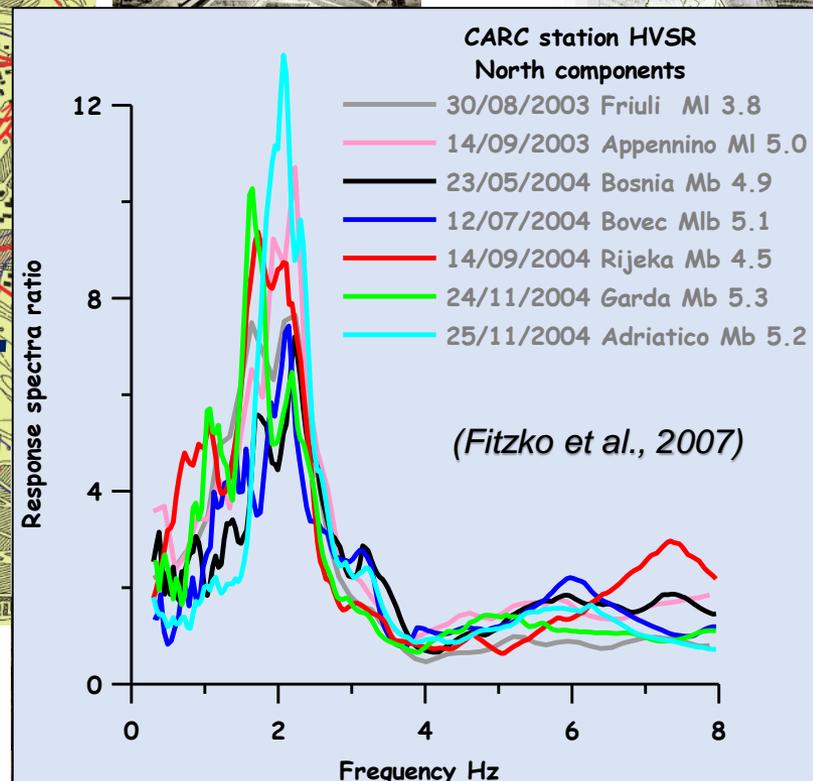
Arenarie e Marne
Flysh – (Eocene) 770 m

Calcari (Mesozoico)

Palazzo Carciotti, Borgo Teresiano, Trieste

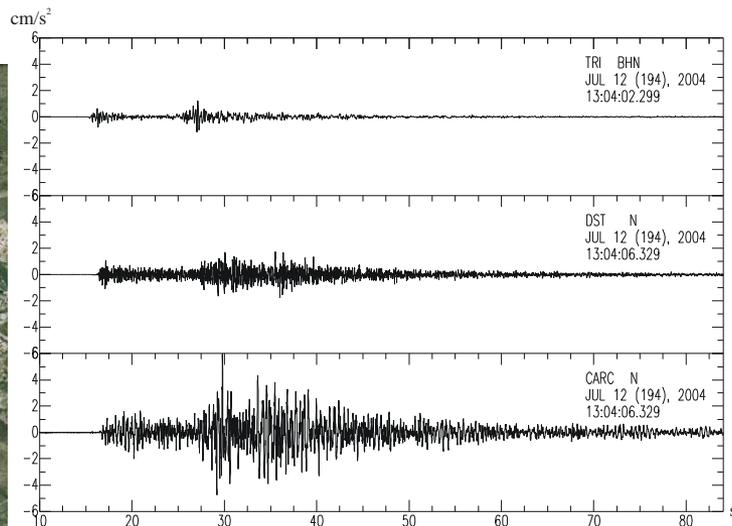
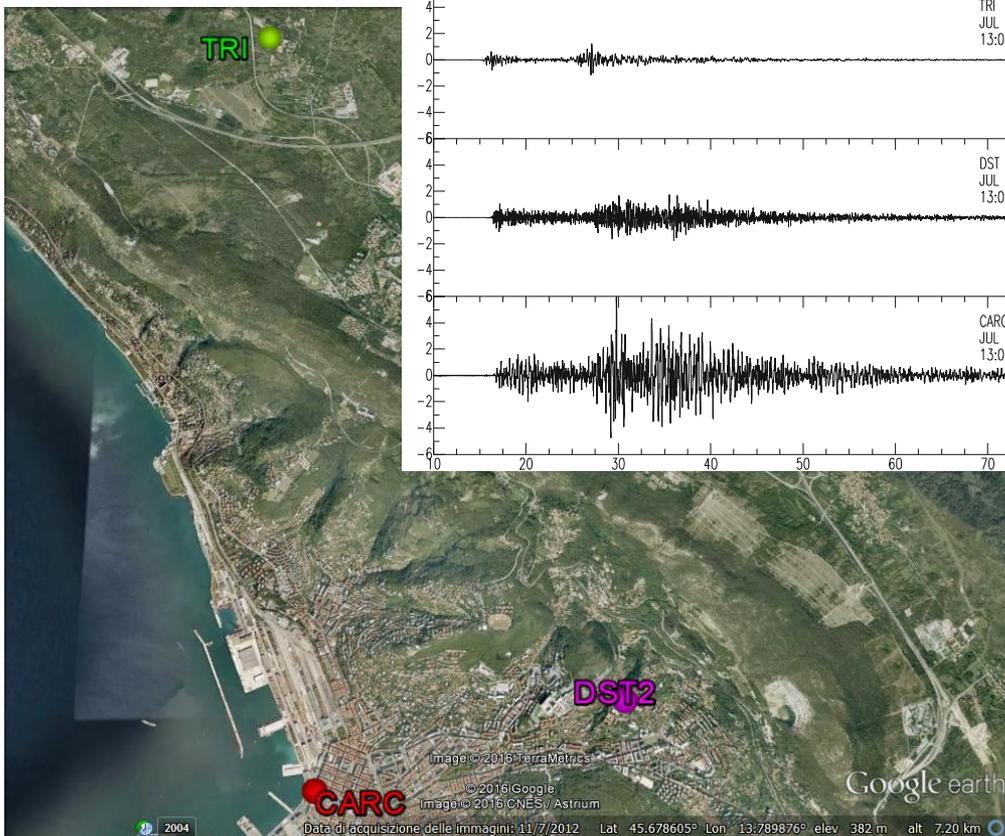


-  Antropico (Attuale)
-  Unità dei depositi ubiquitari (Pleistocene sup. - Attuale) - UIN
-  Flysch di Trieste (Luteziano sup.) - FT

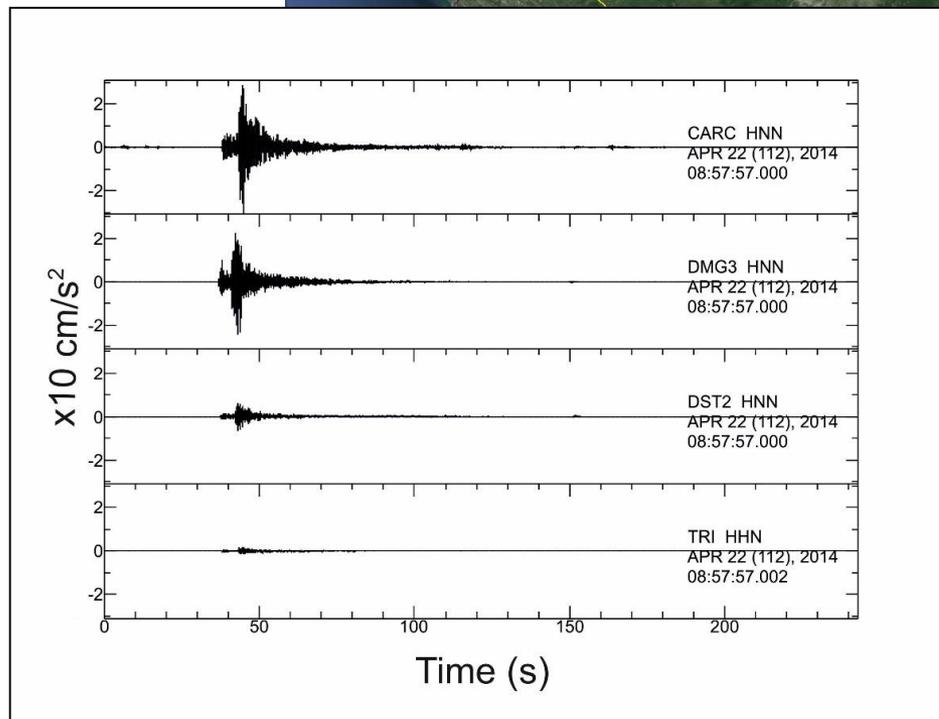
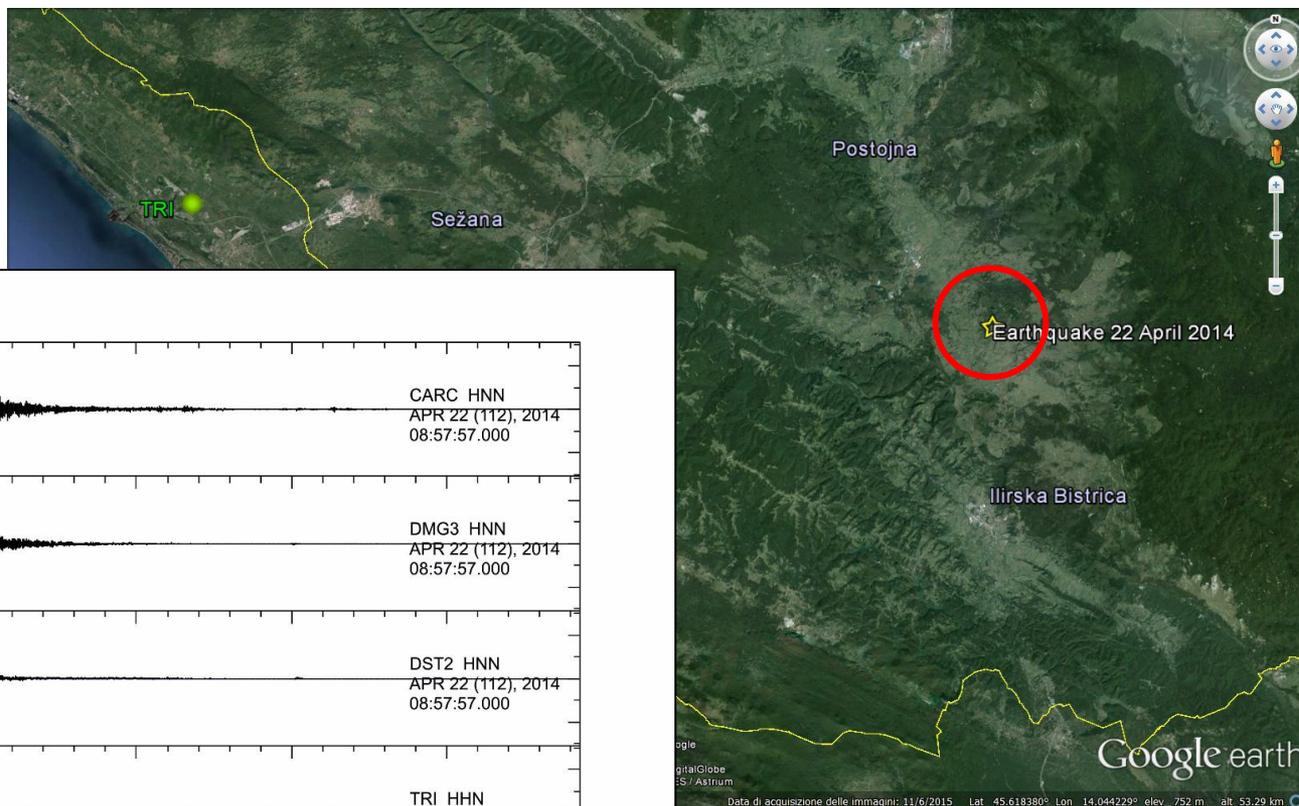


Stazione CARC - Borgo Teresiano - Trieste

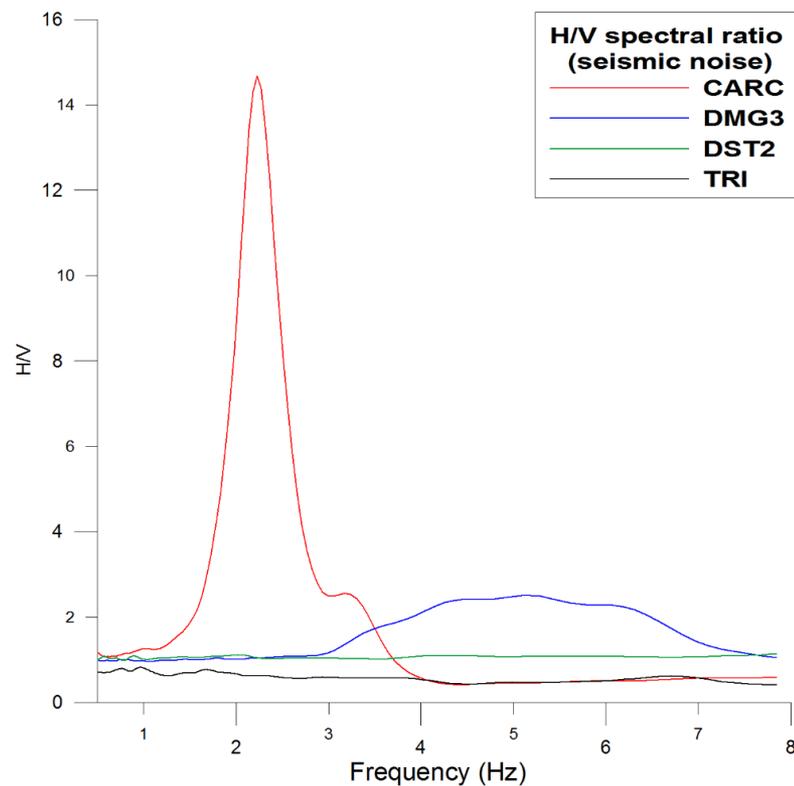
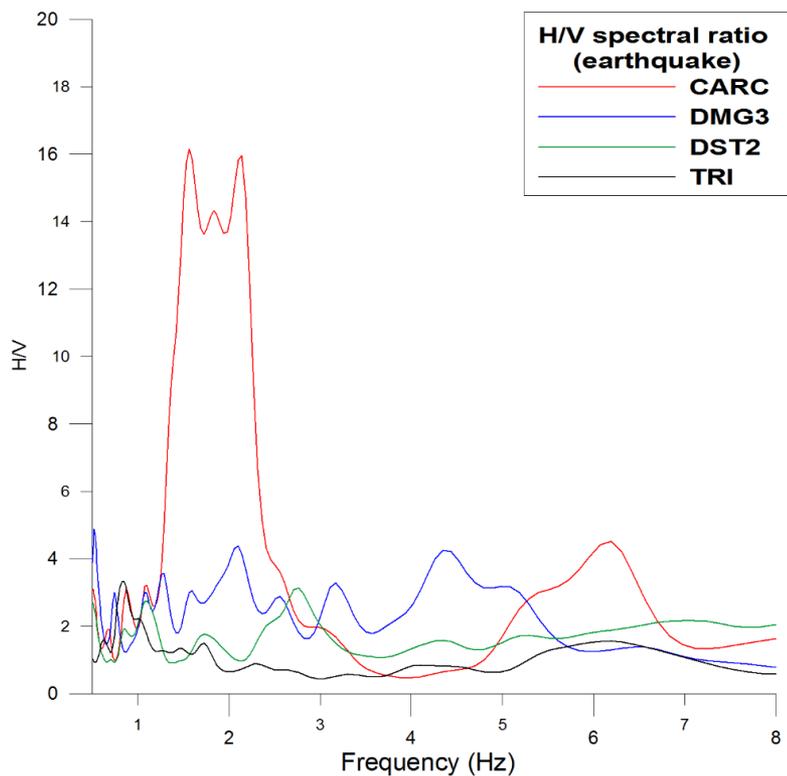
Palazzo Carciotti, Borgo Teresiano, Trieste



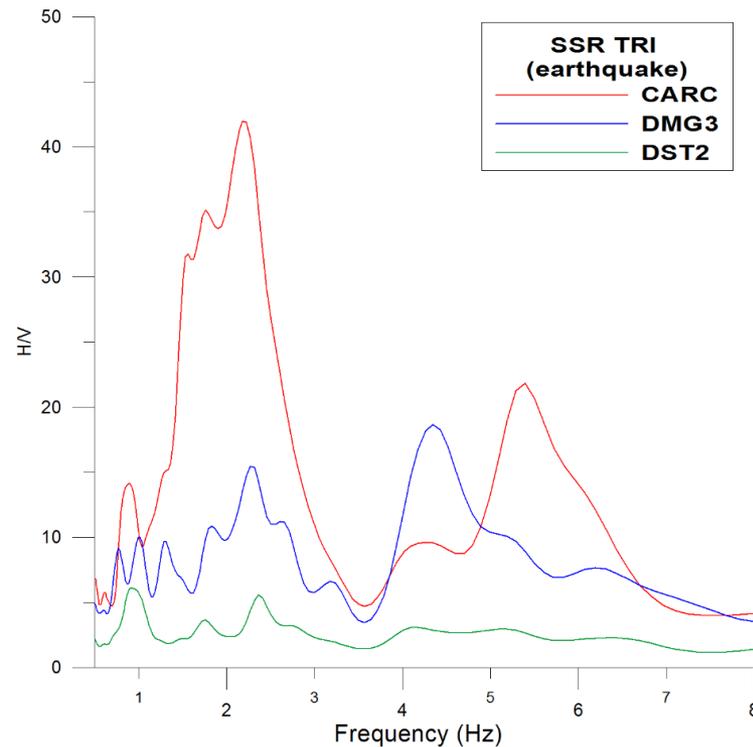
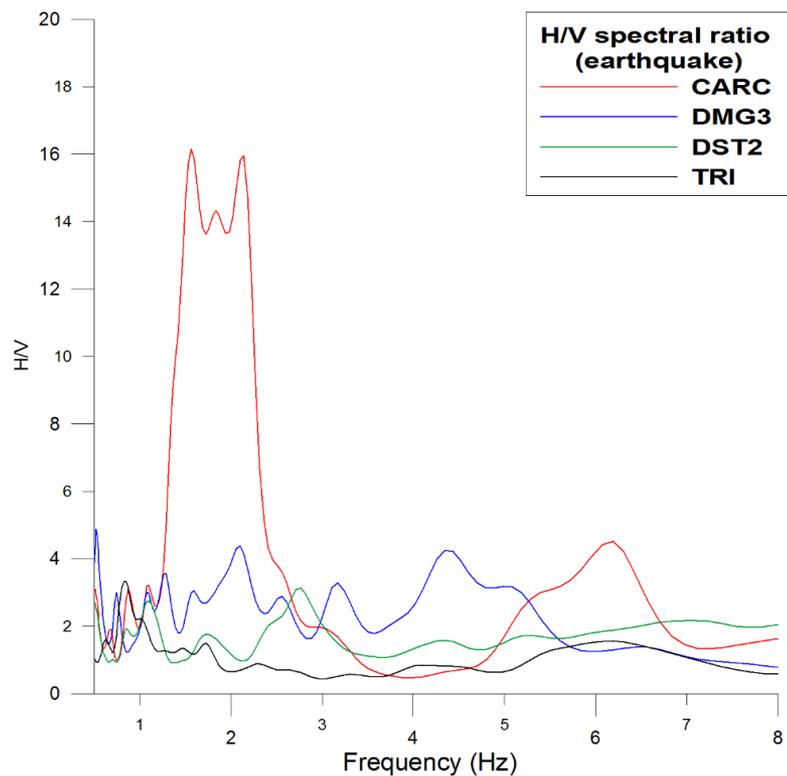
Evento Monte Nevoso - 22 Aprile 2014 – MI 4.7



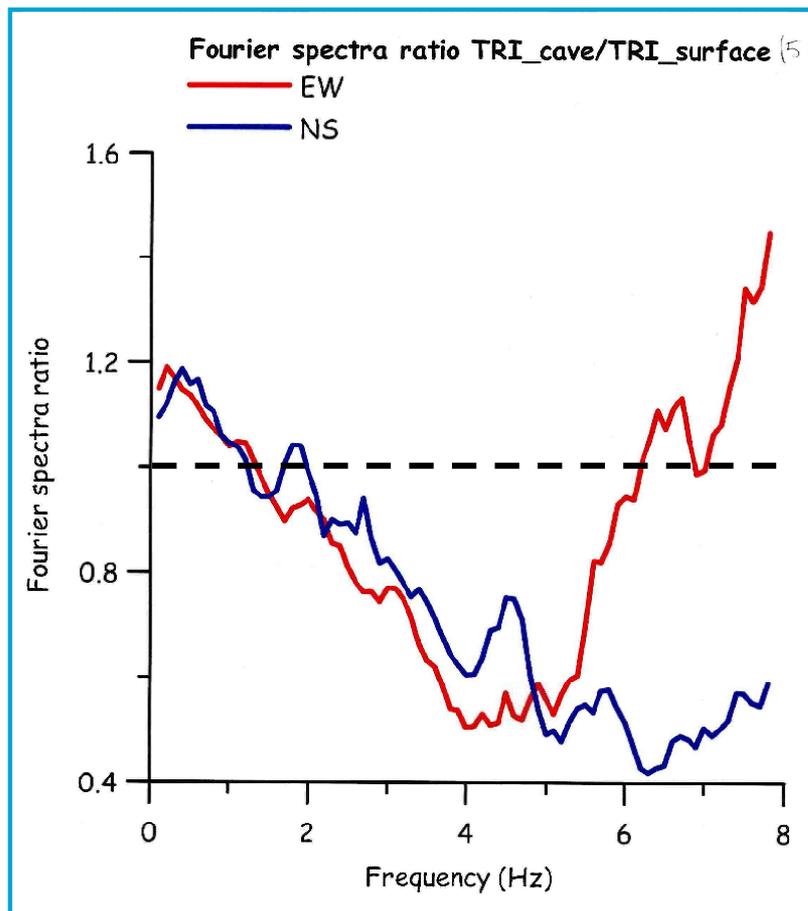
Evento Monte Nevoso - 22 Aprile 2014 – MI 4.7



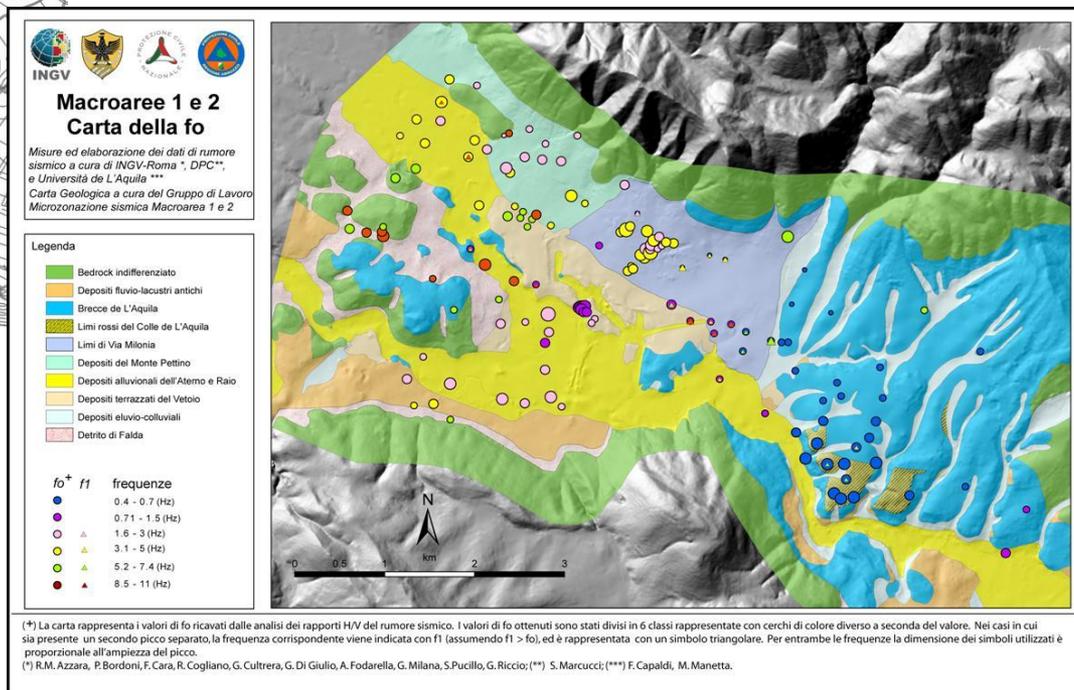
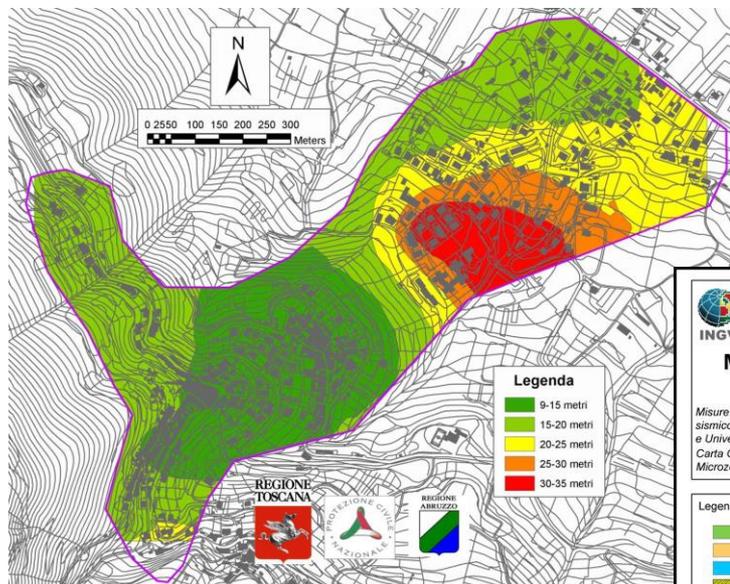
Evento Monte Nevoso - 22 Aprile 2014 – MI 4.7



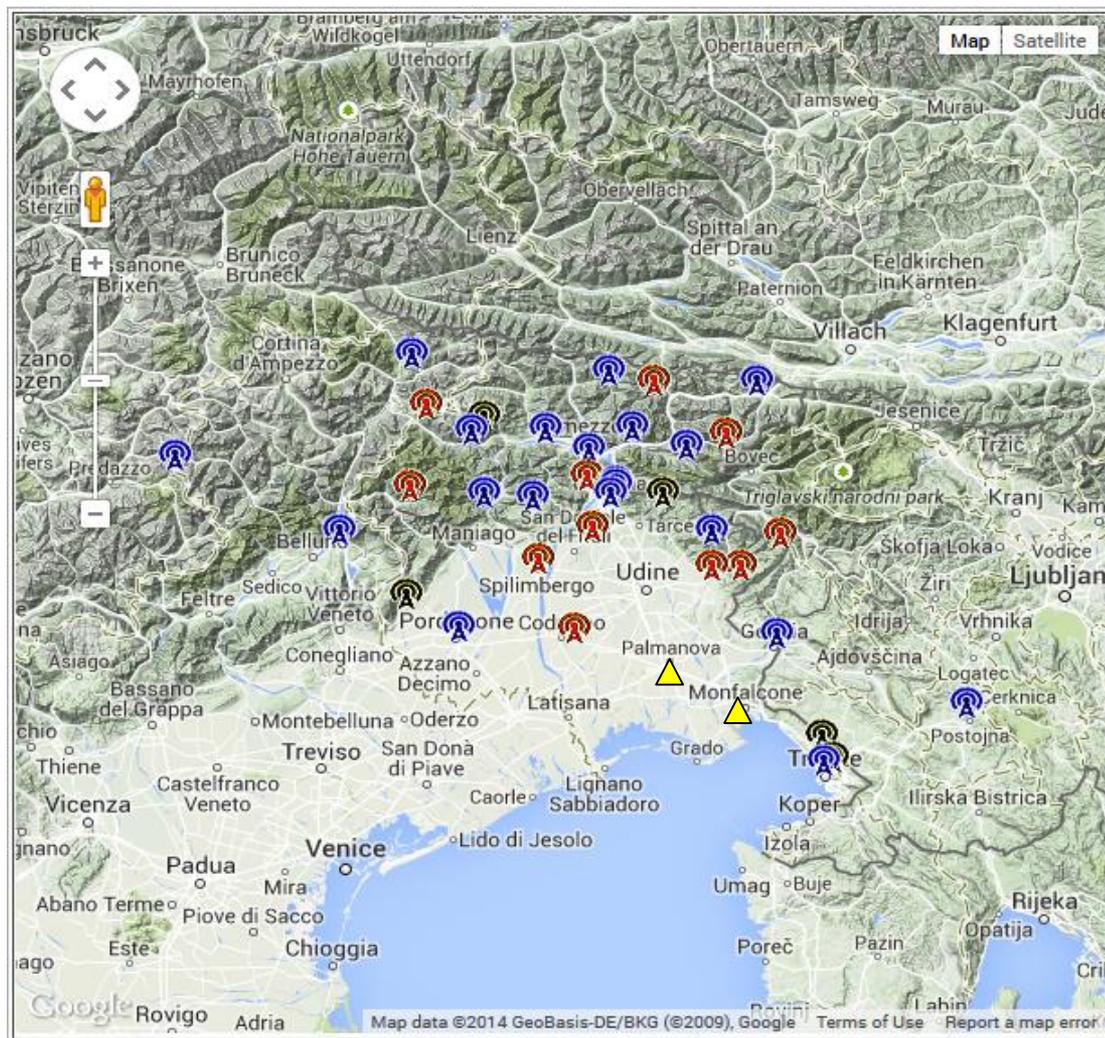
TRI station Grotta Gigante, Trieste



Microzonazione sismica



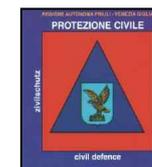
Rete Accelerometrica del FVG-Veneto



1993 - 2000



2000 -



2011 -



 Friuli Venezia Giulia Accelerometric Network (RAF)

 National Accelerometric Network (RAN)

 Stations of NE Italy Broadband Network (NI)

The RAN is of the [Dipartimento della Protezione Civile](#),
Presidenza del Consiglio dei Ministri, Roma

The VINO and TRI stations are managed in collaboration
with OGS. TRI is a MedNet station. The NE Italy BB
Network is managed in collaboration with the Istituto
Nazionale di Oceanografia e di Geofisica Sperimentale -
OGS, Trieste

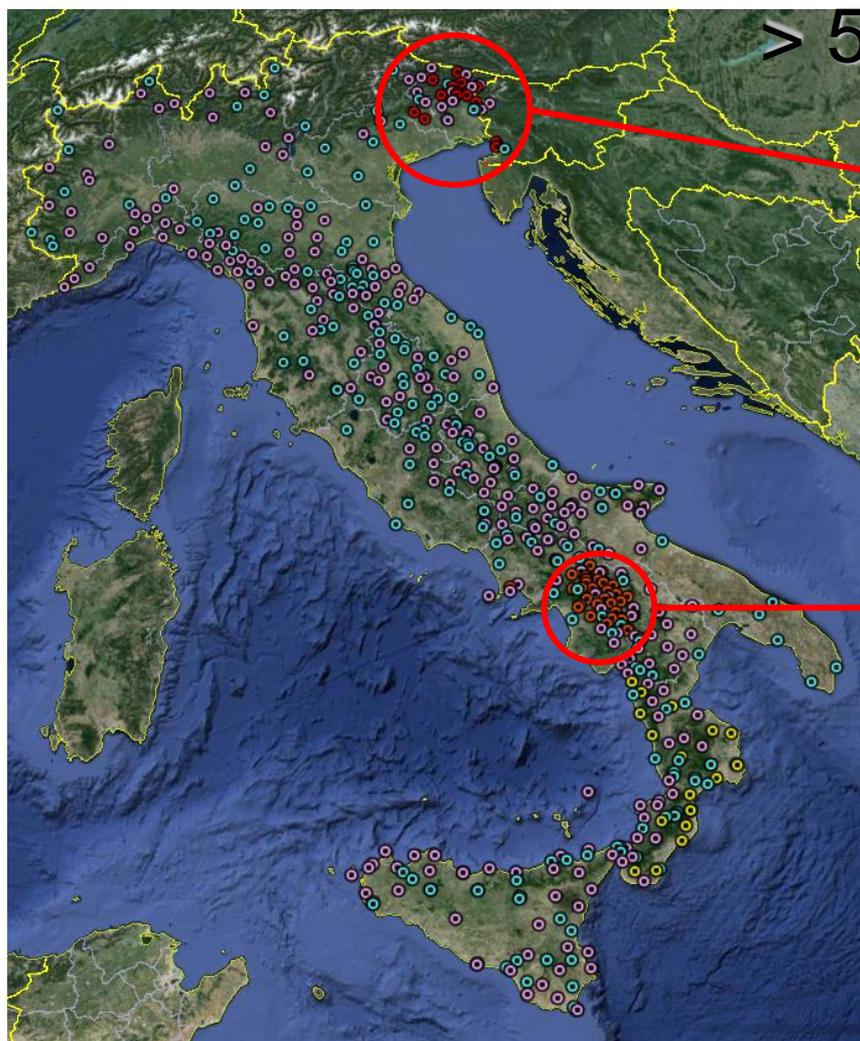
Rete Accelerometrica del FVG-Veneto



Rete Accelerometric Nazionale



- RAN - Syscom
- RAN - Kinematics
- RAN - CESI
- RAF
- ISNet



> 500 stations

Friuli Venezia Giulia
Accelerometric Network – RAF

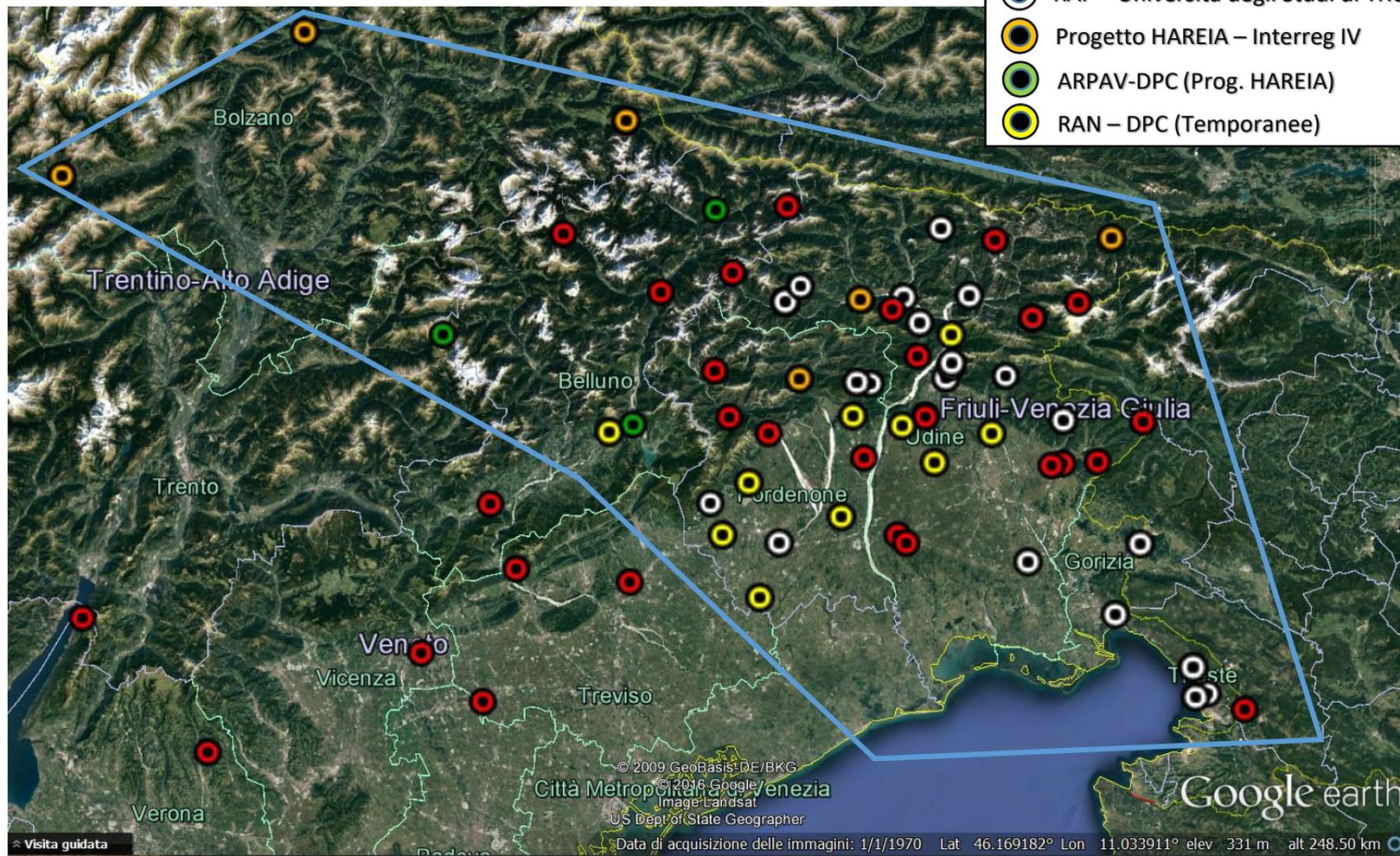


Irpinia
Seismic Network – ISNET

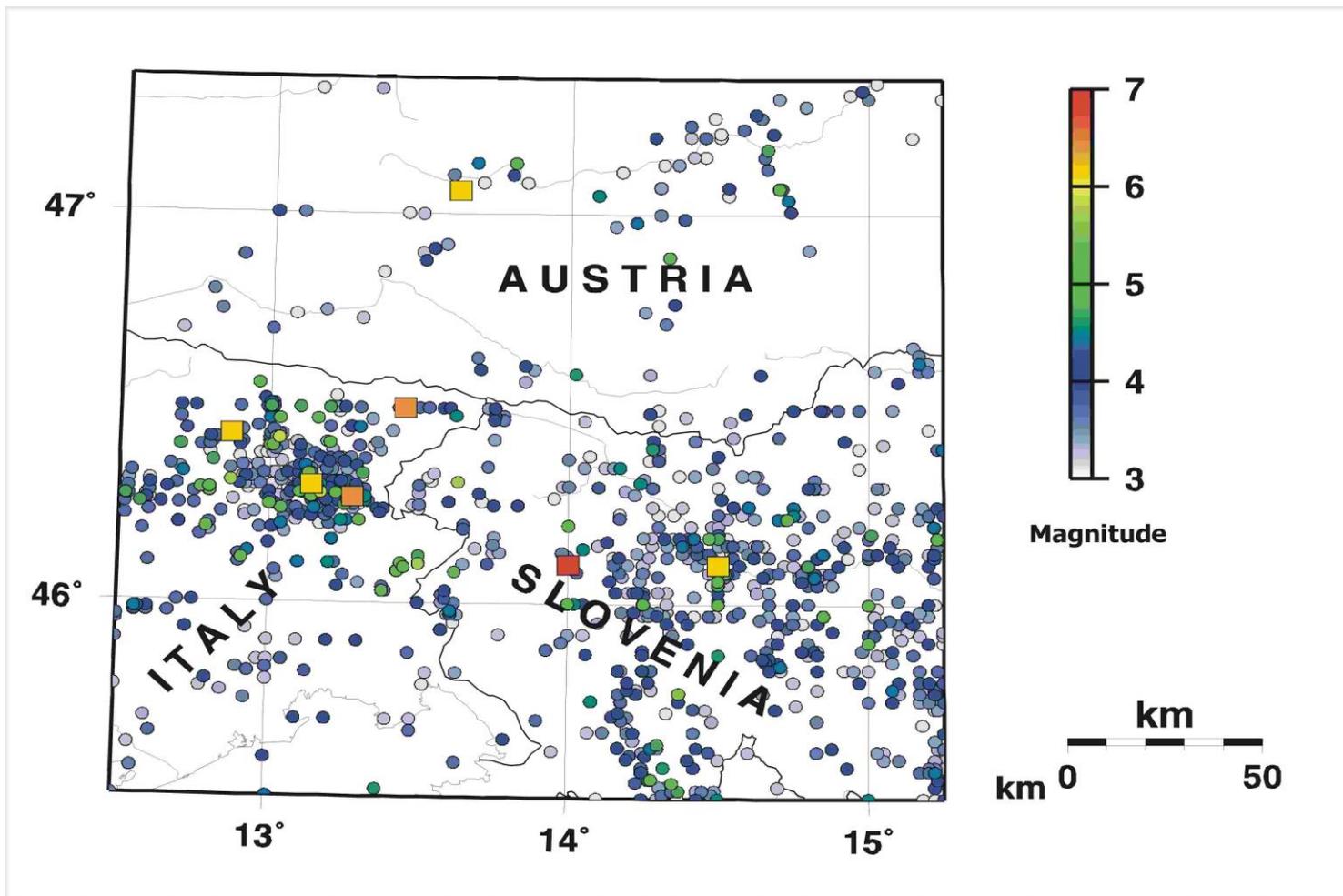


Rete Accelerometrica Integrata

- RAN – Dip. Protezione Civile, Roma (DPC)
- RAF – Università degli Studi di Trieste
- Progetto HAREIA – Interreg IV
- ARPAV-DPC (Prog. HAREIA)
- RAN – DPC (Temporanee)



Sismicità storica alpi sud-orientali

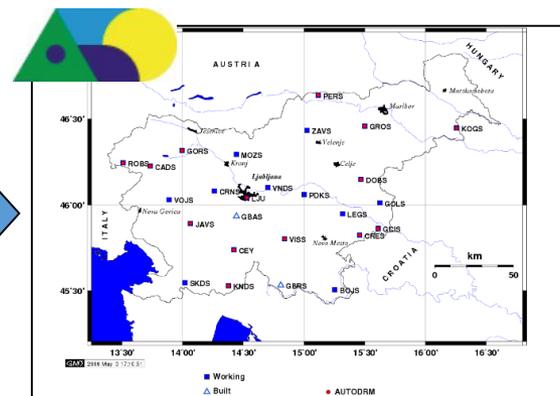
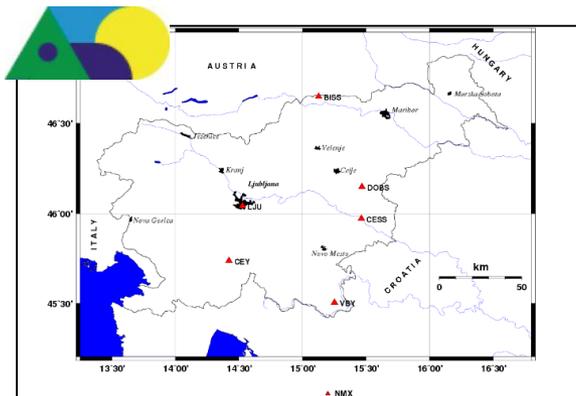


Monitoraggio sismica transfrontaliero



BOVEC 1998

Živčić, (Susans, 2007)



THE INTERREG IIIA PROJECTS

"TRANS-NATIONAL SEISMOLOGICAL NETWORK IN THE SOUTH-EASTERN ALPS"

FASTLINK

HAREIA
Historical And Recent Earthquakes in Italy and Austria

Trans-National Seismological Networks in the South-Eastern Alps

CE3RN

Trans-National Seismological DATABASE 2003-2015



BOVEC 2004

Central and Eastern European Earthquake Research Network CE³RN

Interreg IIIa Italia-Austria 2001-2006 projects

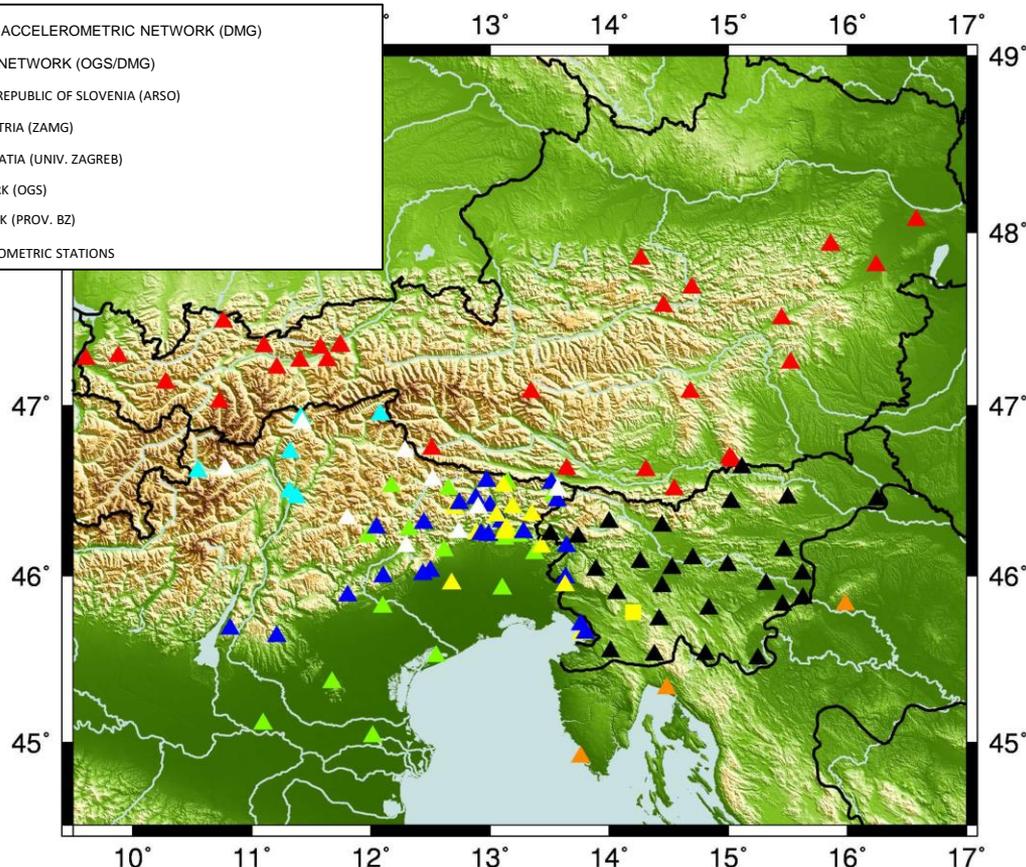
“Trans-National Seismological Networks in the South-Eastern Alps” and “FASTLINK”



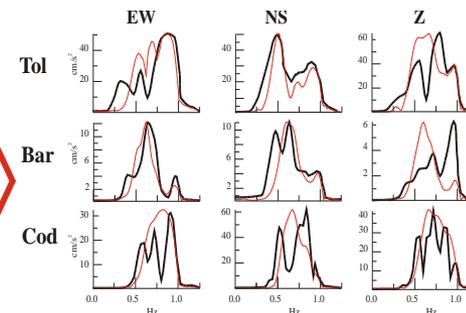
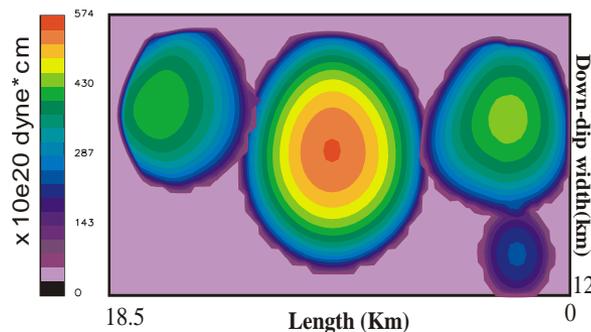
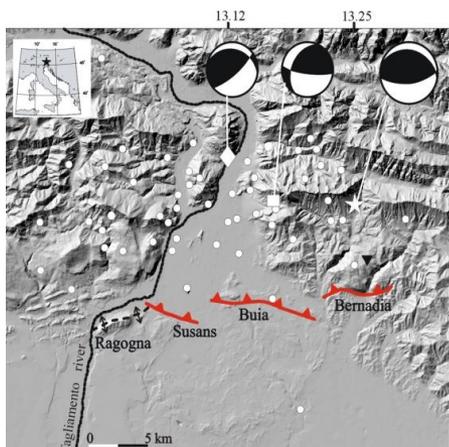
ZAMG



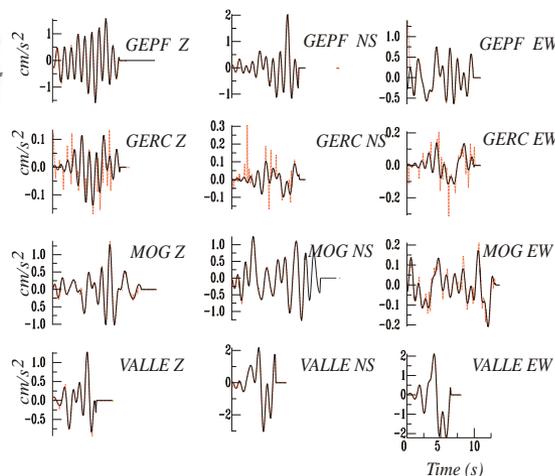
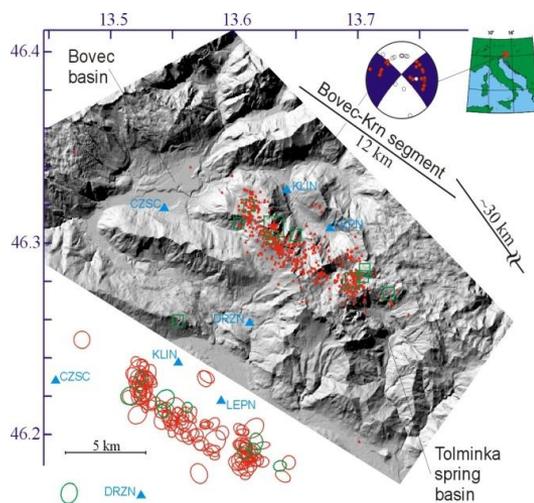
- FRIULI VENEZIA GIULIA ACCELEROMETRIC NETWORK (DMG)
- NE ITALY BROADBAND NETWORK (OGS/DMG)
- SEISMIC NETWORK OF THE REPUBLIC OF SLOVENIA (ARSO)
- SEISMIC NETWORK OF AUSTRIA (ZAMG)
- SEISMIC NETWORK OF CROATIA (UNIV. ZAGREB)
- FRIULI VENETO SP NETWORK (OGS)
- SOUTH TYROL BB NETWORK (PROV. BZ)
- HAREIA PROJECT ACCELEROMETRIC STATIONS



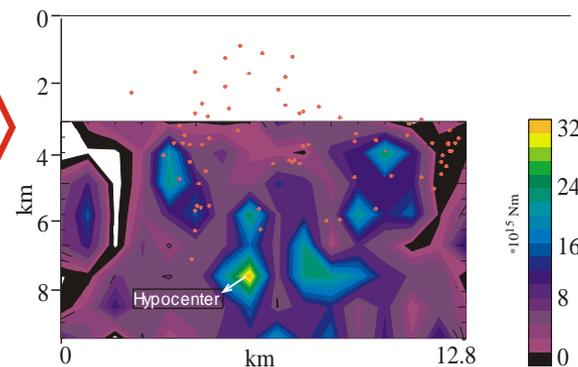
Fault slip models: the 1976 and 1998 main shocks



Aoudia et al., GRL, 2000

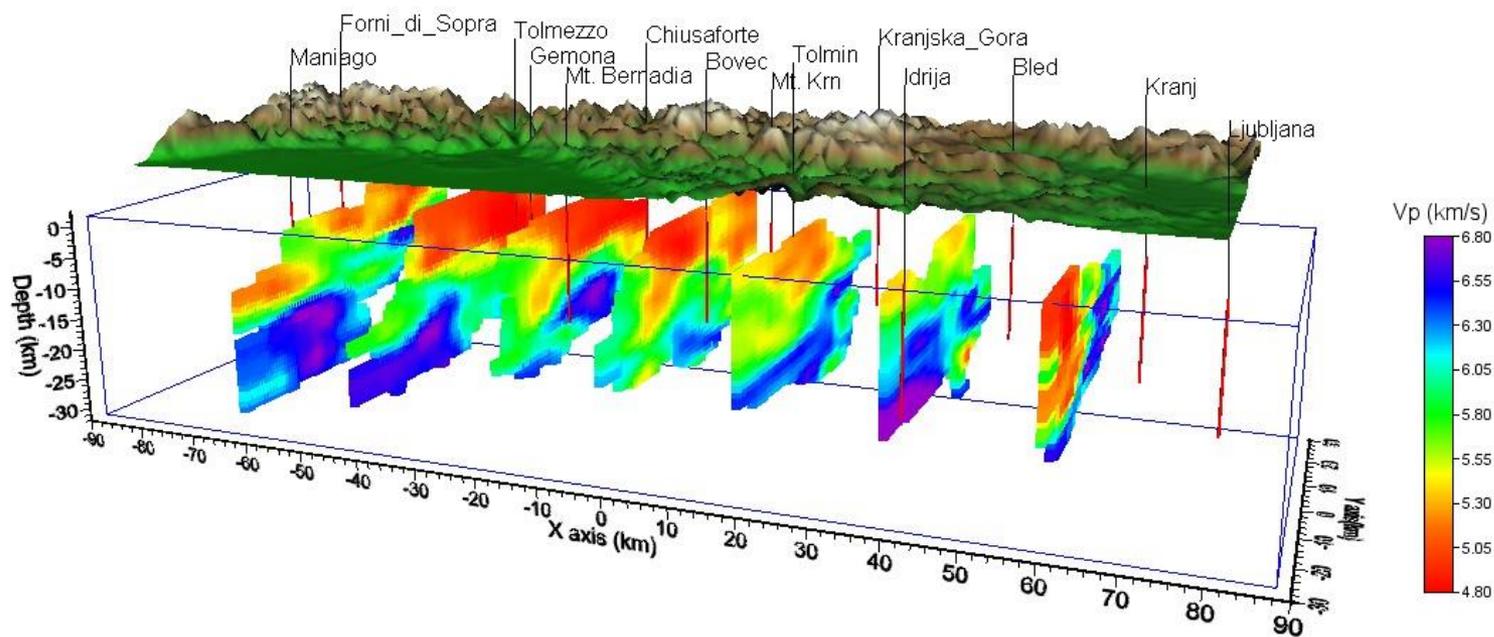


— Real data
- - - Inversion results



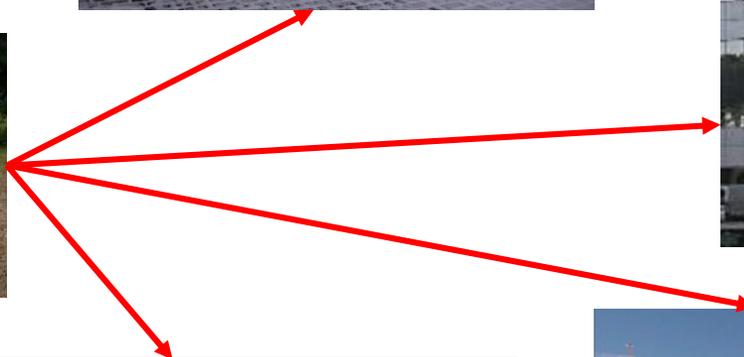
Bajc, et al. GRL, 2001

Tomografia

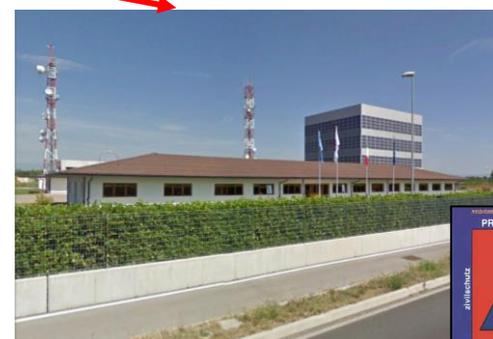




Rete Accelerometrica del FVG-Veneto

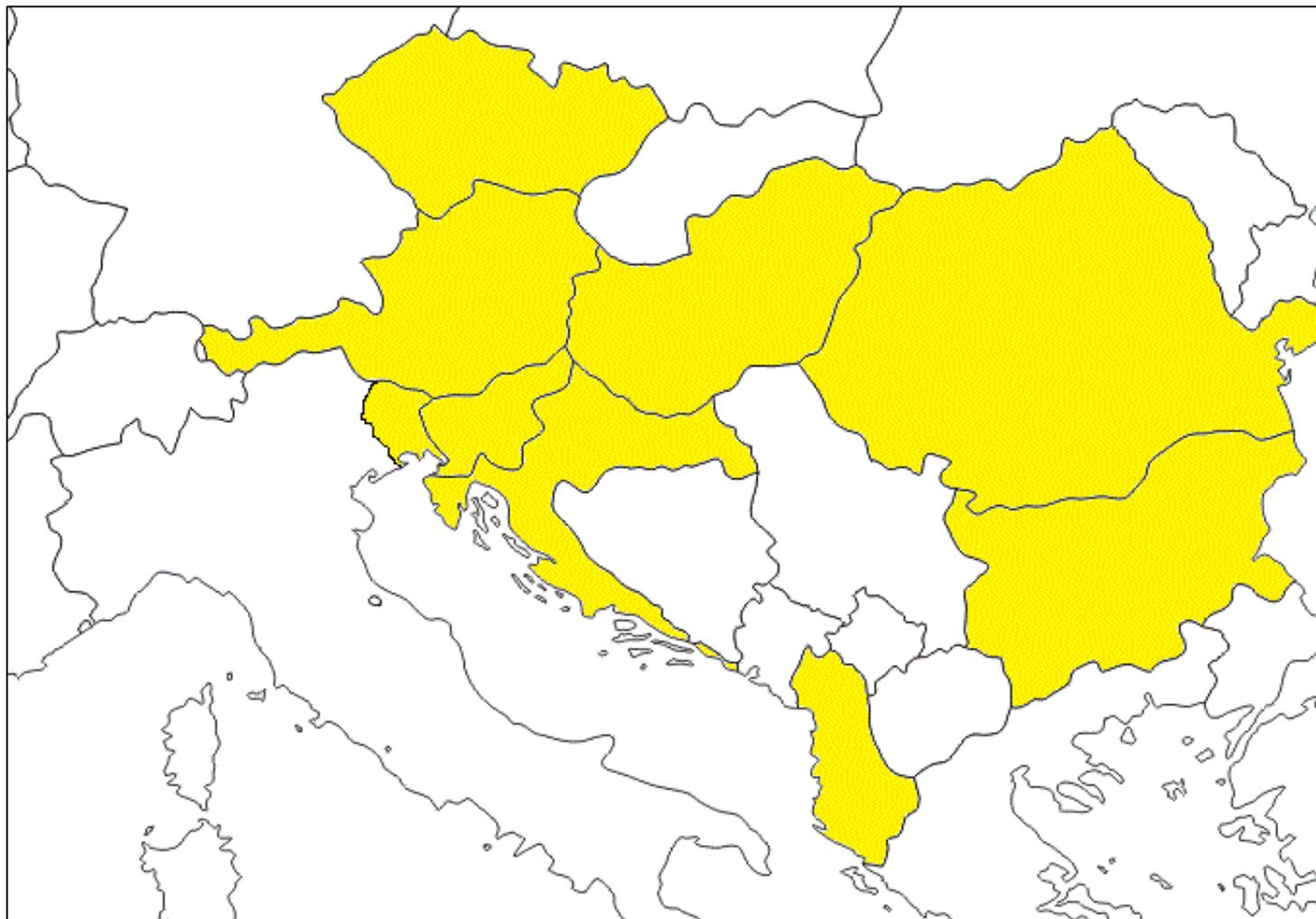


CE³RN
Central and Eastern European
Earthquake Research Network



CE³RN

Central and Eastern European Earthquake Research Network - 2016



Rapporto automatico, in tempo reale per la protezione civile

26/10/2016 21:22:59



ORID: 344475 EVID: 344434

Earthquake AUTOMATIC REPORT

Dipartimento della Protezione Civile - Rome - Italy
Rete Accelerometrica Nazionale
RAN

[o Title]

WARNING:

These information are preliminary
and may be revised when more data are available.

Event: Castelsantangelo_sul_Nera
Origin time: 2016/10/26 19:18:06
Latitude: 42.898 Longitude: 13.121
Magnitude MI: 6.0
AGENCY: DPC

Seismic Moment: 5.08e+18 Nm
Mw: 6.2
AGENCY: DPC

Records analyzed by procedure: 231
Selected limits: max distance=100. km min PGA= 1.0 cm/s*s
min PGA to show response spectra= 1.0 cm/s*s
Records inside the selected limits: 142 response spectra inside the limits: 142

Nearest station: NRC distance: 11.84 km
HGN - PGA=346.88 cm/s*s, PGV=19.96 cm/s
Max recorded PGA: 606.13 cm/s*s Station: FOC Foligno_Colfiorito
HGE - distance=23.06 km, PGV=19.60 cm/s

Procedure implemented by SeisRaM group, University of Trieste, Italy - ver: SPT - 2015



Event: Castelsa - Origin time: 2016/10/26 19:18:06 Lat:42.898 Lon:13.121 MI = 6.0 Agency: DPC
Seismic moment: 5.080e+18 Nm - Mw = 6.2 Agency: DPC

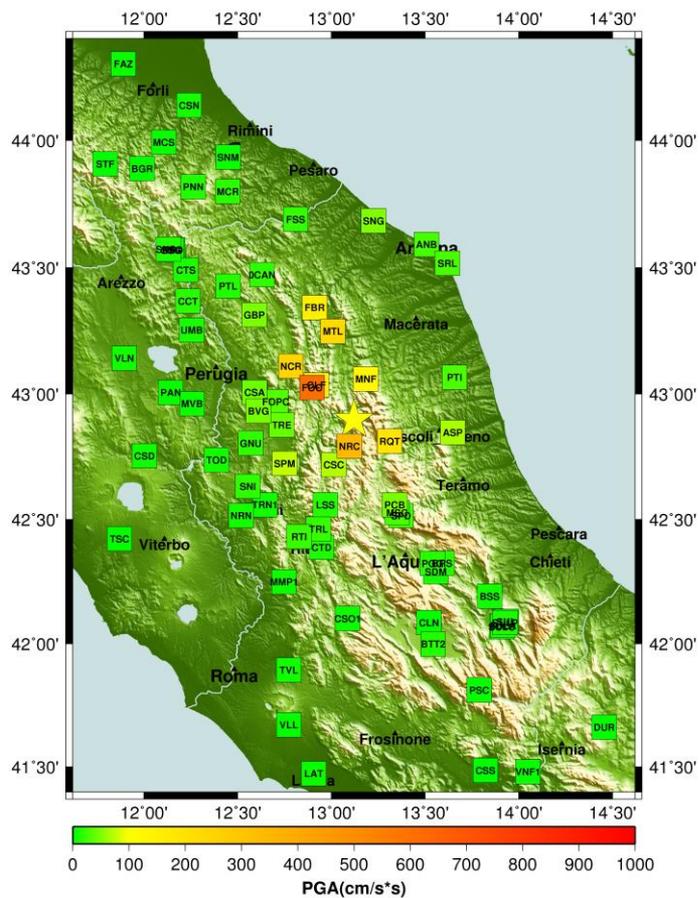
| sta | chan | dista | filter | PGA | EPA | PGV | PGD | PSA03 | PSA10 | PSA30 | EC8 | location |
|------|------|-------|----------|--------|--------|-------|------|---------|--------|--------|-----|----------------------|
| | | km | Hz | cm/s*s | cm/s*s | cm/s | cm | cm/s*s | cm/s*s | cm/s*s | | |
| NRC | HGE | 12 | 0.2-50.0 | 242.42 | 172.05 | 19.01 | 2.00 | 357.42 | 174.66 | 16.34 | B | Norcia |
| NRC | HGN | 12 | 0.2-50.0 | 346.88 | 269.93 | 19.96 | 1.74 | 398.15 | 105.84 | 30.85 | B | Norcia |
| NRC | HGZ | 12 | 0.2-50.0 | 211.46 | 134.60 | 8.75 | 1.09 | 275.52 | 63.99 | 12.05 | B | Norcia |
| RQT | HGE | 18 | 0.2-50.0 | 188.81 | 115.67 | 5.36 | 0.77 | 169.52 | 49.68 | 9.30 | B* | Arquata_Del_Tronto |
| RQT | HGN | 18 | 0.2-50.0 | 147.80 | 109.77 | 5.64 | 1.03 | 255.30 | 64.97 | 14.20 | B* | Arquata_Del_Tronto |
| RQT | HGZ | 18 | 0.2-50.0 | 116.17 | 50.55 | 3.98 | 0.90 | 113.45 | 41.83 | 14.39 | B* | Arquata_Del_Tronto |
| MNF | HGE | 19 | 0.2-50.0 | 128.04 | 81.35 | 8.36 | 1.61 | 178.54 | 68.11 | 10.65 | A* | MonteFiegni-Fiastra |
| MNF | HGN | 19 | 0.2-50.0 | 87.18 | 81.19 | 7.64 | 2.33 | 195.07 | 123.40 | 30.46 | A* | MonteFiegni-Fiastra |
| MNF | HGZ | 19 | 0.2-50.0 | 98.35 | 68.07 | 5.77 | 2.55 | 180.01 | 81.65 | 26.25 | A* | MonteFiegni-Fiastra |
| CSC | HGE | 22 | 0.2-50.0 | 70.02 | 53.03 | 3.63 | 0.95 | 109.97 | 47.65 | 13.34 | B | Cascia |
| CSC | HGN | 22 | 0.2-50.0 | 68.86 | 40.81 | 3.25 | 0.82 | 93.76 | 65.26 | 14.69 | B | Cascia |
| CSC | HGZ | 22 | 0.2-50.0 | 39.76 | 31.57 | 2.56 | 0.75 | 64.54 | 21.66 | 12.66 | B | Cascia |
| CLF | HGE | 22 | 0.2-50.0 | 122.01 | 91.70 | 11.04 | 1.85 | 259.34 | 237.60 | 13.97 | D | Colfiorito_Casone |
| CLF | HGN | 22 | 0.2-50.0 | 155.64 | 122.26 | 13.69 | 2.57 | 264.80 | 357.05 | 18.22 | D | Colfiorito_Casone |
| CLF | HGZ | 22 | 0.2-50.0 | 82.97 | 81.19 | 5.35 | 1.02 | 106.22 | 74.43 | 7.38 | D | Colfiorito_Casone |
| FDC | HGE | 23 | 0.2-50.0 | 606.13 | 477.17 | 19.60 | 0.90 | 1252.98 | 47.27 | 7.49 | C* | Foligno_Colfiorito |
| FDC | HGN | 23 | 0.2-50.0 | 365.33 | 215.49 | 9.57 | 1.10 | 426.11 | 56.75 | 9.40 | C* | Foligno_Colfiorito |
| FDC | HGZ | 23 | 0.2-50.0 | 169.10 | 88.95 | 3.64 | 0.51 | 193.81 | 17.14 | 6.55 | C* | Foligno_Colfiorito |
| TRE | HGE | 31 | 0.2-50.0 | 40.25 | 36.64 | 2.96 | 0.86 | 75.79 | 39.66 | 13.70 | C* | Trevi |
| TRE | HGN | 31 | 0.2-50.0 | 37.69 | 34.26 | 2.73 | 0.50 | 82.20 | 36.89 | 5.80 | C* | Trevi |
| TRE | HGZ | 31 | 0.2-50.0 | 25.86 | 20.39 | 2.13 | 0.63 | 53.66 | 26.59 | 6.75 | C* | Trevi |
| FOPC | HGE | 35 | 0.2-50.0 | 32.45 | 30.05 | 2.69 | 0.70 | 58.73 | 36.90 | 10.89 | na | Foligno Prot Civ Reg |
| FOPC | HGN | 35 | 0.2-50.0 | 31.67 | 30.28 | 2.78 | 0.97 | 90.06 | 57.15 | 11.56 | na | Foligno Prot Civ Reg |
| FOPC | HGZ | 35 | 0.2-50.0 | 26.51 | 18.02 | 1.92 | 0.49 | 35.57 | 29.77 | 6.73 | na | Foligno Prot Civ Reg |
| SPM | HGE | 36 | 0.2-50.0 | 75.94 | 45.17 | 2.17 | 0.55 | 97.51 | 13.07 | 5.23 | A* | Spoletto_Monteluco |
| SPM | HGN | 36 | 0.2-50.0 | 57.39 | 44.07 | 1.74 | 0.69 | 110.17 | 11.66 | 8.12 | A* | Spoletto_Monteluco |
| SPM | HGZ | 36 | 0.2-50.0 | 23.11 | 15.26 | 1.10 | 0.40 | 28.21 | 9.76 | 6.77 | A* | Spoletto_Monteluco |
| NCR | HGE | 36 | 0.2-50.0 | 225.76 | 182.83 | 7.67 | 0.64 | 239.86 | 42.60 | 5.65 | E | Nocera_Umbra |

dista = epicentral distance
filter = automatic band pass butterworth filter
EC8 = site classification (Eurocode from ITACA)

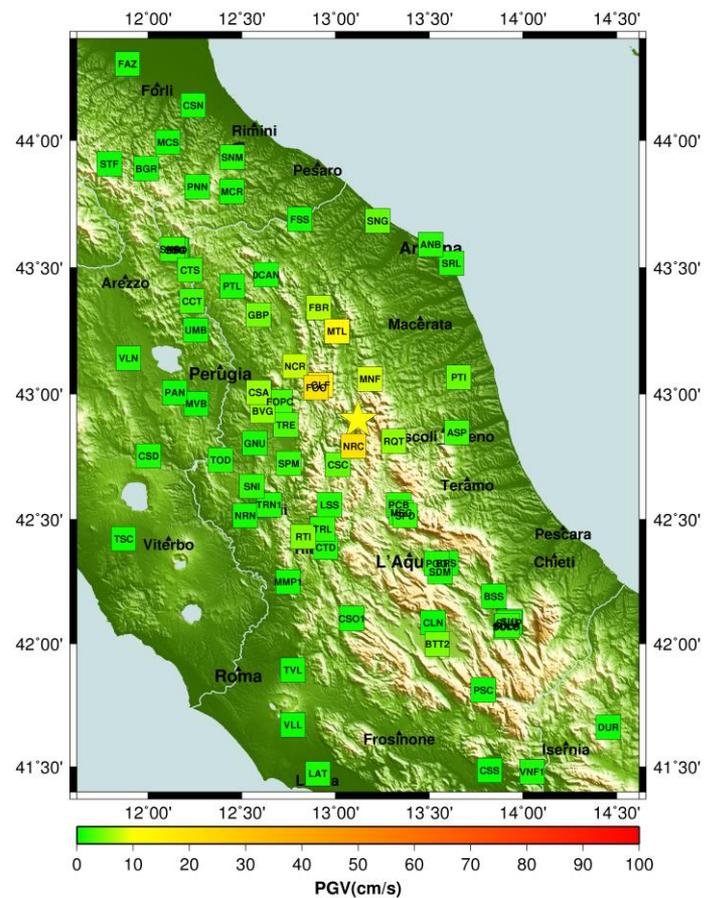
PGA, PGV, PGD = peak ground acceleration, velocity and displacement
EPA = effective ground acceleration (Kramer, 1996)
PSA03, PSA10, PSA30 = spectral acceleration (0.3, 1.0, 3.0 sec)

Analisi automatica, in tempo reale, dei dati accelerometrici per la protezione civile

2016/10/26 19:18:06 MI:6.0 Castelsantangelo_sul_Nera

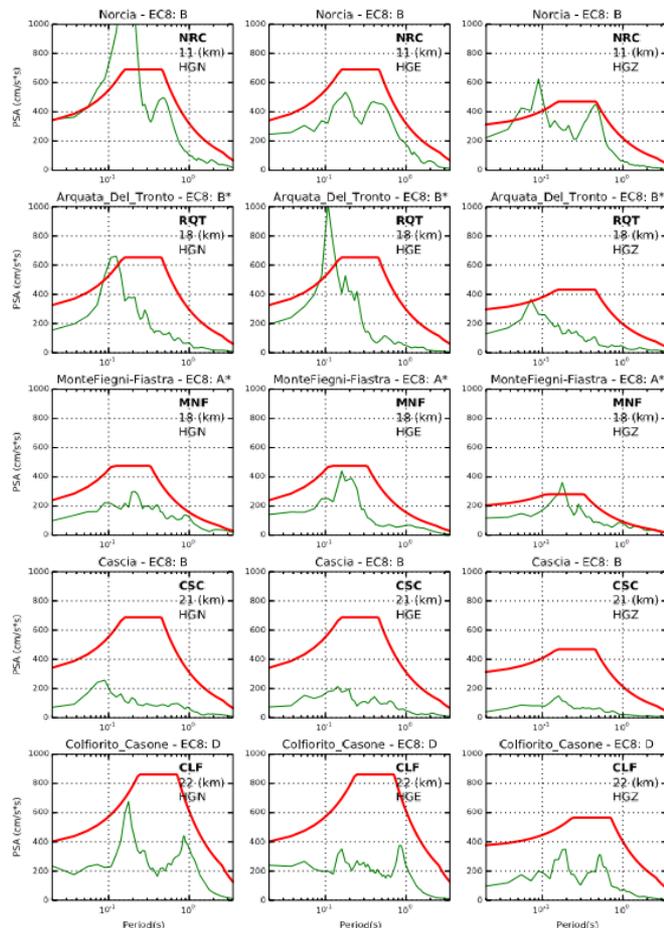


2016/10/26 19:18:06 MI:6.0 Castelsantangelo_sul_Nera

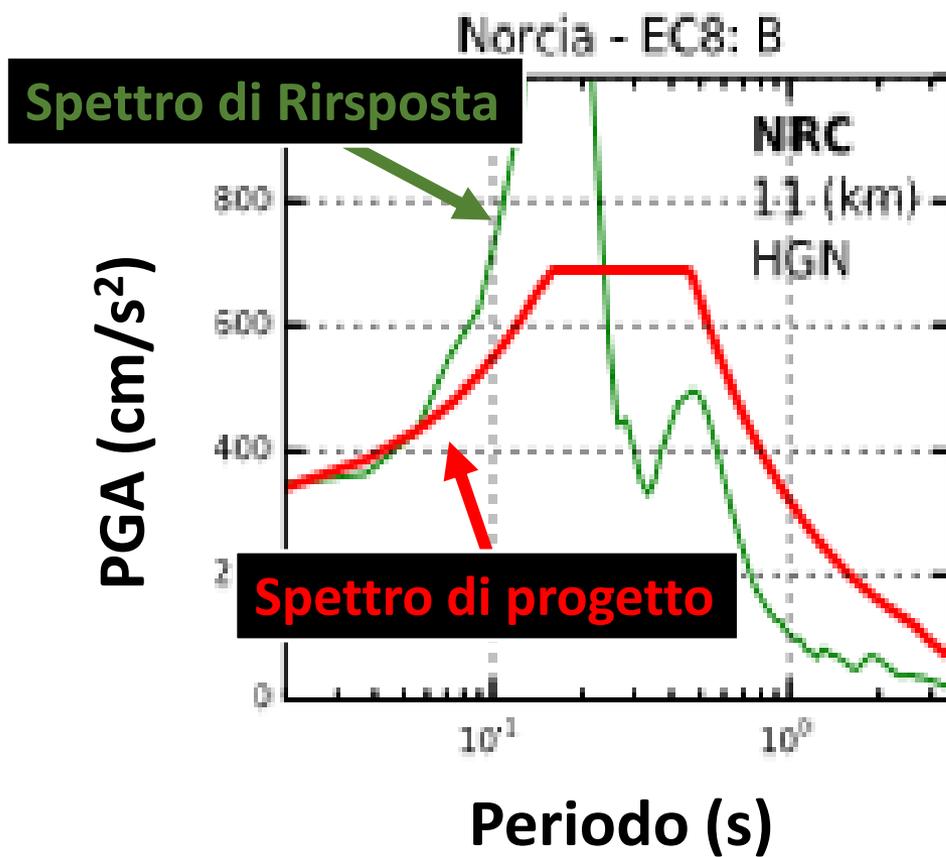


Rapporto automatico, in tempo reale per la protezione civile

Event: Castelsa - Origin time: 2016/10/26 19:18:06 Lat:42.898 Lon:13.121 MI = 6.0



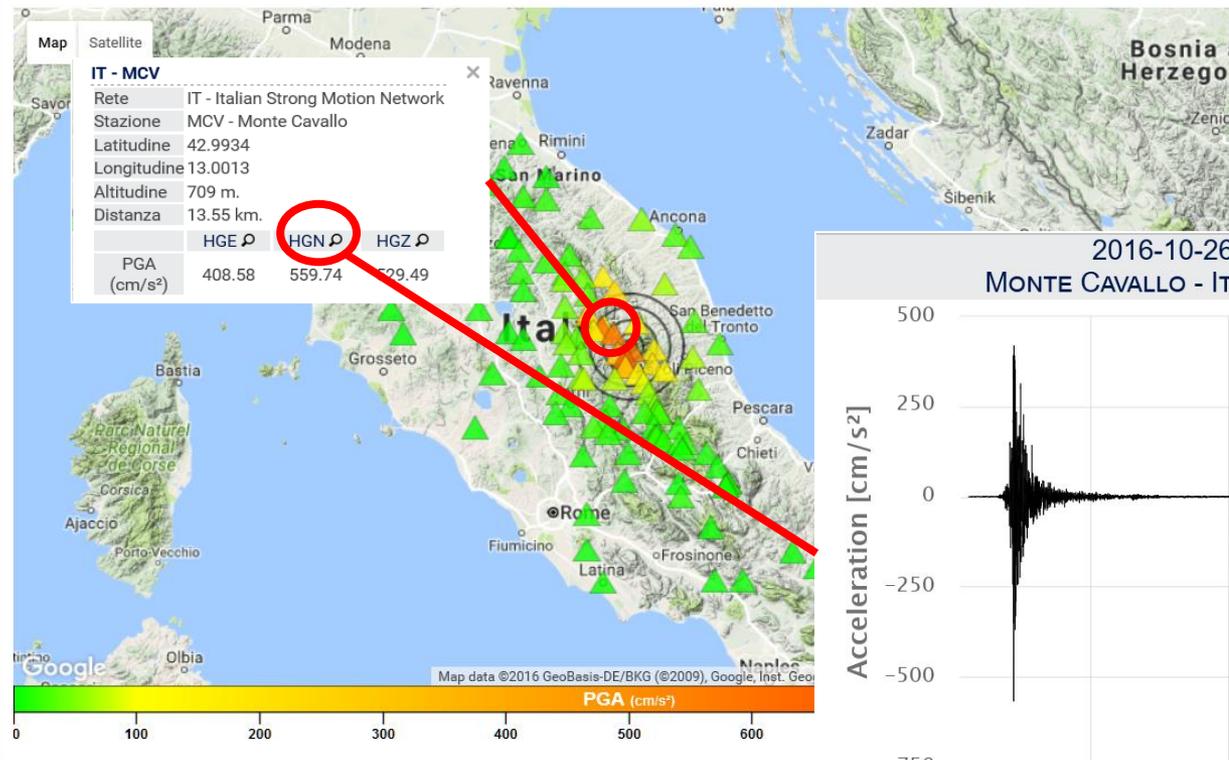
Spectral Acceleration SA (camping 5%) (thin green line)
 Predicted SA - return period of 475 years as in the Italian Technical norms for buildings (NTCOB) (red line)
 Recorded smoothed spectral acceleration following the criteria suggested by Working Group MS (2008) (thick green line)



<http://ran.protezionecivile.it>



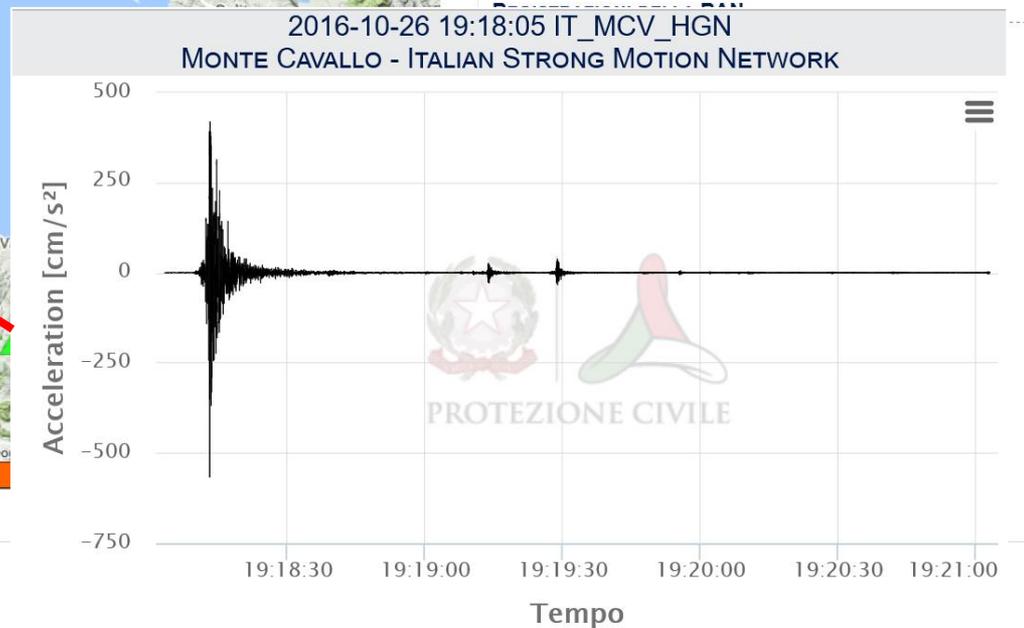
RETE ACCELEROMETRICA NAZIONALE - RAN DOWNLOAD



PROTEZIONE CIVILE
 Presidenza del Consiglio dei Ministri
 Dipartimento della Protezione Civile

DETTAGLIO EVENTO
 Luogo: Ussita, Macerata
 MI: 5.9 Data: 2016-10-26 19:18:05
 Lat: 42.915 Lon: 13.128 Profondità: 08.4km

[Parametri](#) [Download](#)



Il terremoto, a 40 anni dall'evento del Friuli

http://ran.protezionecivile.it

PARAMETRI RAN

| Elenco parametri RAN | | | | Epicentro (auth: INGV) MI 5.9, 2016-10-26 19:18:05 (UTC) - Ussita, Macerata | | | | | | | | | | |
|----------------------|-----|---------|---------|---|-----------------|------------|----------------|---------------|------------------|------------------|------------------|-----------------|-----------------|-------|
| Sta | Can | Lat (°) | Lon (°) | Nome Stazione | Filtro ① Hz | dist km | PGA ① cm/s² | PGV ① cm/s | PSA03 ① cm/s² | PSA10 ① cm/s² | PSA30 ① cm/s² | Arias ① cm/s | Housner ① cm | EC8 ① |
| CNE | HGE | 42.8944 | 13.1528 | Castel Santangelo sul Nera | Ba 0.2 6 50.0 6 | 3.11 | 553.544495 | 23.362356 | 1288.220337 | 232.333084 | 18.377827 | 107.167976 | 94.148964 | - |
| CNE | HGN | 42.8944 | 13.1528 | Castel Santangelo sul Nera | Ba 0.2 6 50.0 6 | 3.11 | 420.069122 | 30.533468 | 865.694702 | 373.006439 | 30.073645 | 93.419106 | 116.965912 | - |
| CNE | HGZ | 42.8944 | 13.1528 | Castel Santangelo sul Nera | Ba 0.2 6 50.0 6 | 3.11 | 489.291260 | 15.159959 | 531.467957 | 116.675125 | 31.444519 | 93.735588 | 51.707516 | - |
| CMI | HGE | 42.8504 | 13.0928 | Campi | Ba 0.2 6 50.0 6 | 7.62 | 685.462830 | 48.729881 | 1781.117920 | 508.715515 | 40.544647 | 208.076309 | 174.904205 | - |
| CMI | HGN | 42.8504 | 13.0928 | Campi | Ba 0.2 6 50.0 6 | 7.62 | 349.890320 | 23.547428 | 799.176025 | 225.277084 | 31.580013 | 91.011108 | 78.134651 | - |
| CMI | HGZ | 42.8504 | 13.0928 | Campi | Ba 0.2 6 50.0 6 | 7.62 | 495.512177 | 11.858644 | 335.602478 | 113.827332 | 15.718957 | 56.689289 | 41.996677 | - |
| PRE | HGE | 42.8793 | 13.0334 | Preci | Ba 0.2 6 50.0 6 | 8.80 | 282.131958 | 7.655034 | 343.694275 | 61.494850 | 14.080216 | 29.066908 | 30.227024 | - |
| PRE | HGN | 42.8793 | 13.0334 | Preci | Ba 0.2 6 50.0 6 | 8.80 | 239.329285 | 9.614402 | 365.353668 | 49.514091 | 21.829815 | 34.803505 | 27.257990 | - |
| PRE | HGZ | 42.8793 | 13.0334 | Preci | Ba 0.2 6 50.0 6 | 8.80 | 174.519302 | 5.216872 | 188.199326 | 51.470867 | 12.814964 | 16.671478 | 27.194874 | - |
| MCV | HGE | 42.9934 | 13.0013 | Monte Cavallo | Ba 0.2 6 50.0 6 | 13.55 | 408.582764 | 11.220574 | 390.395691 | 74.556282 | 13.457872 | 80.424057 | 35.383453 | - |
| MCV | HGN | 42.9934 | 13.0013 | Monte Cavallo | Ba 0.2 6 50.0 6 | 13.55 | 559.737732 | 14.318295 | 954.867126 | 62.464130 | 19.381353 | 111.353828 | 47.699158 | - |
| MCV | HGZ | 42.9934 | 13.0013 | Monte Cavallo | Ba 0.2 6 50.0 6 | 13.55 | 529.489319 | 7.429808 | 192.979385 | 61.325577 | 8.175445 | 66.780632 | 22.970127 | - |
| NOR | HGE | 42.7924 | 13.0924 | Norcia | Ba 0.2 6 50.0 6 | 13.91 | 222.447205 | 16.471518 | 425.226410 | 248.260025 | 13.641493 | 25.092558 | 66.180450 | C* |
| NOR | HGN | 42.7924 | 13.0924 | Norcia | Ba 0.2 6 50.0 6 | 13.91 | 137.548615 | 9.917775 | 235.951157 | 154.517929 | 40.185349 | 16.744089 | 51.758324 | C* |
| NOR | HGZ | 42.7924 | 13.0924 | Norcia | Ba 0.2 6 50.0 6 | 13.91 | 96.897064 | 7.086030 | 147.115463 | 105.094620 | 12.112900 | 10.870301 | 34.973919 | C* |
| NRC | HGE | 42.7925 | 13.0964 | Norcia | Ba 0.2 6 50.0 6 | 13.91 | 242.267395 | 18.992956 | 357.196442 | 174.554520 | 16.333855 | 27.599295 | 60.018810 | B |
| NRC | HGN | 42.7925 | 13.0964 | Norcia | Ba 0.2 6 50.0 6 | 13.91 | 346.669495 | 19.946661 | 397.902496 | 105.774551 | 30.831427 | 49.789341 | 63.566521 | B |
| NRC | HGZ | 42.7925 | 13.0964 | Norcia | Ba 0.2 6 50.0 6 | 13.91 | 211.332703 | 8.743941 | 275.348328 | 63.945946 | 12.041706 | 17.117792 | 32.929207 | B |
| MMO | HGE | 42.8993 | 13.3268 | Montemonaco | Ba 0.2 6 50.0 6 | 16.45 | 171.050262 | 6.342821 | 302.757111 | 79.596825 | 11.418564 | 18.580093 | 31.965408 | - |
| MMO | HGN | 42.8993 | 13.3268 | Montemonaco | Ba 0.2 6 50.0 6 | 16.45 | 170.994492 | 11.574311 | 306.006470 | 168.568008 | 18.389462 | 24.084583 | 50.906113 | - |
| MMO | HGZ | 42.8993 | 13.3268 | Montemonaco | Ba 0.2 6 50.0 6 | 16.45 | 93.511299 | 4.930449 | 161.708450 | 66.573303 | 9.277277 | 9.444488 | 20.906601 | - |
| MNF | HGE | 43.0596 | 13.1844 | MonteFiegni-Fiastra | Ba 0.2 6 50.0 6 | 16.75 | 127.960503 | 8.353045 | 178.423233 | 68.049622 | 10.685244 | 7.762556 | 26.479792 | A* |
| MNF | HGN | 43.0596 | 13.1844 | MonteFiegni-Fiastra | Ba 0.2 6 50.0 6 | 16.75 | 87.120094 | 7.634027 | 194.951843 | 123.312218 | 30.512157 | 7.788480 | 31.249706 | A* |
| MNF | HGZ | 43.0596 | 13.1844 | MonteFiegni-Fiastra | Ba 0.2 6 50.0 6 | 16.75 | 98.285515 | 5.765221 | 179.898712 | 81.600746 | 26.230217 | 5.701234 | 27.065187 | A* |
| RQT | HGE | 42.8130 | 13.3110 | Arquata_Del_Tronto | Ba 0.2 6 50.0 6 | 18.66 | 188.689743 | 5.358561 | 169.419571 | 49.650517 | 9.295050 | 42.272381 | 23.045345 | B* |
| RQT | HGN | 42.8130 | 13.3110 | Arquata_Del_Tronto | Ba 0.2 6 50.0 6 | 18.66 | 147.712723 | 5.635134 | 255.138031 | 64.930031 | 14.191557 | 29.742075 | 23.973879 | B* |
| RQT | HGZ | 42.8130 | 13.3110 | Arquata_Del_Tronto | Ba 0.2 6 50.0 6 | 18.66 | 116.099098 | 3.978818 | 113.381508 | 41.808716 | 14.379747 | 8.726532 | 16.634663 | B* |
| FCC | HGE | 42.7545 | 13.1932 | Forca Canapine | Ba 0.2 6 50.0 6 | 18.91 | 135.504105 | 4.119731 | 209.573334 | 30.651966 | 10.311465 | 11.038939 | 17.468452 | - |
| FCC | HGN | 42.7545 | 13.1932 | Forca Canapine | Ba 0.2 6 50.0 6 | 18.91 | 113.644394 | 4.952429 | 142.733704 | 44.352097 | 8.955695 | 10.854320 | 17.821522 | - |
| FCC | HGZ | 42.7545 | 13.1932 | Forca Canapine | Ba 0.2 6 50.0 6 | 18.91 | 61.479443 | 2.988155 | 111.270401 | 27.469952 | 14.562296 | 3.628394 | 12.334505 | - |
| CLF | HGE | 43.0367 | 12.9204 | Colfiorito_Casone | Ba 0.2 6 50.0 6 | 21.66 | 121.932213 | 11.027856 | 259.174255 | 237.457764 | 13.959499 | 19.793224 | 49.492130 | D |
| CLF | HGN | 43.0367 | 12.9204 | Colfiorito_Casone | Ba 0.2 6 50.0 6 | 21.66 | 155.547745 | 13.685712 | 264.637268 | 356.833374 | 18.193239 | 29.179775 | 75.505699 | D |



PROTEZIONE CIVILE

Presidenza del Consiglio dei Ministri
Dipartimento della Protezione Civile

6 19:18:05

Profondità: 08.4km

ametri [Download](#)

LLA RAN

I:3.4 Prof.08.2km NreCs:43

I:3.3 Prof.10.7km NreCs:35

I:3.1 Prof.07.1km NreCs:29

I:3.5 Prof.07.7km NreCs:36

I:3.3 Prof.08.7km NreCs:35

I:3.0 Prof.08.3km NreCs:29

I:3.3 Prof.09.6km NreCs:40

I:3.1 Prof.08.6km NreCs:36

I:2.8 Prof.10.2km NreCs:21

I:3.1 Prof.10.7km NreCs:26

I:2.8 Prof.10.5km NreCs:16

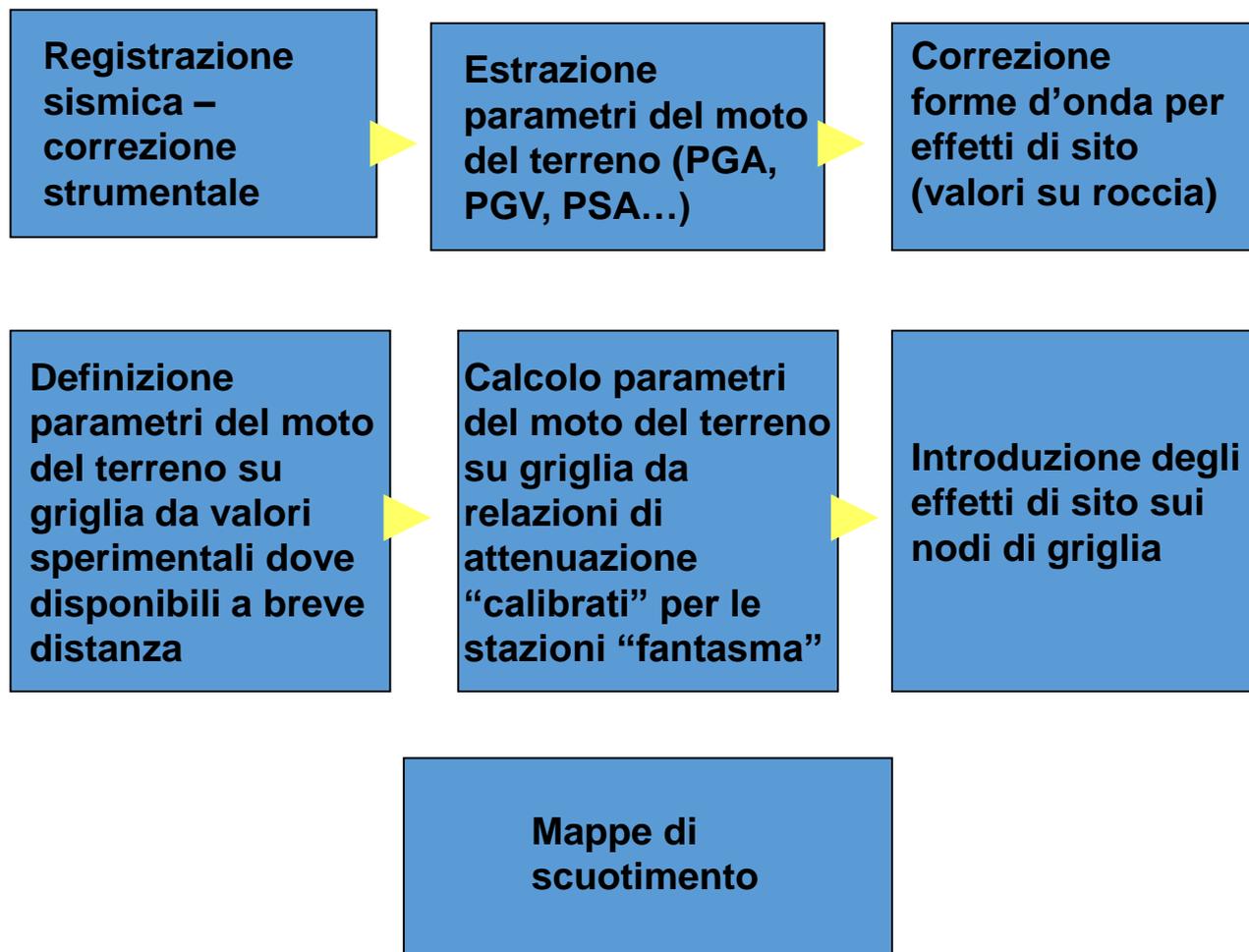
I:3.1 Prof.09.1km NreCs:30

I:3.4 Prof.08.8km NreCs:38

I:4.0 Prof.08.4km NreCs:26

I:4.2 Prof.08.6km NreCs:59

Mappe di scuotimento in tempo reale



Classi NEHRP

A CURA DEL

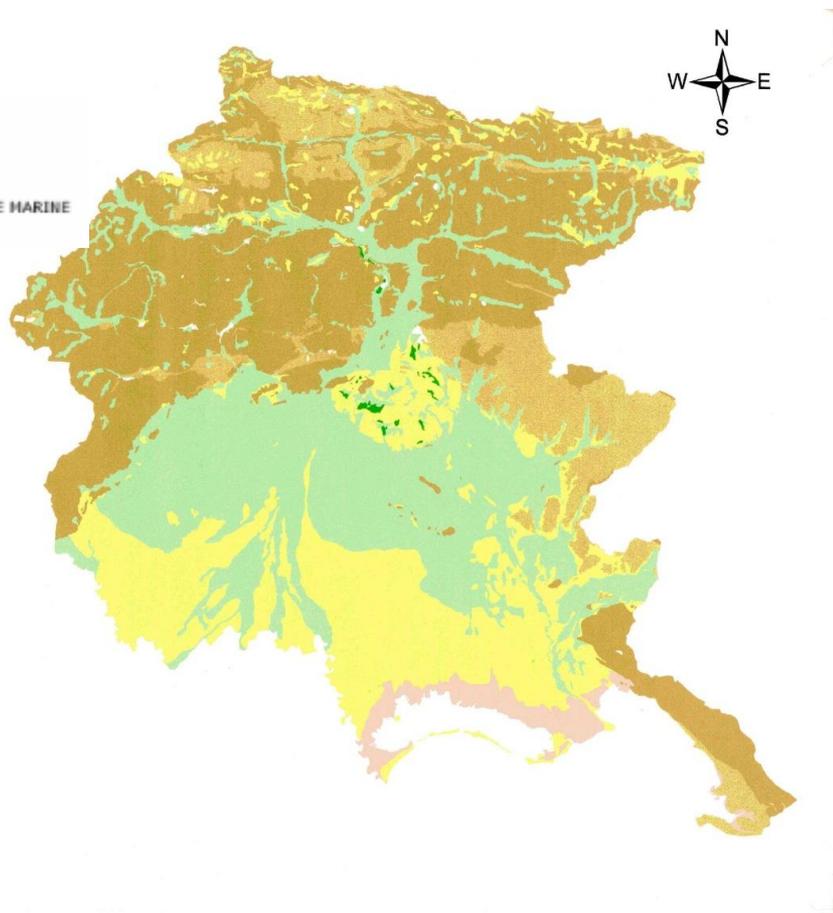


DIPARTIMENTO DI SCIENZE GEOLOGICHE, AMBIENTALI E MARINE
UNIVERSITÀ DEGLI STUDI DI TRIESTE

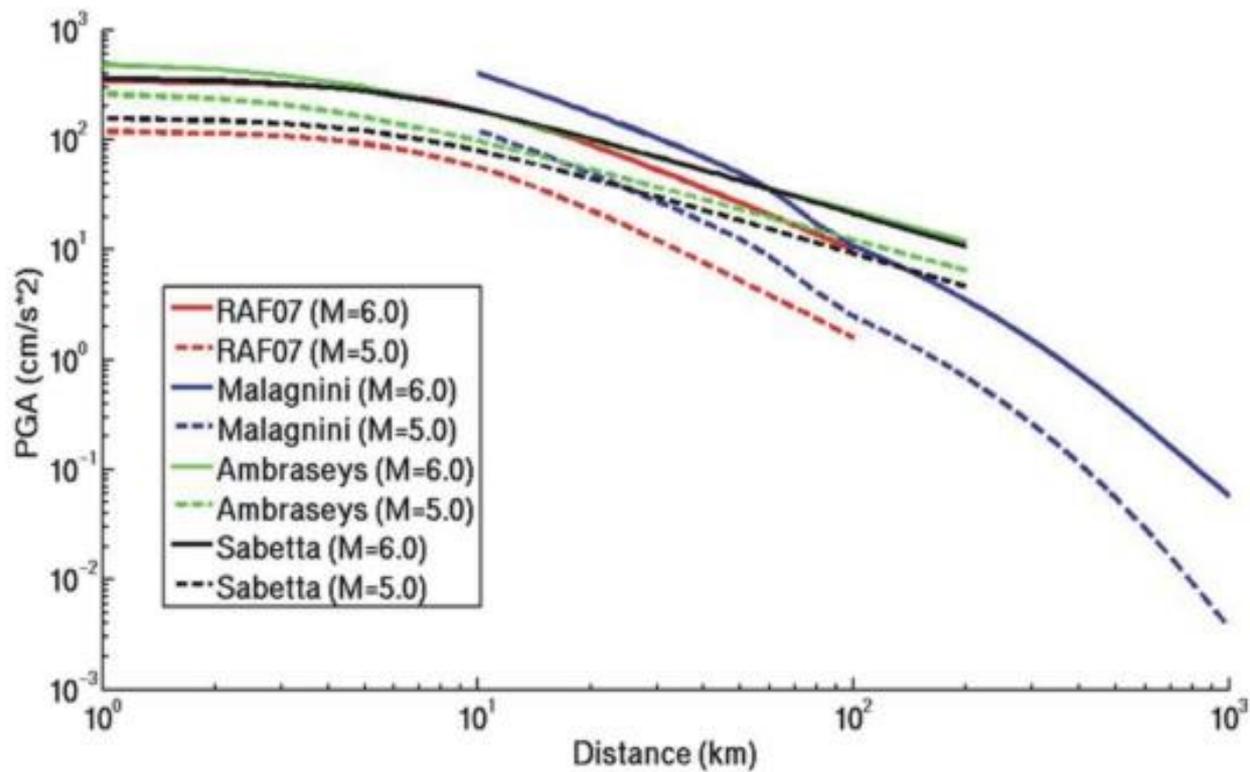
Legenda

-  A rocce "massicce"
-  B rocce "stratificate"
-  C sedimenti ghiaiosi
-  D sedimenti sabbiosi, limosi e glaciali
-  E sedimenti palustri e torbosi
-  F aree di bonifica e di riporto

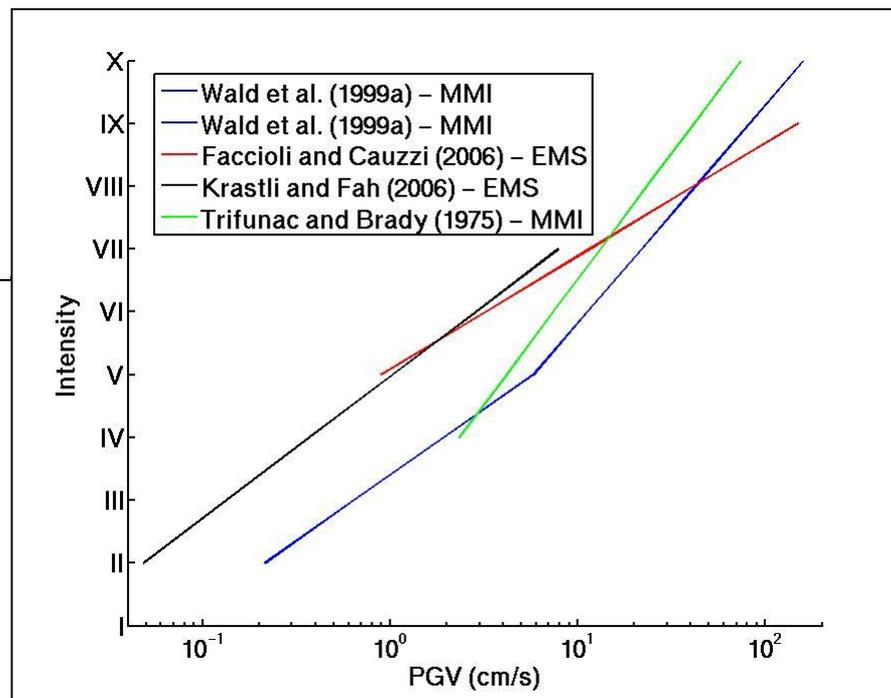
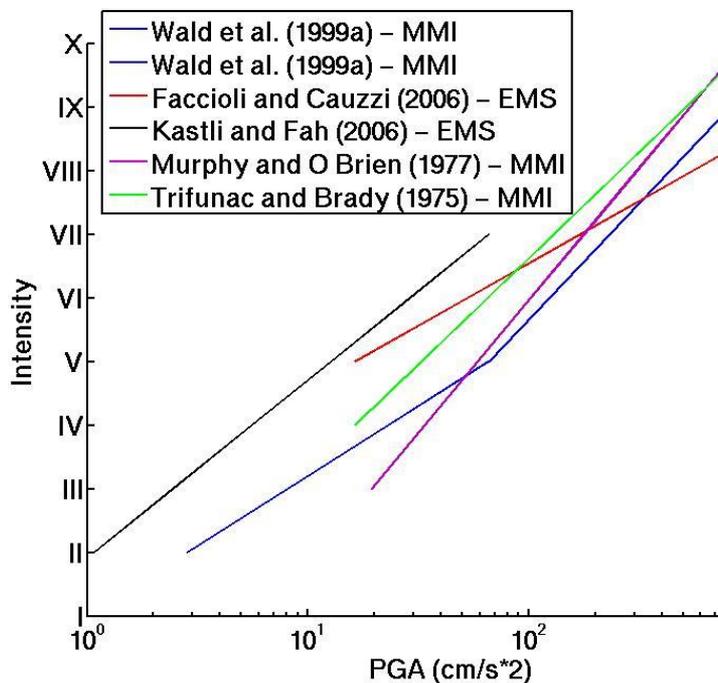
0 12.5 25 50 km



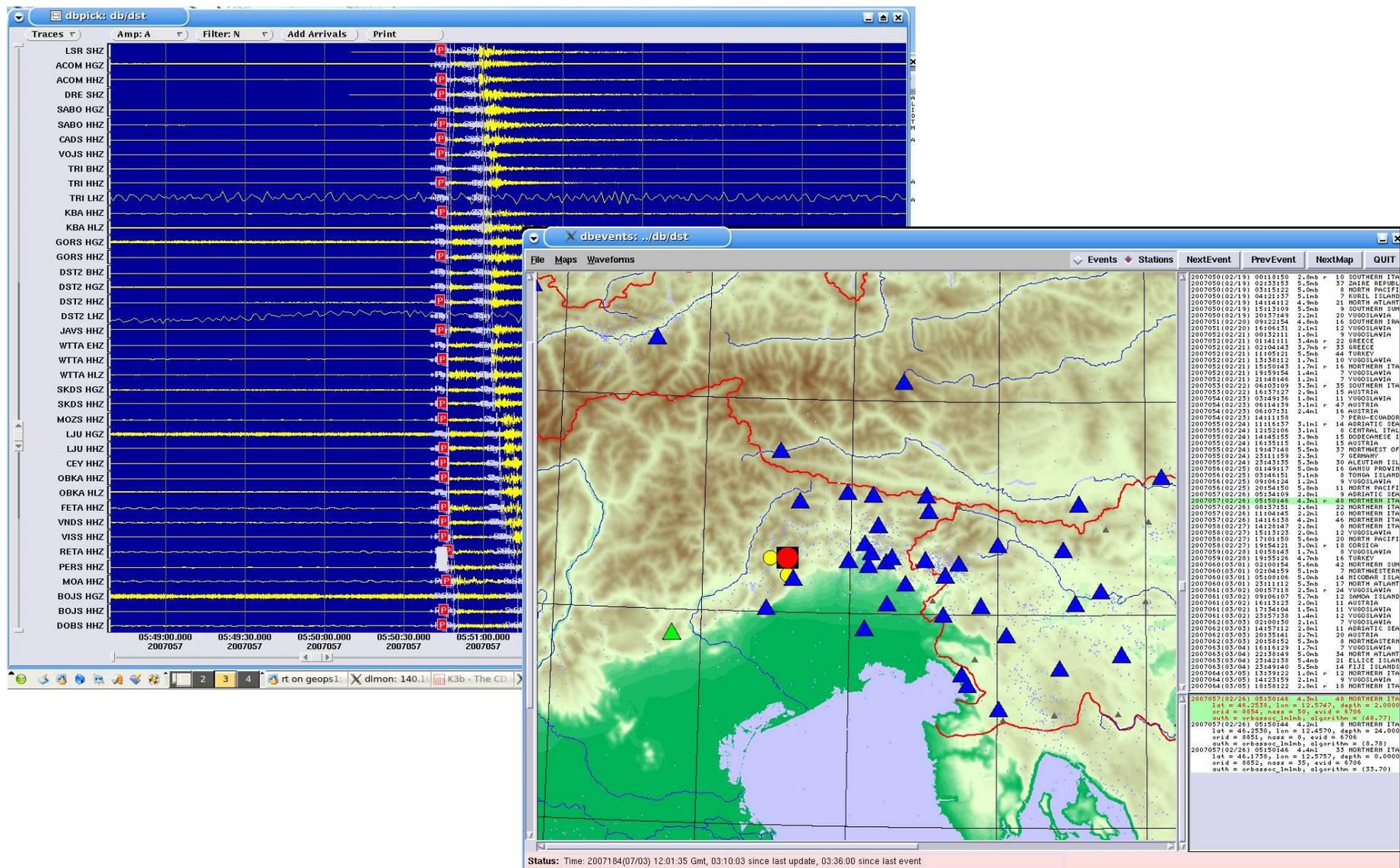
Relazioni di attenuazione

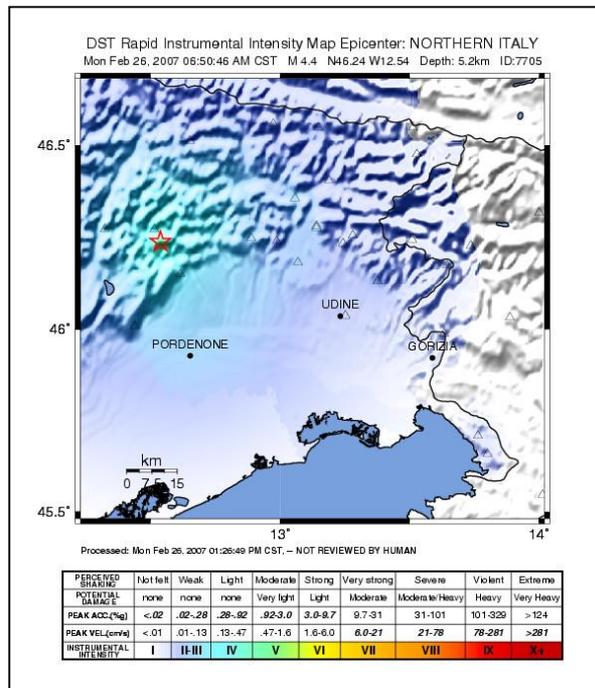
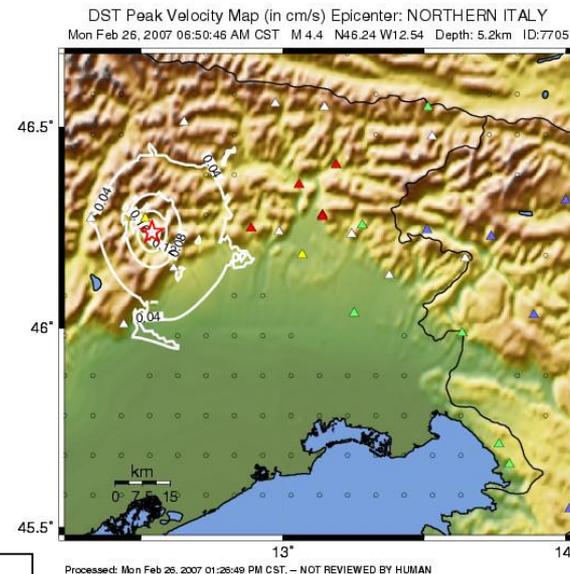
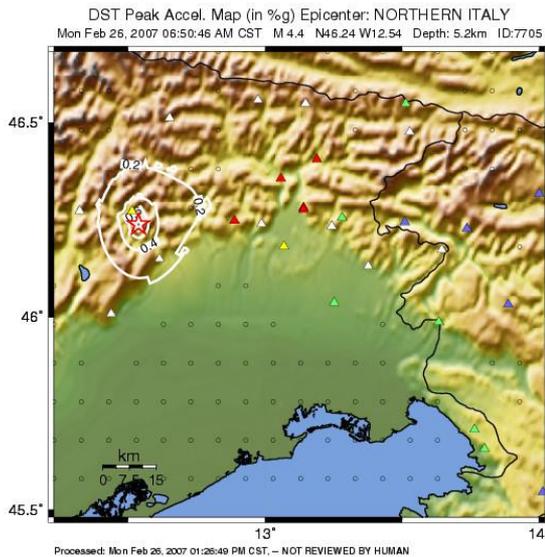


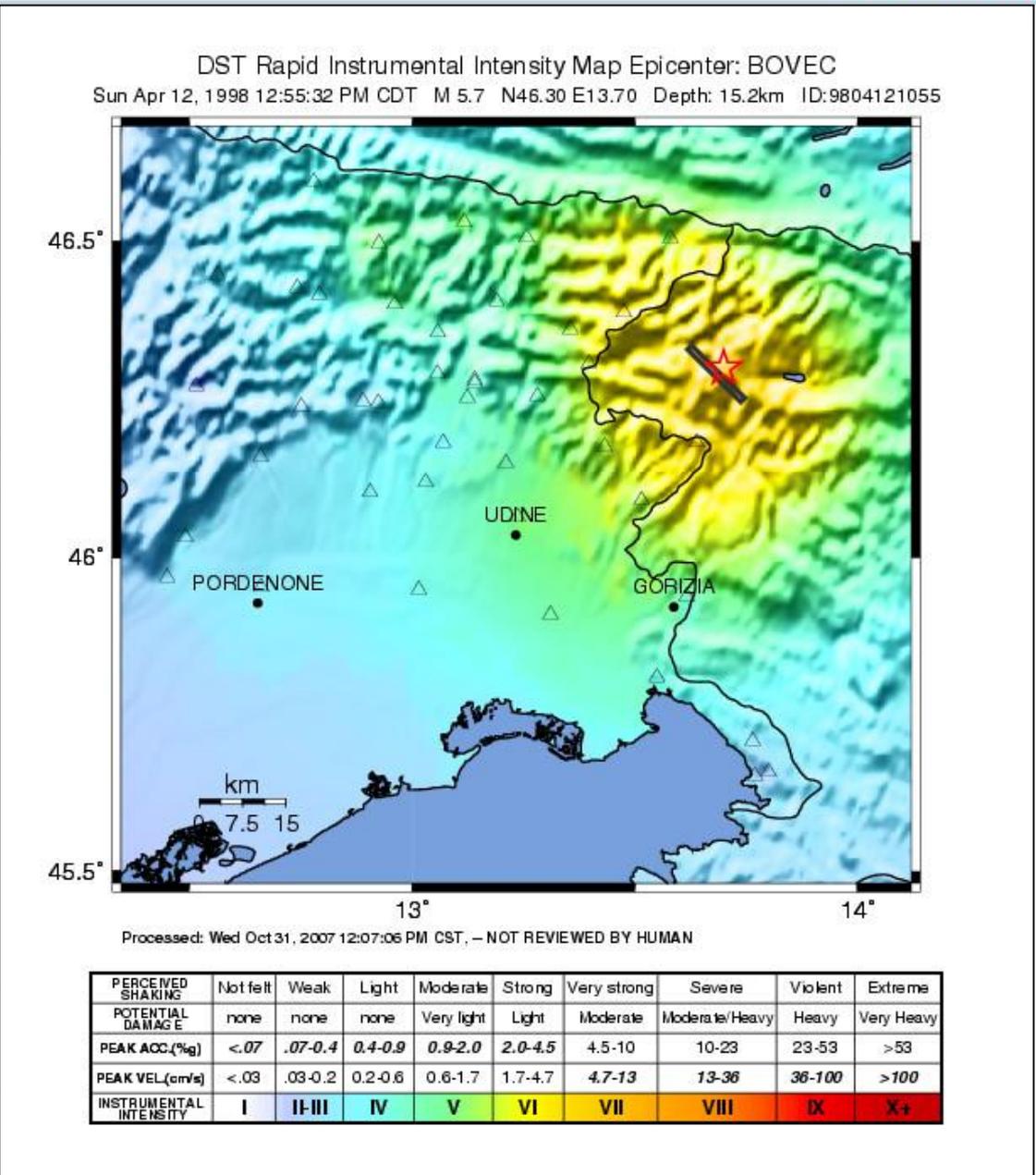
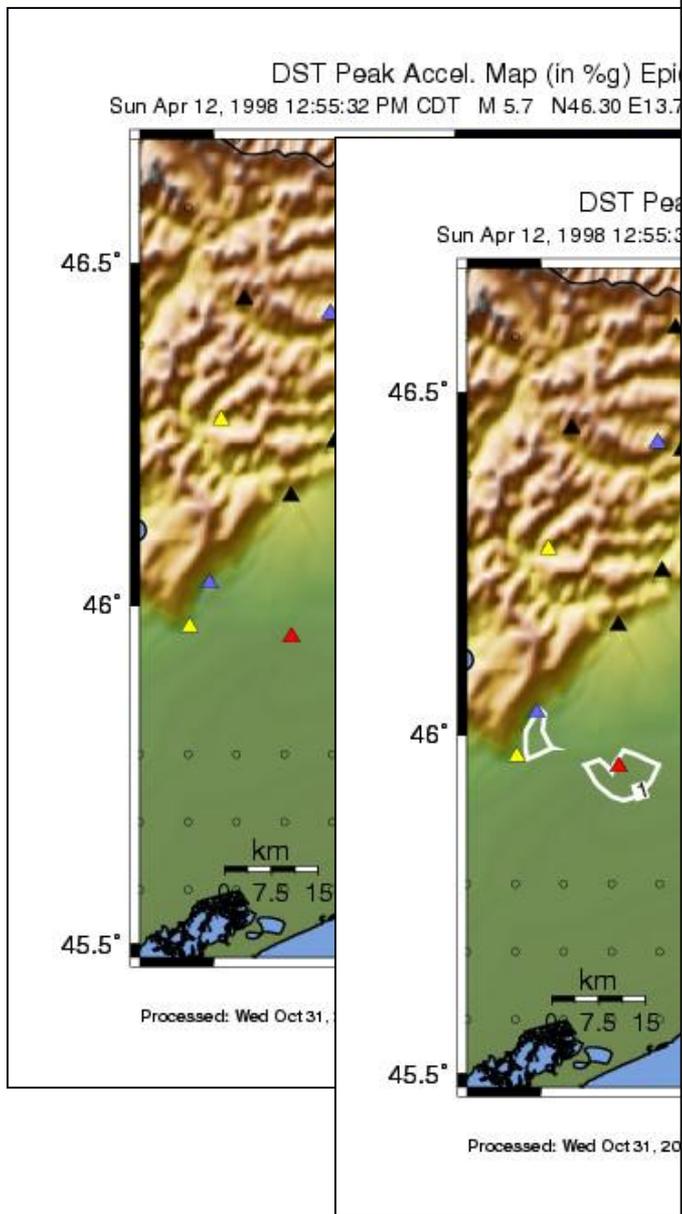
Relazioni PGA/PGV – Intensità



Integrated networks in Southern Alps area



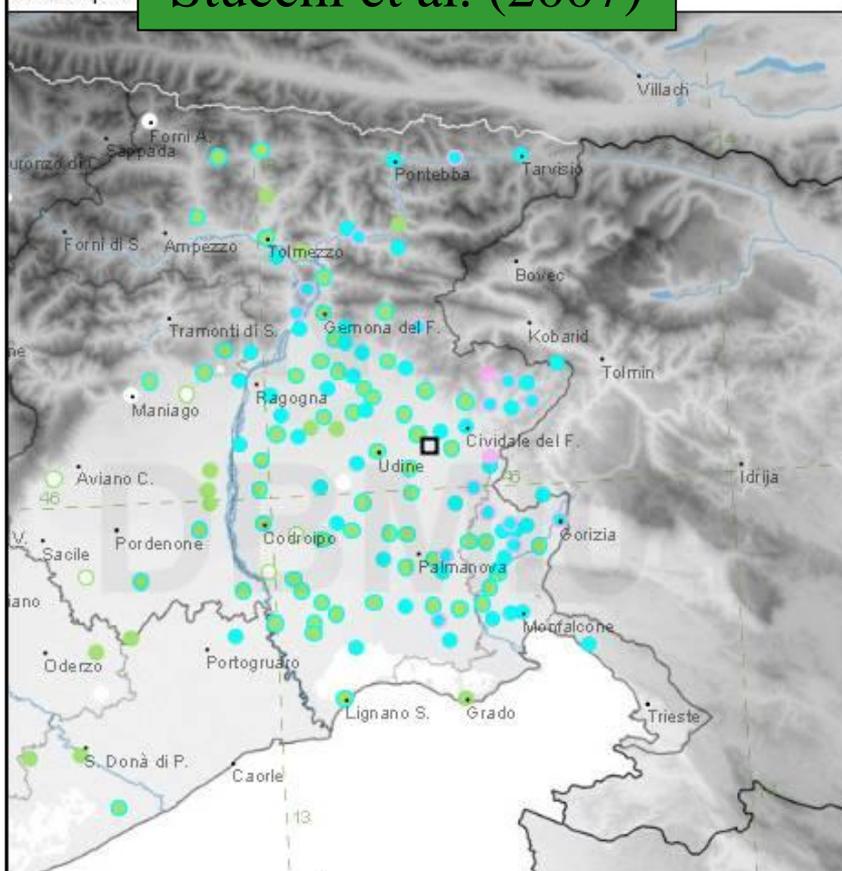




Terremoto di Udine - 1998 Mw 5.70

Area epicentrale

Stucchi et al. (2007)



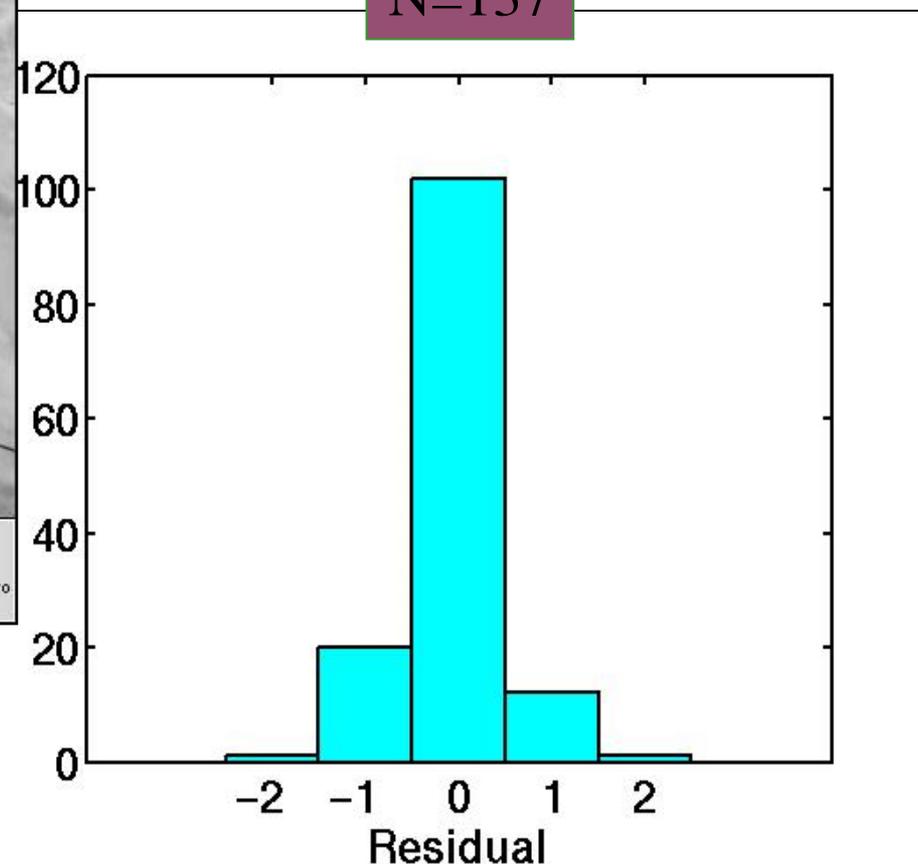
INGV-DBMI04

| | | | | | | | | | | |
|----------|-----|-----|-----|-----|-----|-----|------|-------|----|-----------|
| IS (MCS) | NF | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | epicentro |
| ≤3 | 3-4 | 4-5 | 5-6 | 6-7 | 7-8 | 8-9 | 9-10 | 10-11 | | |

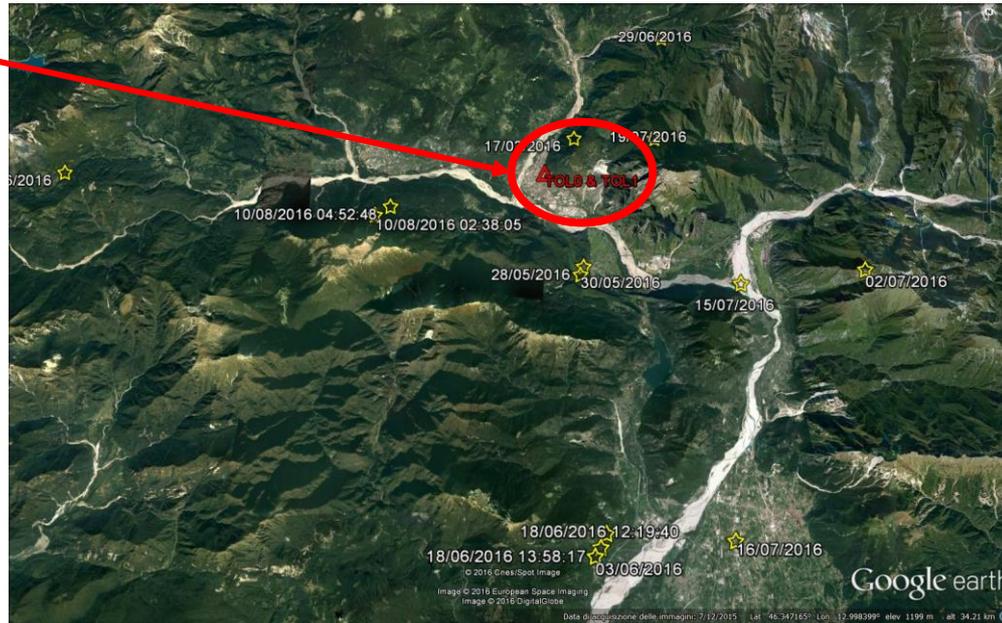
$$Misfit = \frac{\sum_{i=1}^N |I_{COM} - I_{OBS}|}{N} = 0.264$$



N=137

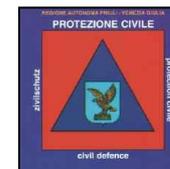
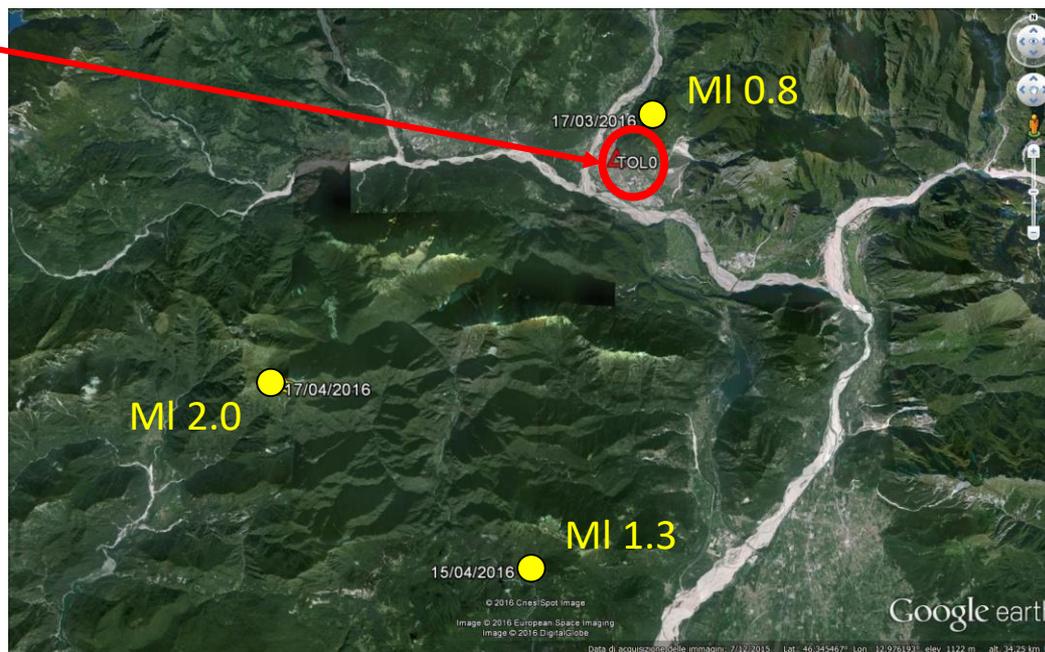


Tolmezzo

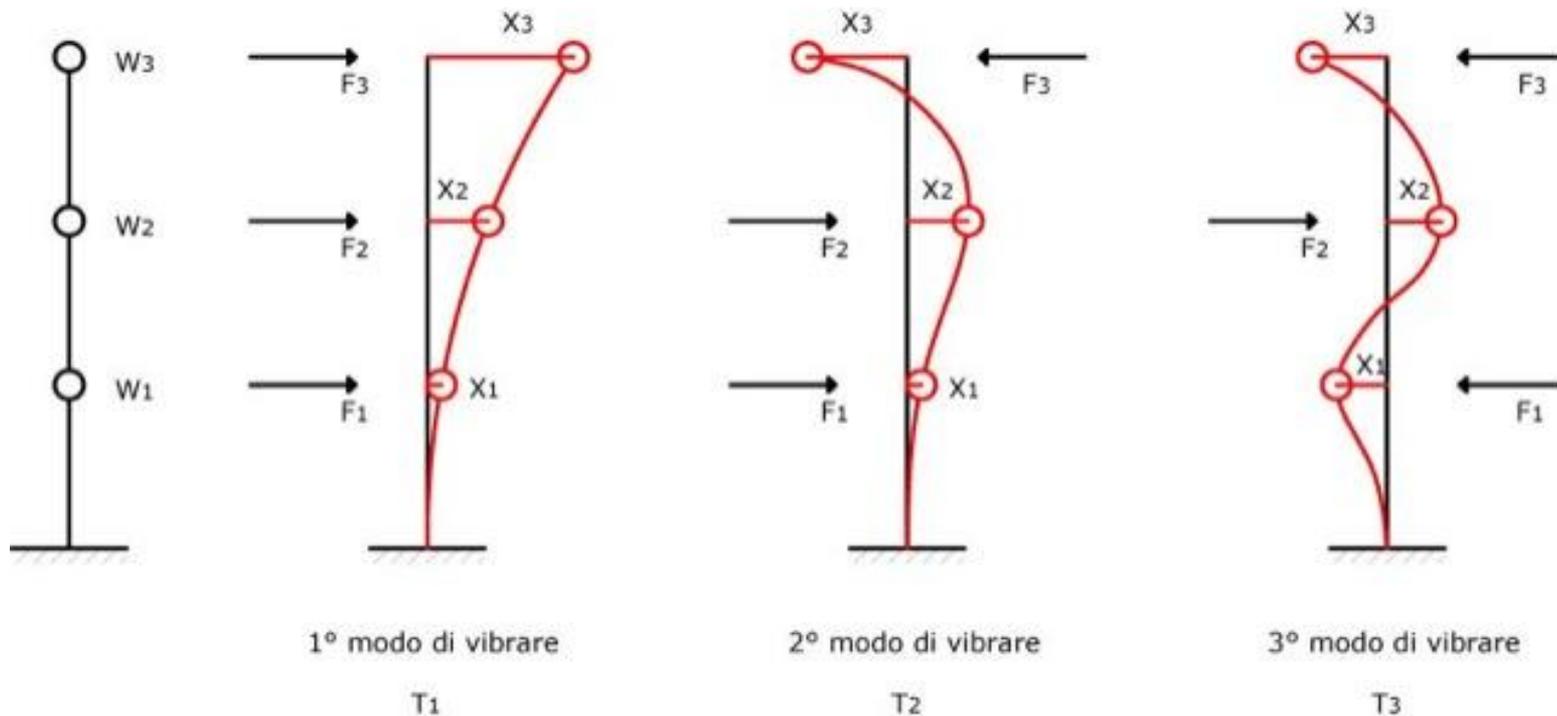


1976 – 2016 Simposio “Monitoraggio sismico e accelerometrico per la Protezione Civile: stato dell’arte e nuove strategie a 40 anni dal terremoto del Friuli / CRS Udine 19 aprile 2016

Tolmezzo

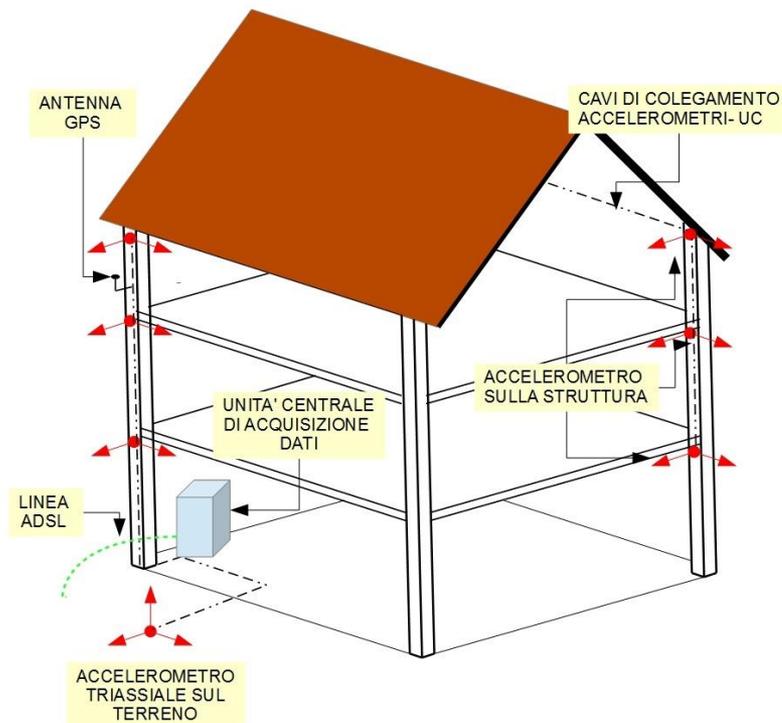


Modi elementari o modi naturali di vibrare



OSSERVATORIO SISMICO DELLE STRUTTURE

«sistema di monitoraggio completo»



Un sistema per il monitoraggio sismico «completo» di un edificio è costituito da un accelerometro triassiale sul terreno e da una N accelerometri fissati alla struttura al livello dei vari impalcati.

Per ogni impalcato si misurano un numero di componenti accelerometriche sufficienti a ricostruirne completamente il movimento

Tutti gli accelerometri sono collegati via cavo ad una unità centrale che provvede all'acquisizione sincronizzata dei segnali e alla loro scrittura su una memoria fissa (in caso di superamento di determinate soglie di accelerazione: evento sismico)

I dati sono sempre referenziati con il tempo assoluto UTC ottenuto attraverso un'antenna GPS.

Mediante un collegamento ADSL o UMTS i dati sono immediatamente trasmessi ad un server che provvede a processarli e ad inserirli nel data base

Monitoraggio strutturale attraverso misure di vibrazione - Trieste 5 -aprile-2016

La rete accelerometrica RAF e sua integrazione nella RAN:
informazioni in tempo quasi reale a supporto dei processi decisionali

Tolmezzo

