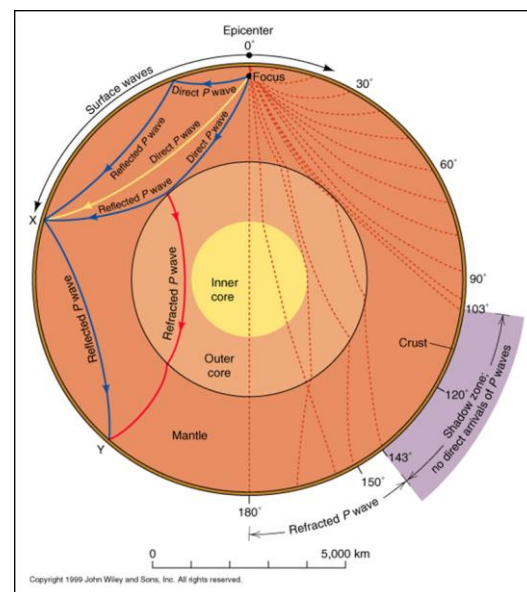
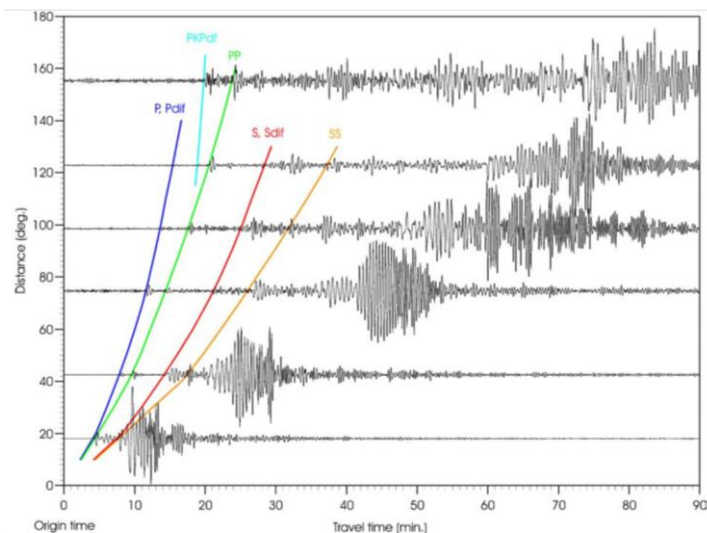




Sismometria
e
Monitoraggio Sismico

2019/20

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.



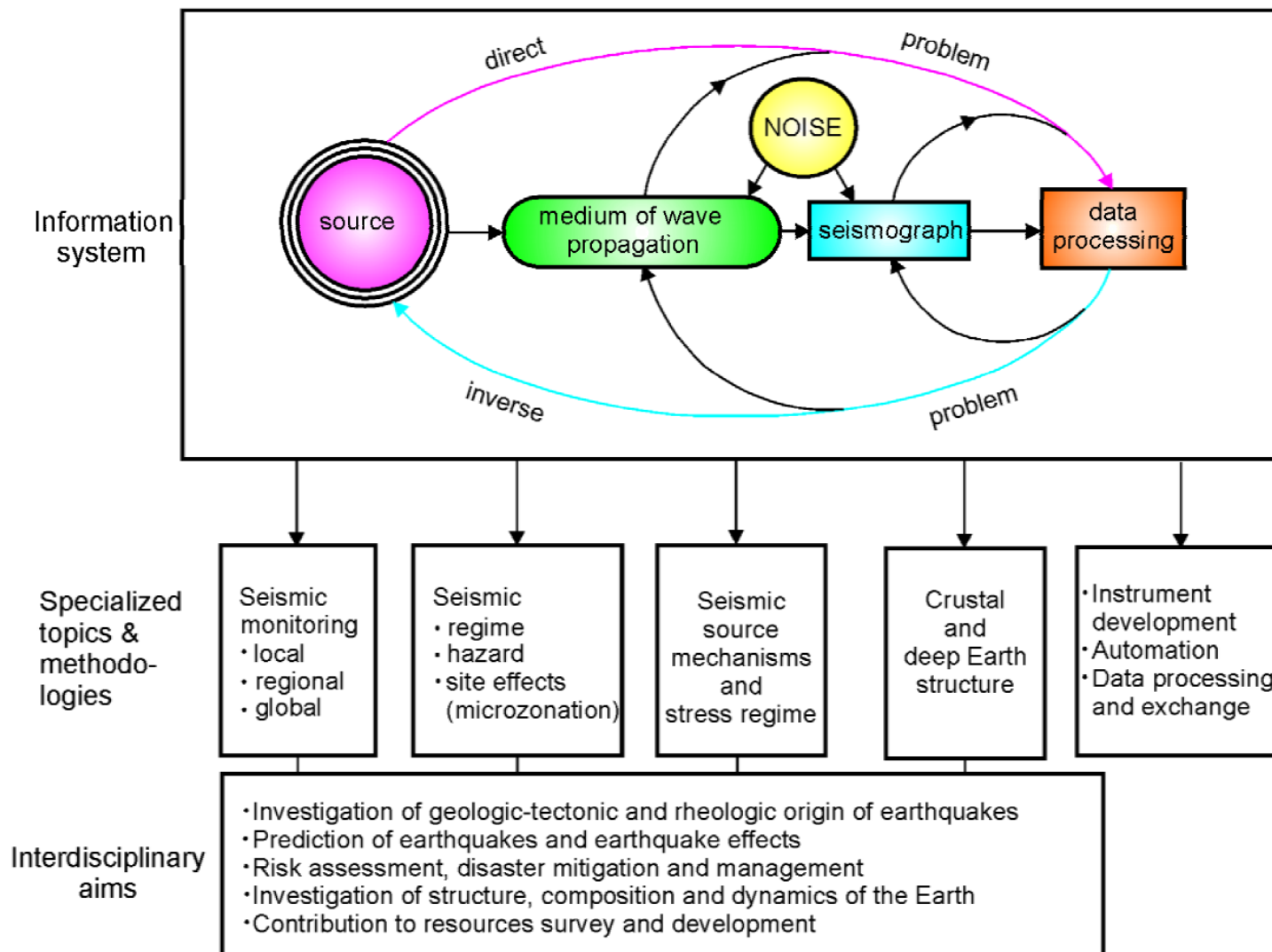


Diagramma che illustra la sismologia come analisi di un sistema informativo complesso collegato a una varietà di compiti specializzati e interdisciplinari di ricerca e applicazioni.

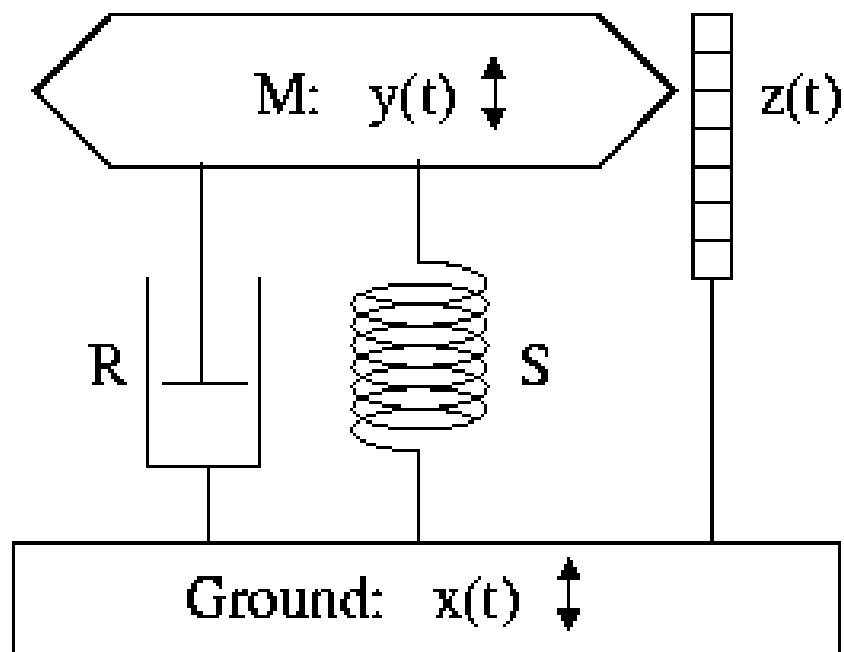
La sismometria è la disciplina tecnica che si occupa della rilevazione e misura del moto del terreno.

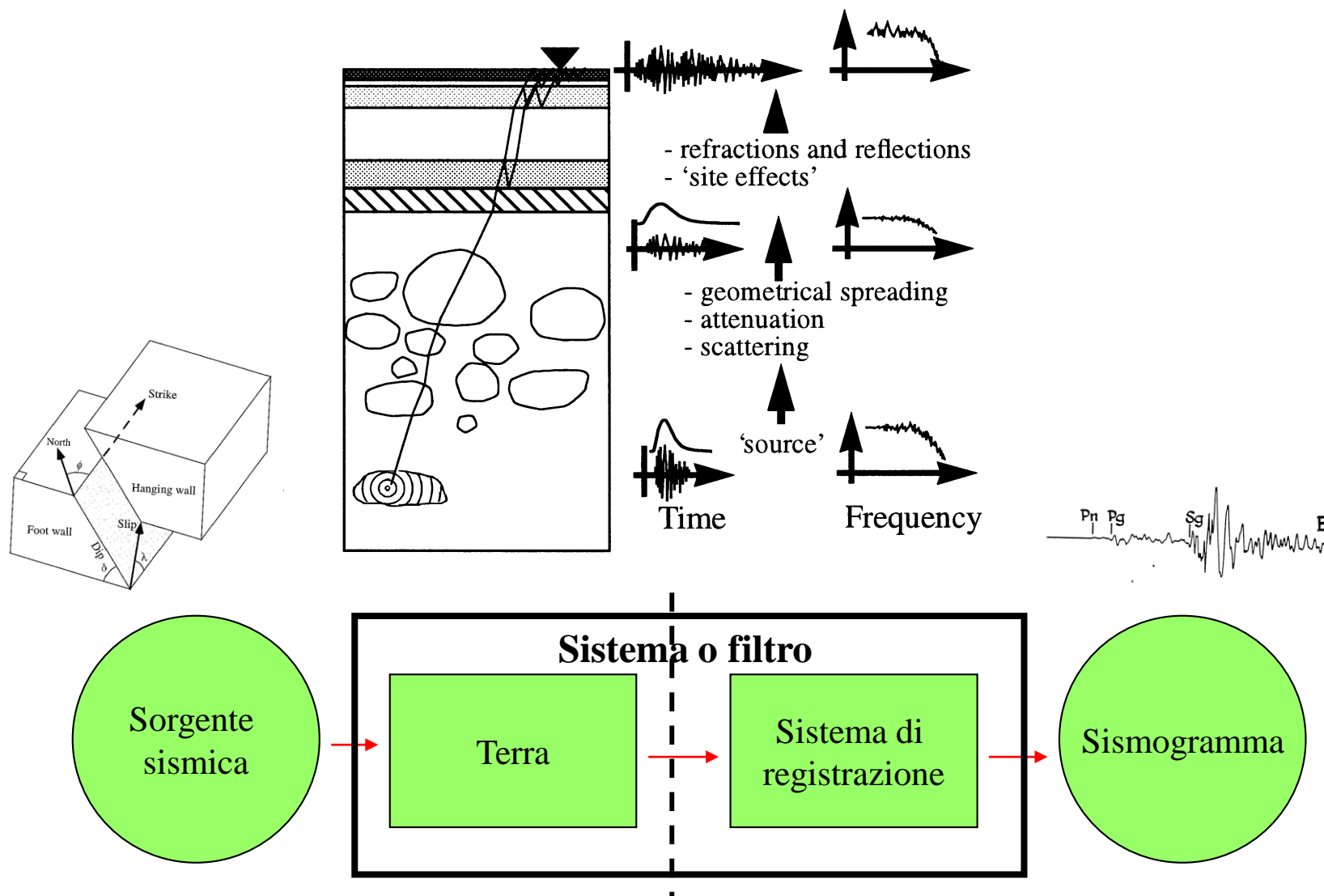
Comprende le caratteristiche dei sismografi, la loro calibrazione, la loro installazione e l'interpretazione quantitativa dei sismogrammi in termini di movimento del terreno.

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)

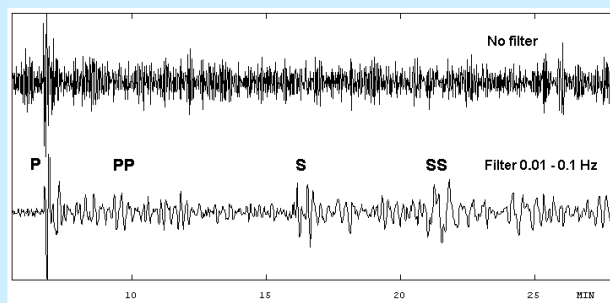
Diversi tipi di sismografi
L'evoluzione dei sismografi
Richiami di teoria
Come sono fatti i sismografi
Rappresentazione matematica della risposta strumentale
Processo di campionamento
Conversione analogico-digitale
Filtri digitali anti-alias
Sismografi a controreazione
Selezione dei siti
Installazione
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

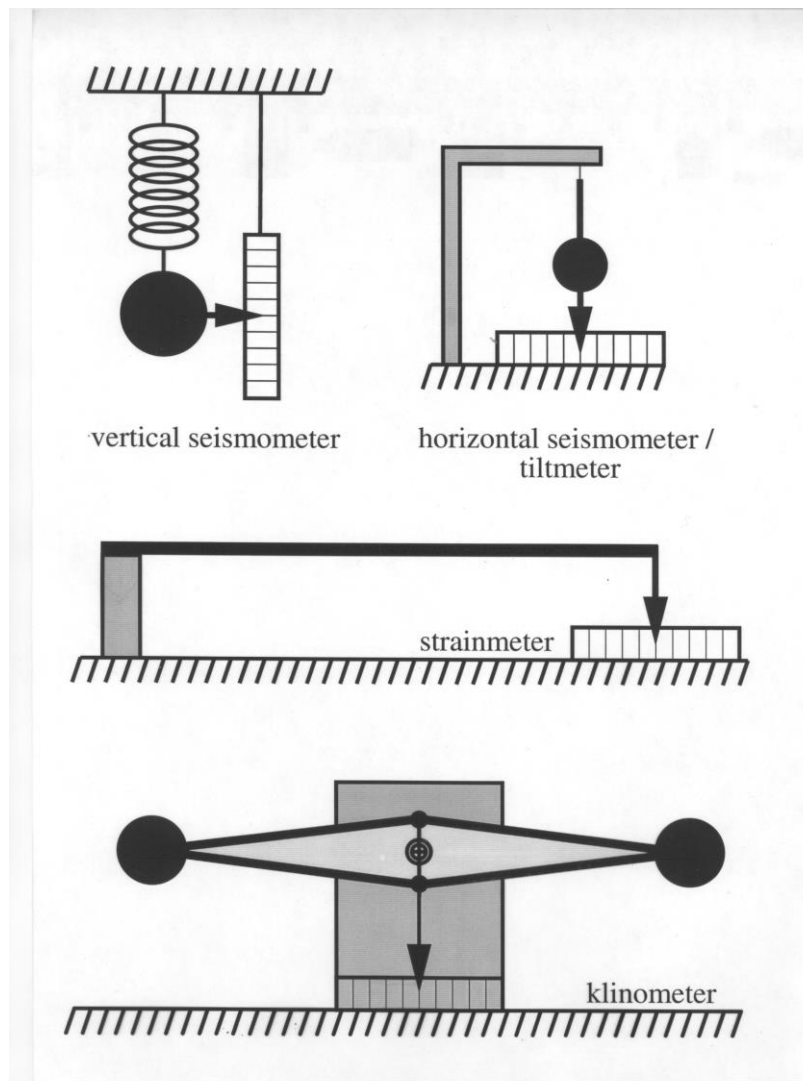
Registrazioni sismologiche di alta qualità

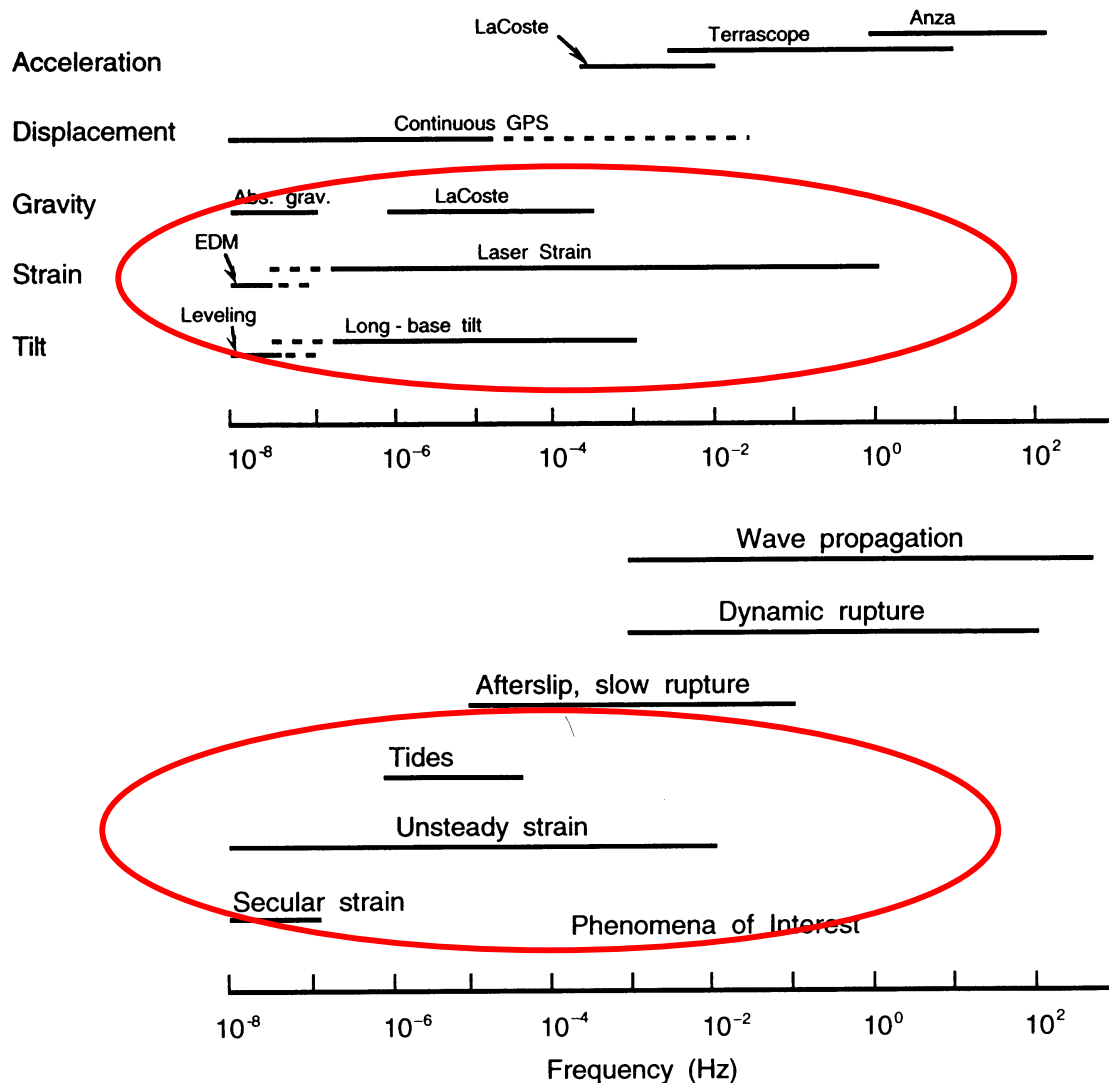
- 1) **Alta “percezione”** (capacità dell’installazione di registrare quanti più eventi possibile).
- 2) **Completezza del data set** (registrazioni continue e stabili nello spazio e nel tempo)
- 3) **Alta fedeltà** delle registrazioni al movimento del terreno.
- 4) **Rappresentatività** dei dati rispetto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

2 tipi di sensori sismici:

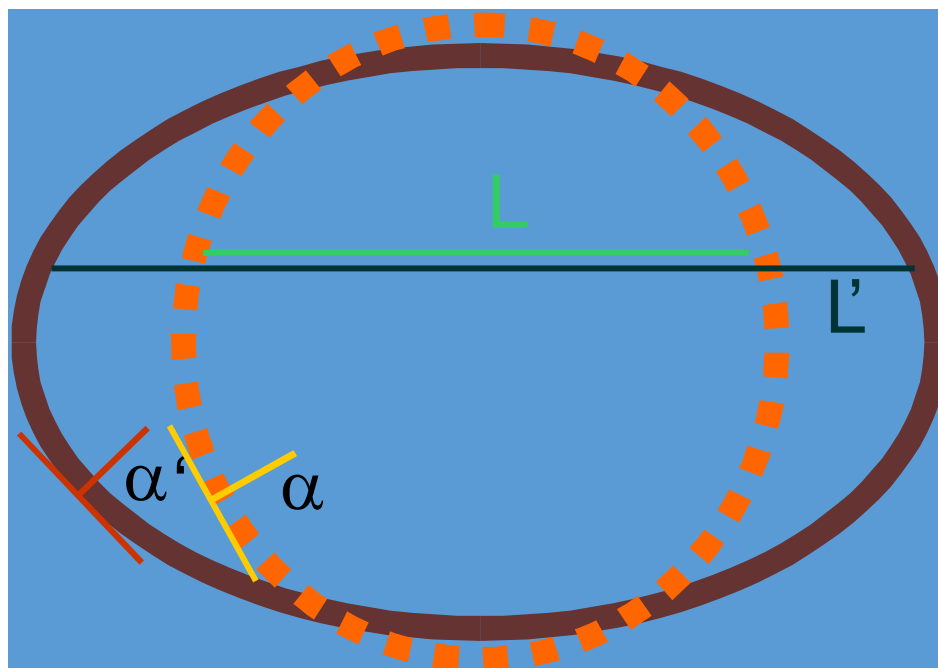
Estensimetri e clinometri. Misurano il moto relativo di un punto rispetto ad un secondo punto

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

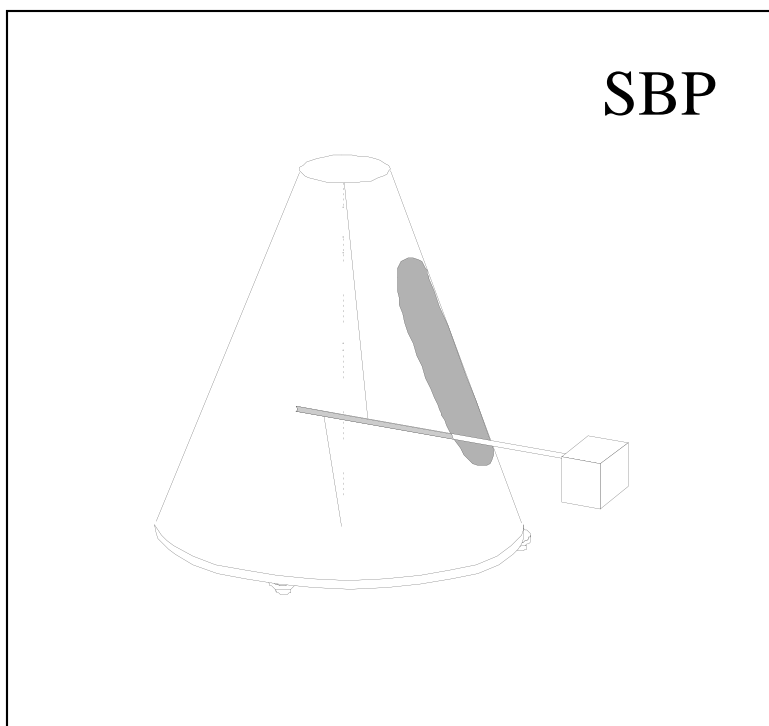




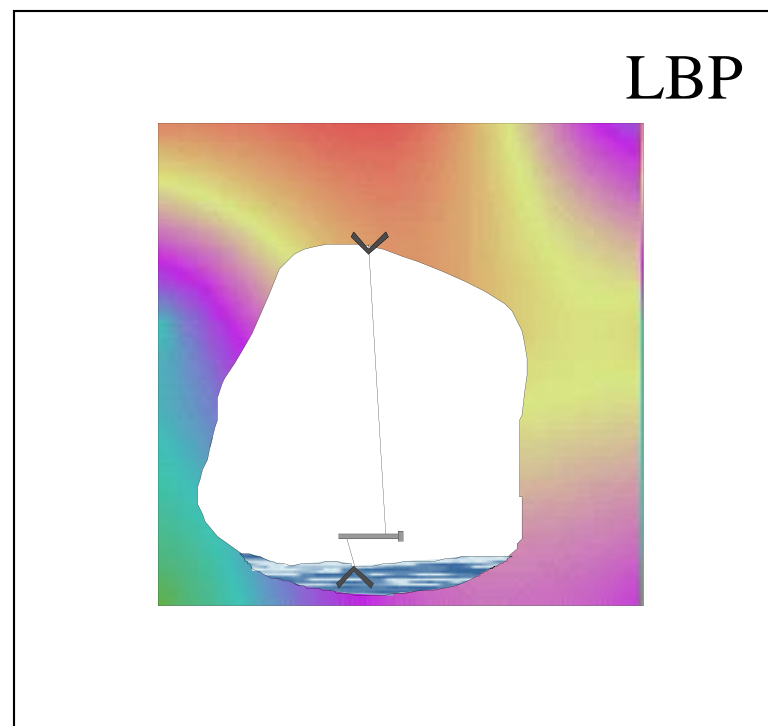
Estensimetri e clinometri



Clinometri

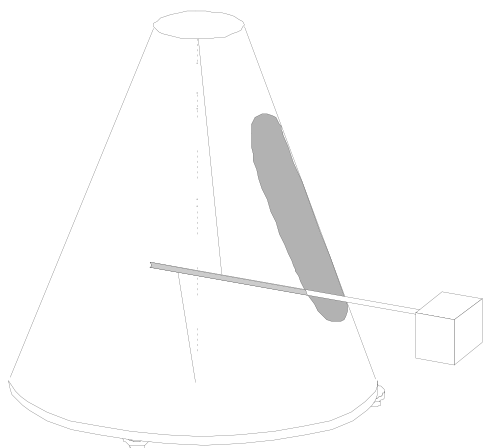


Pendoli Grotta Gigante

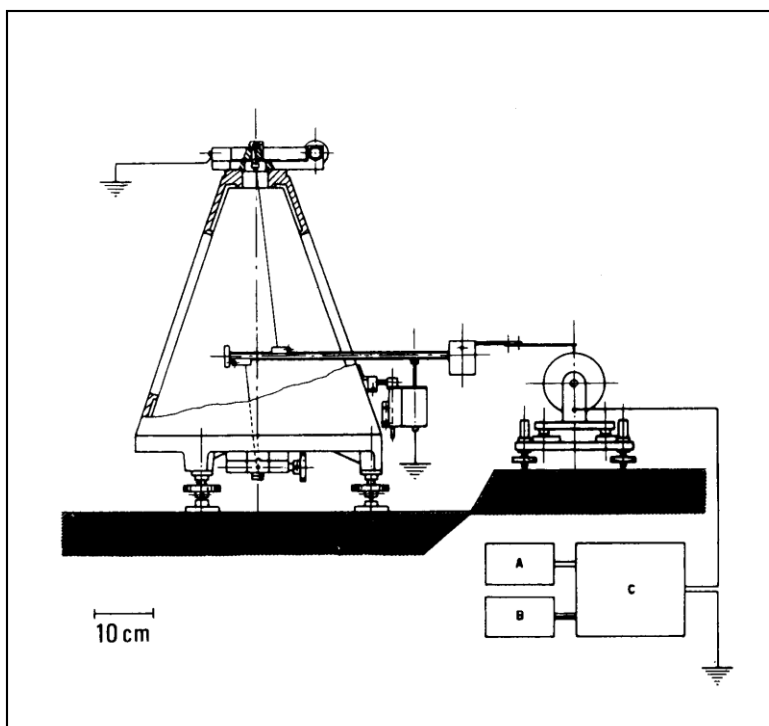


Clinometri

SBP



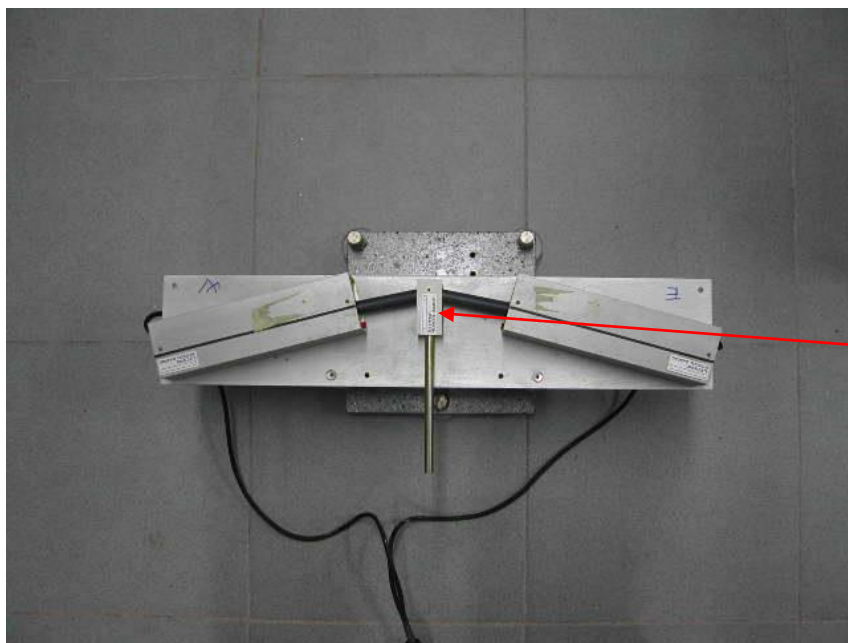
Clinometri



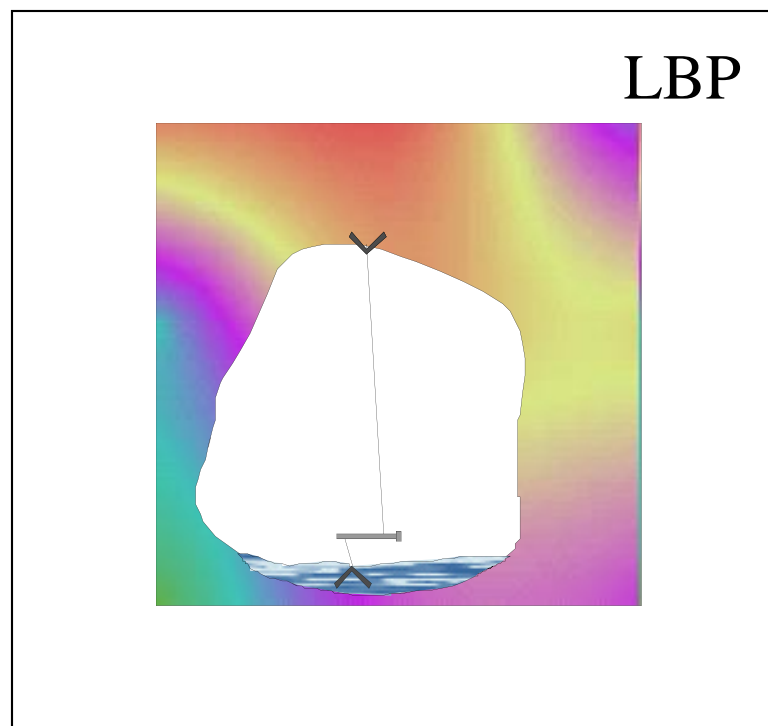
Clinometri



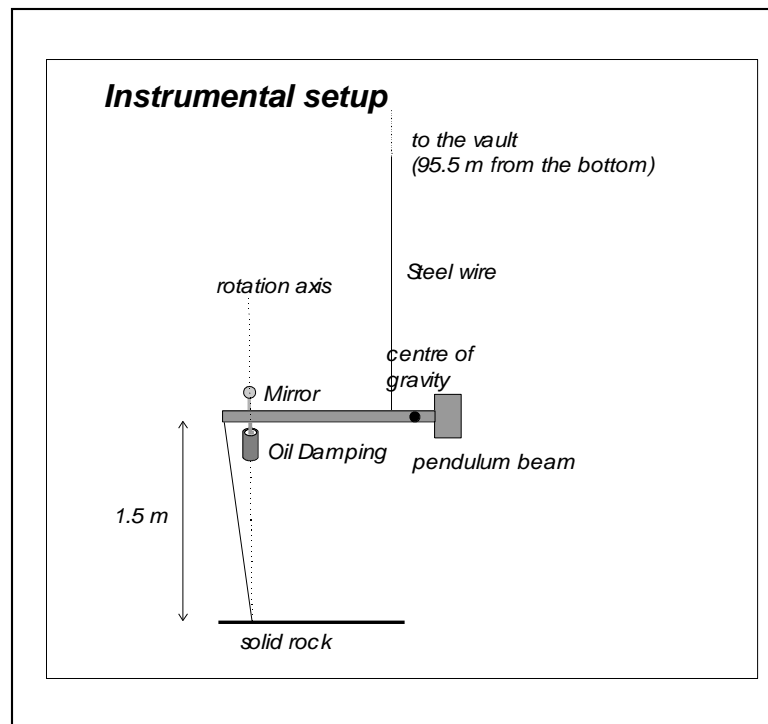
Clinometri



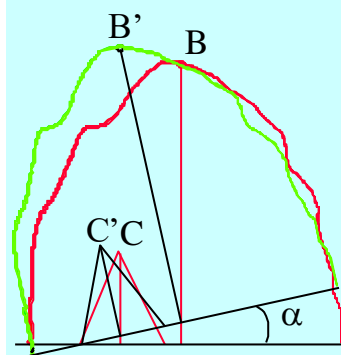
Pendoli di Grotta Gigante



Pendoli di Grotta Gigante

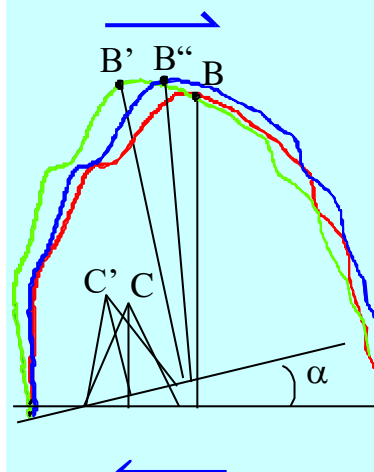


Rotation

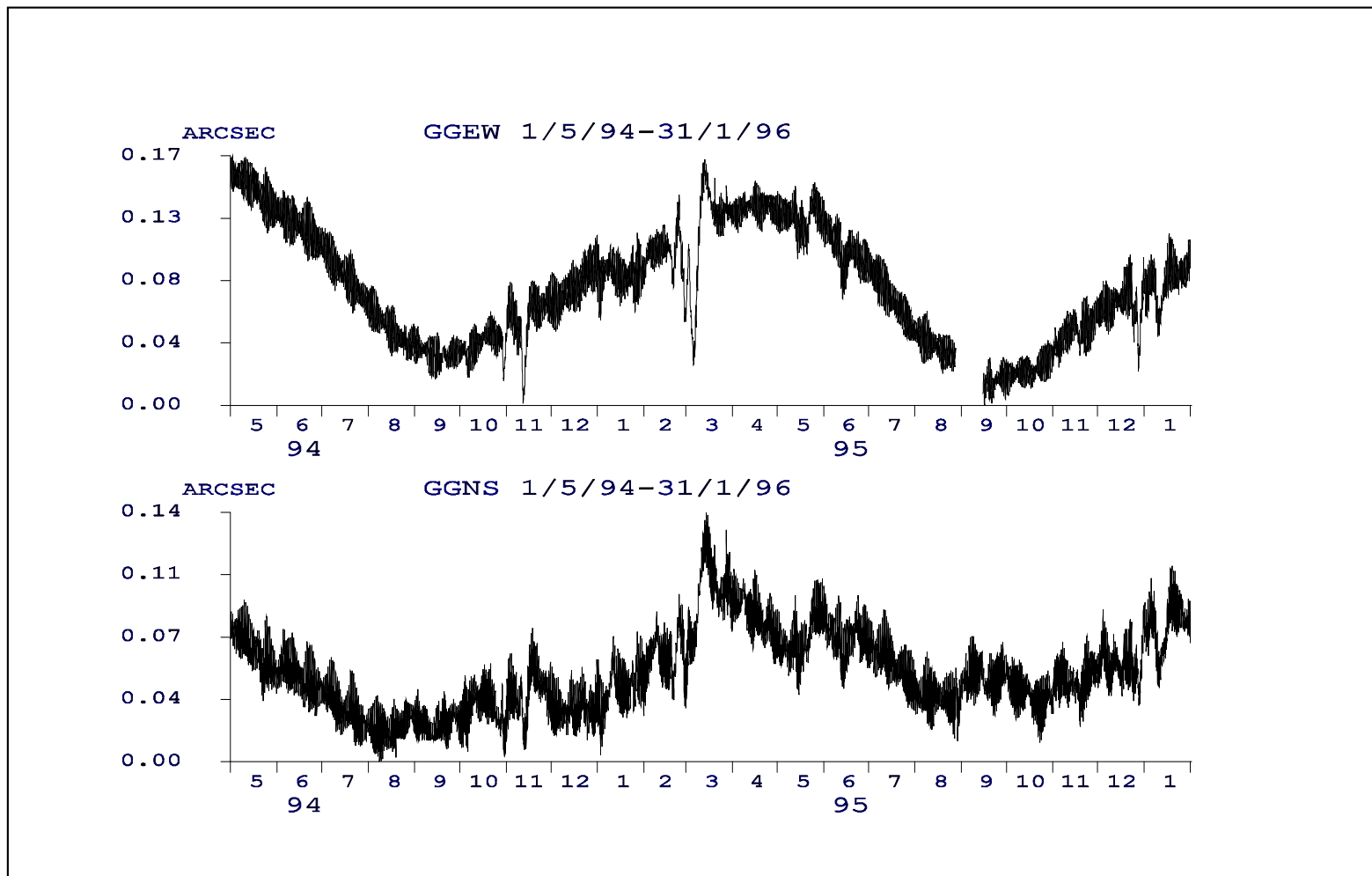


B, C **initial positions**
B', C' **after rotation**

Rotation and shear



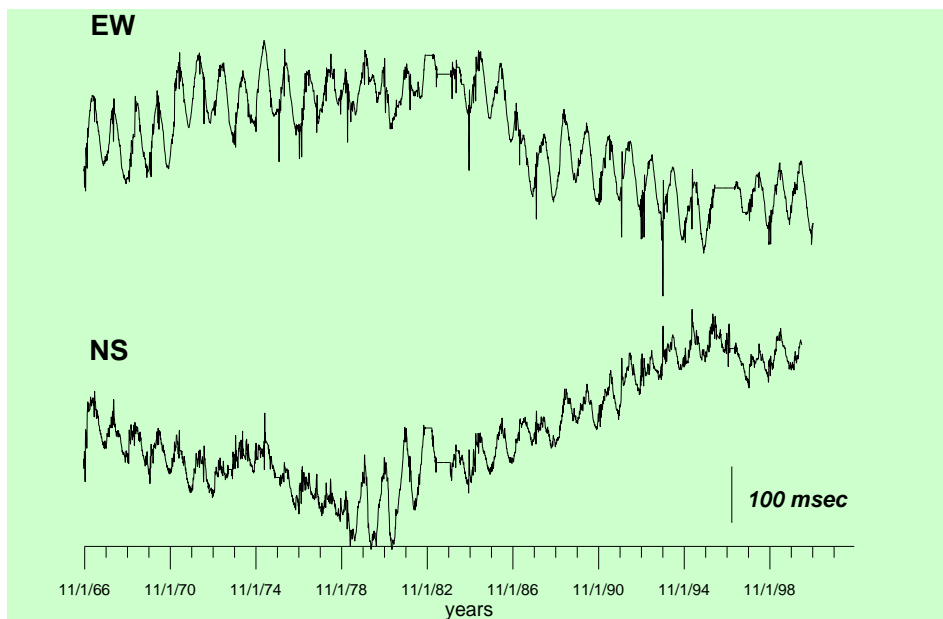
B, C **initial positions**
B', C' **after rotation**
B'' **after shear**



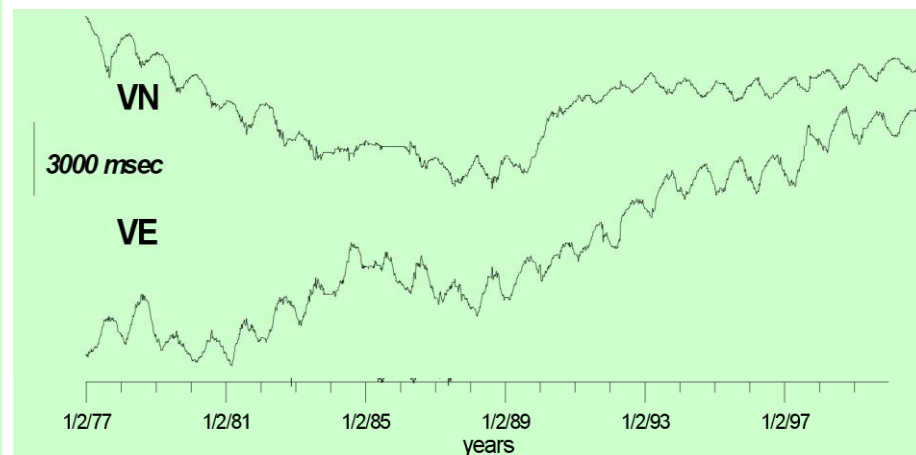
Esempio di registrazioni LBP.

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



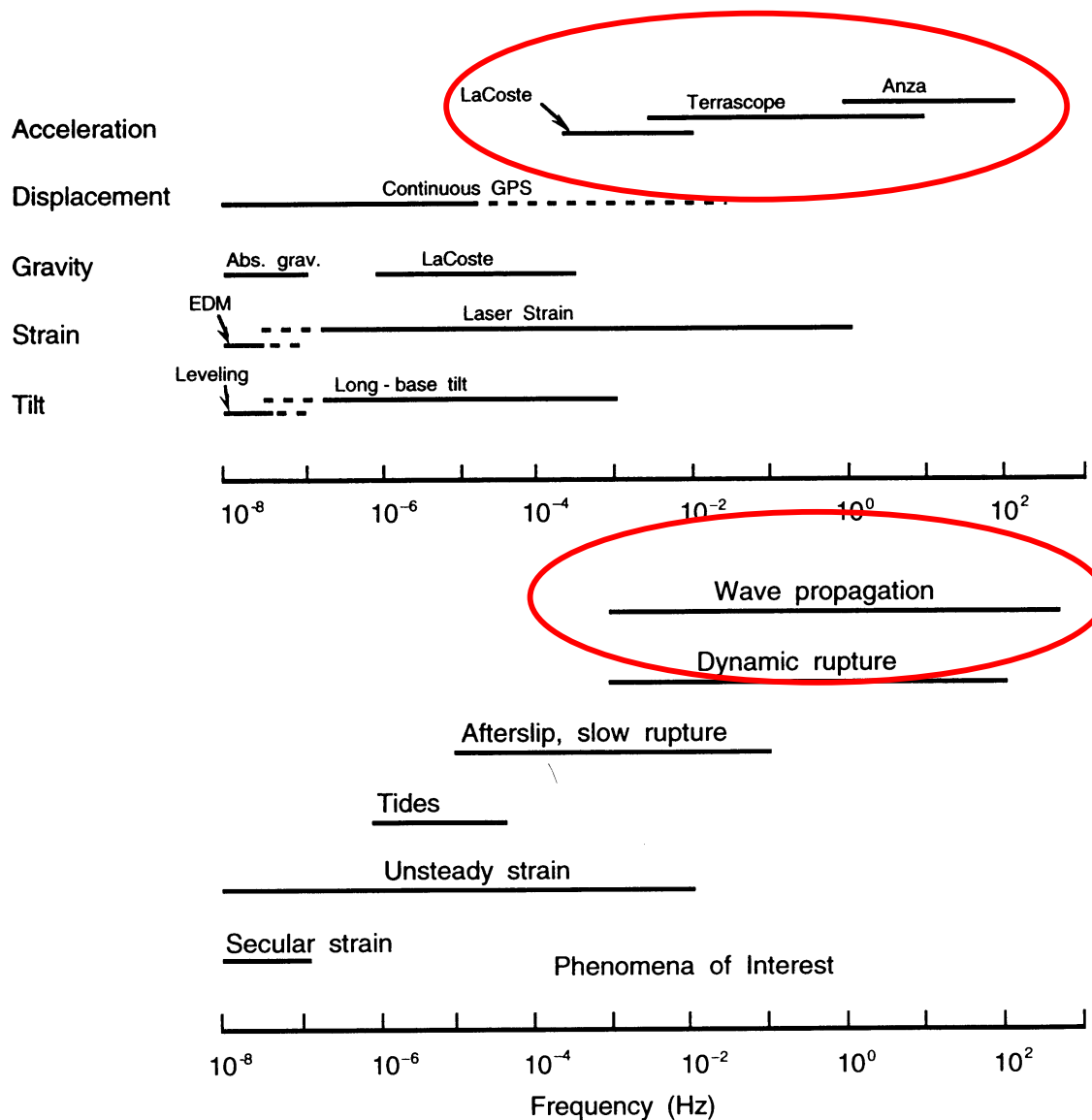
SBP – Grotta di Villanova

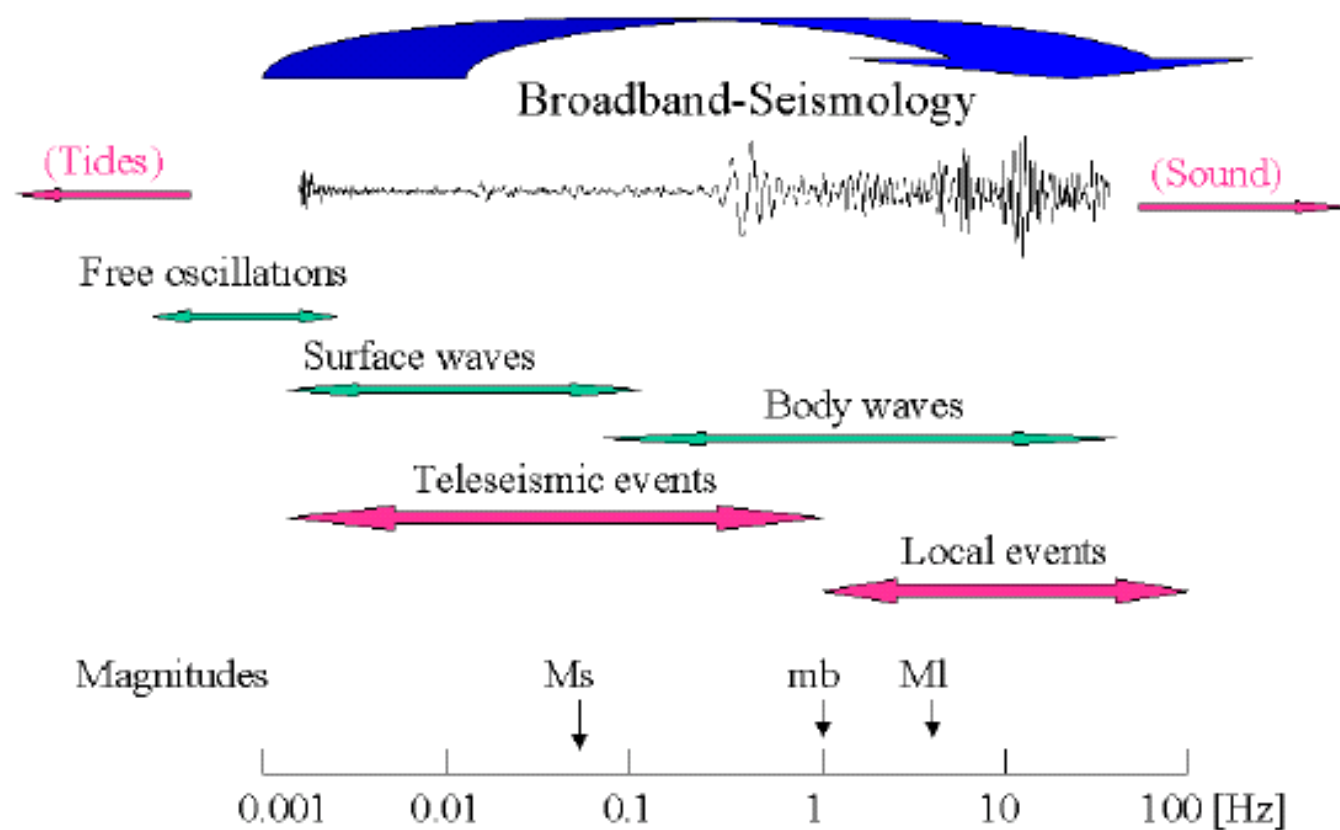


di sensori sismici:

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

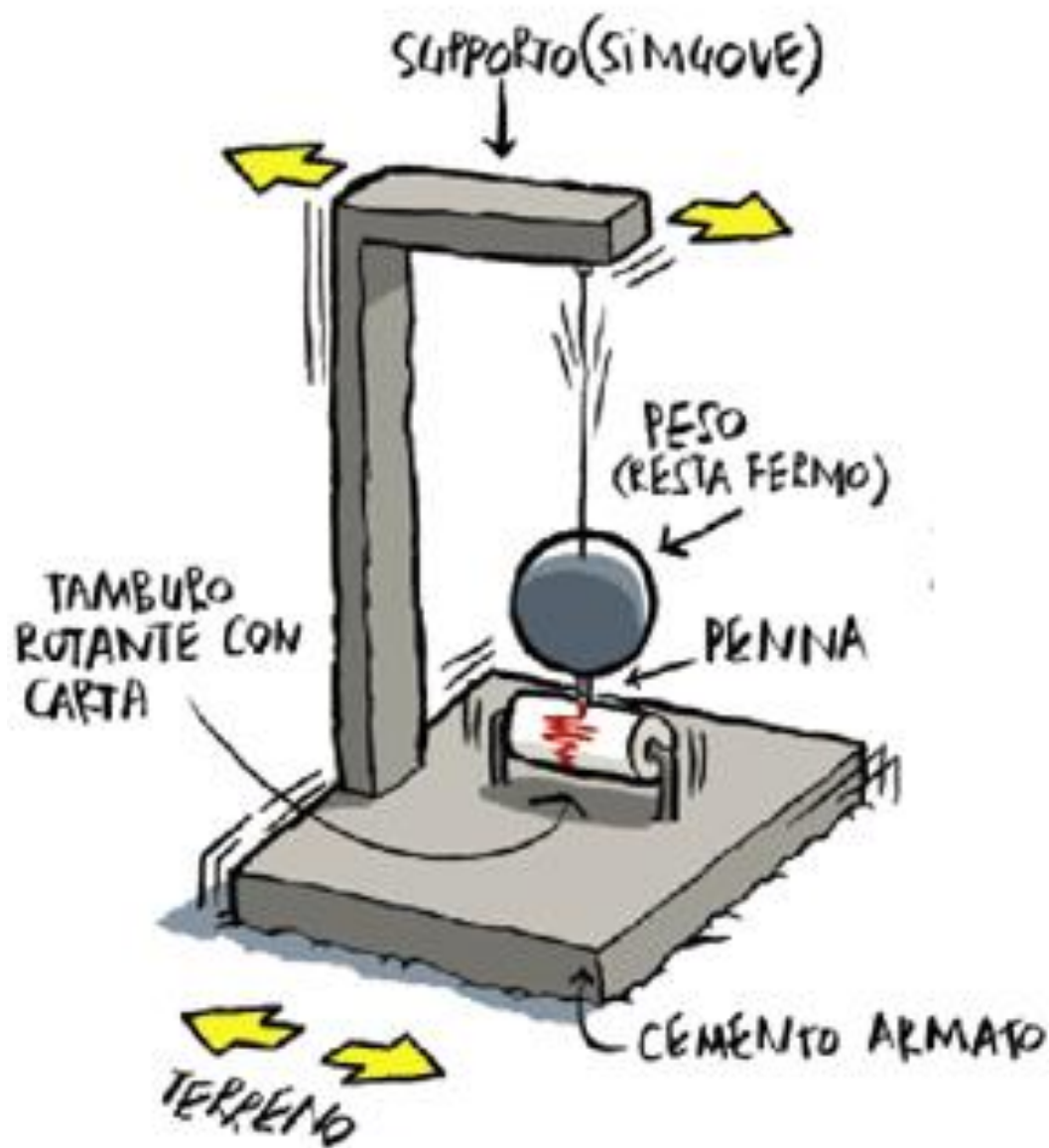


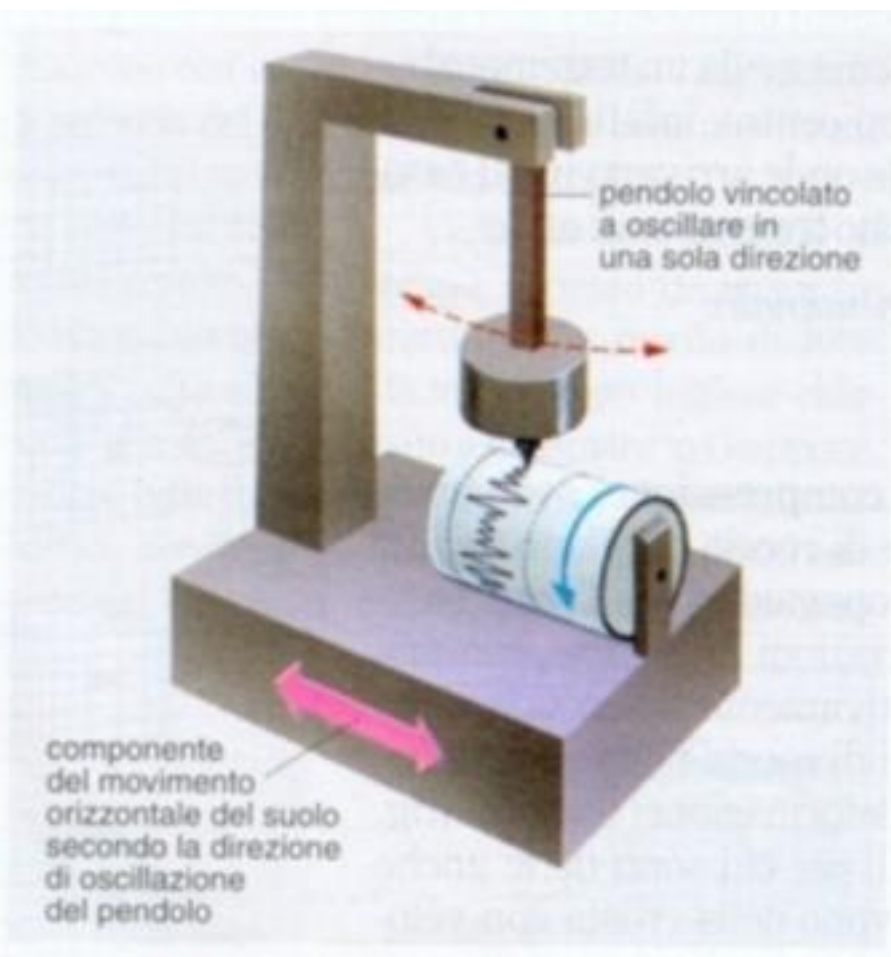
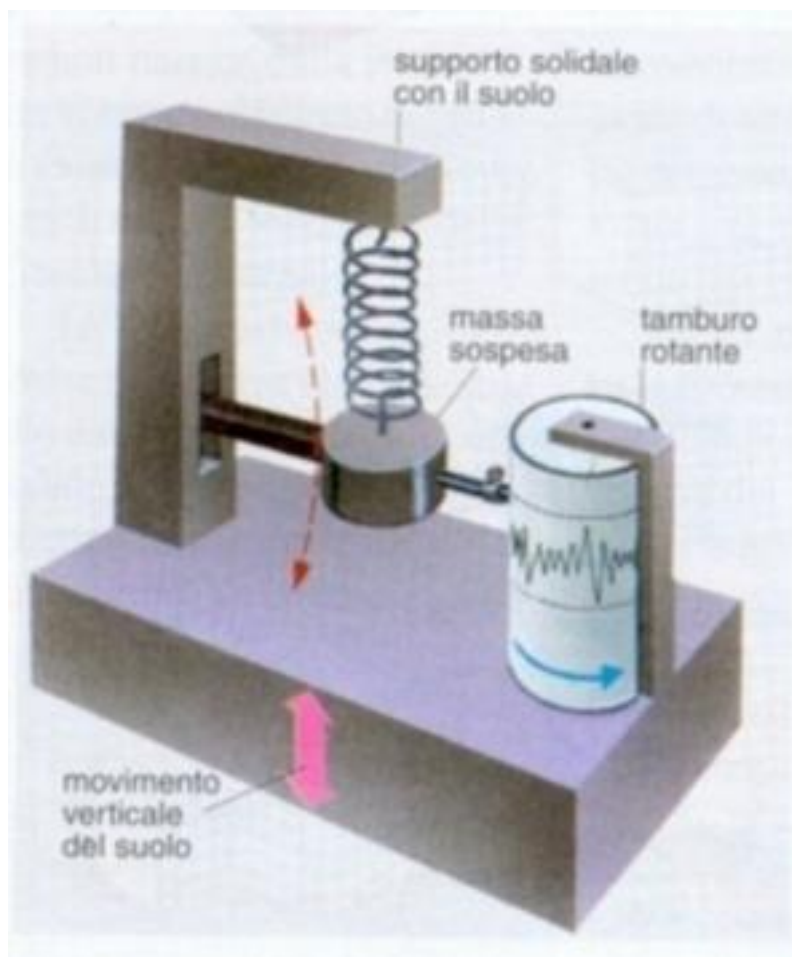


Per misurare lo spostamento del terreno su cui lo strumento poggia si utilizza il

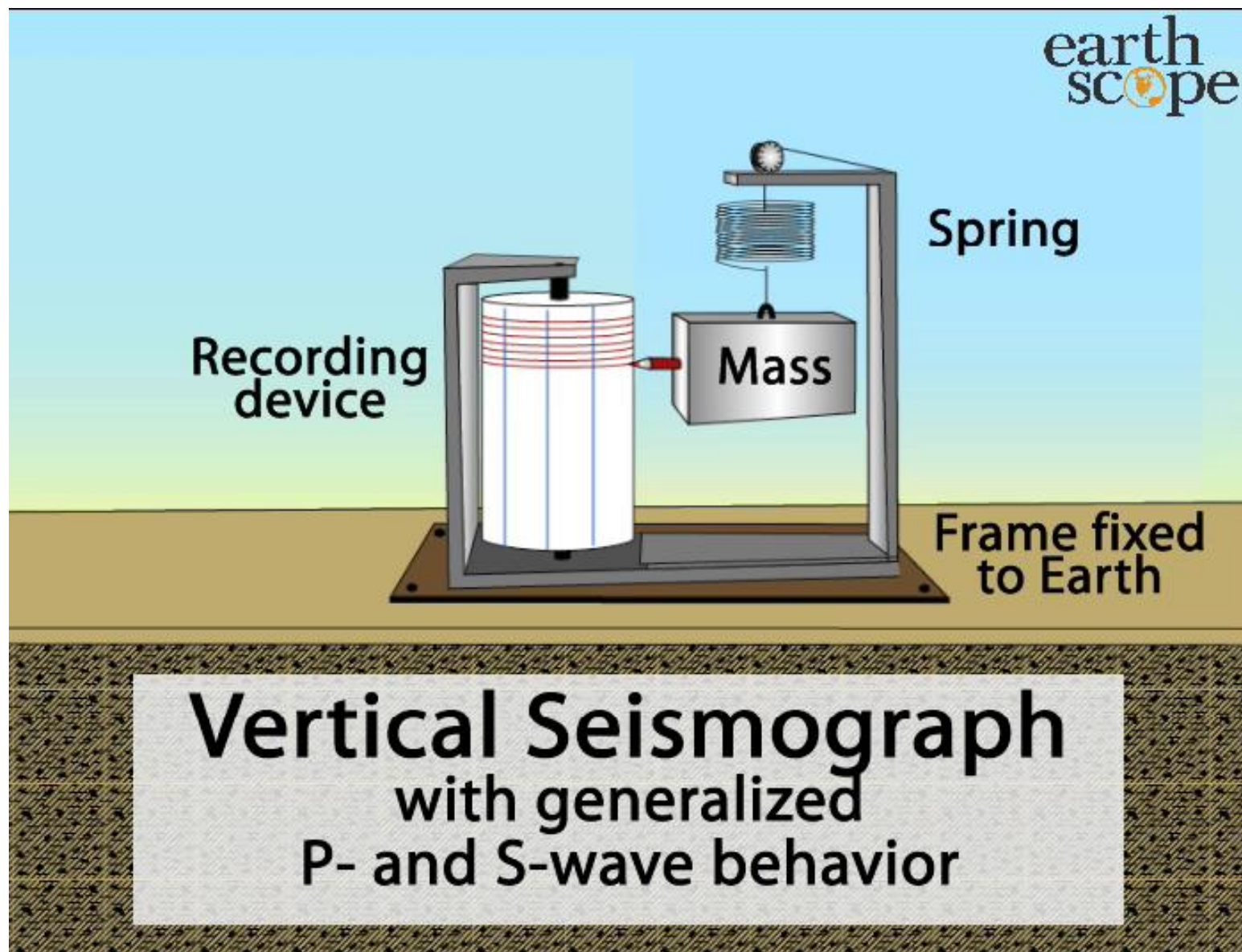
principio d'inerzia:

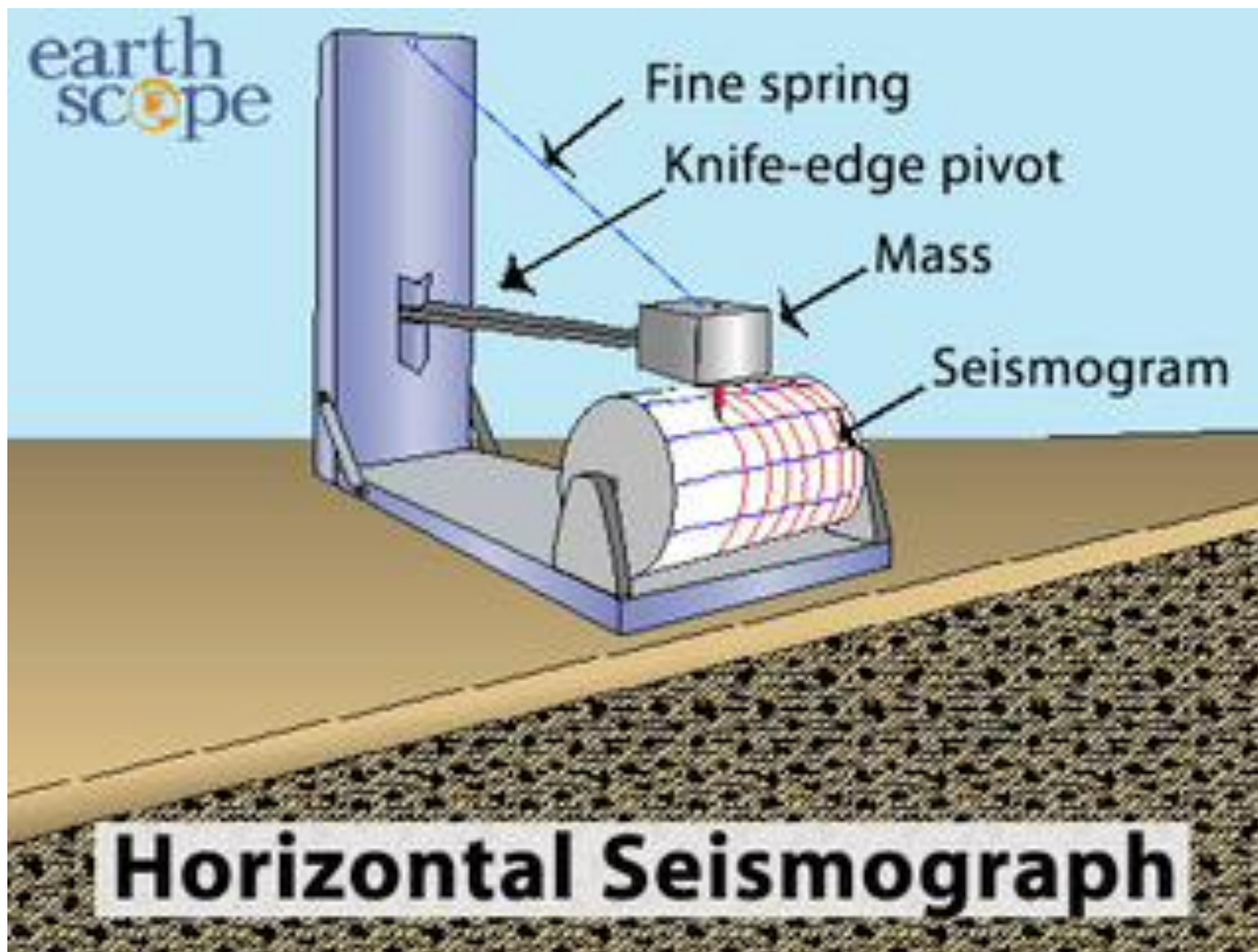
per un moto del terreno sufficientemente rapido una massa sospesa rimarrà immobile e ci darà un punto di riferimento su cui misurare il moto del suolo.

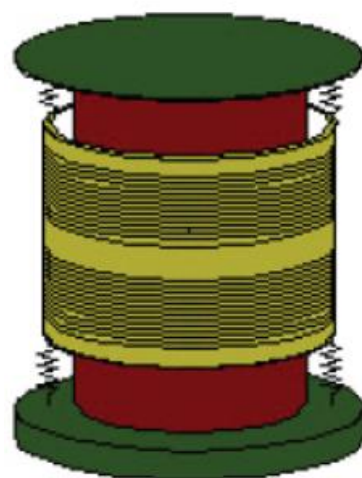
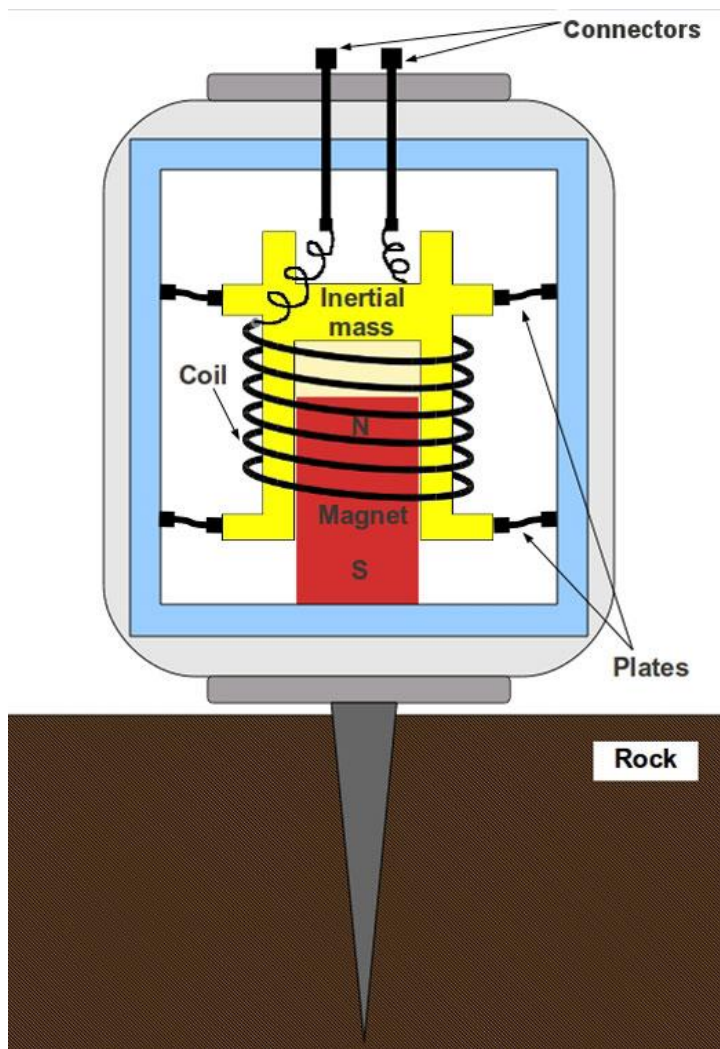




earth
scope



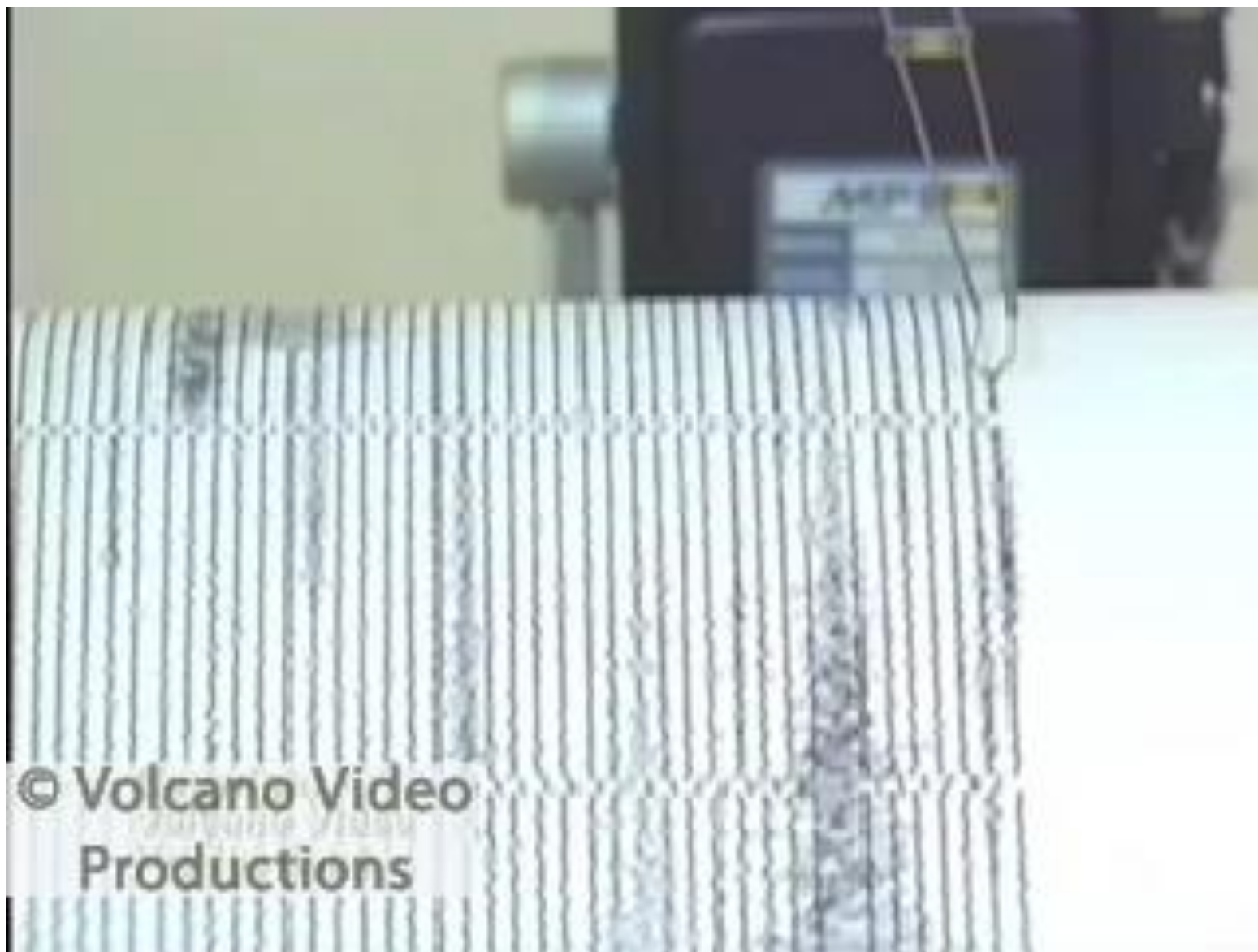




$y(t)$, coil displacement



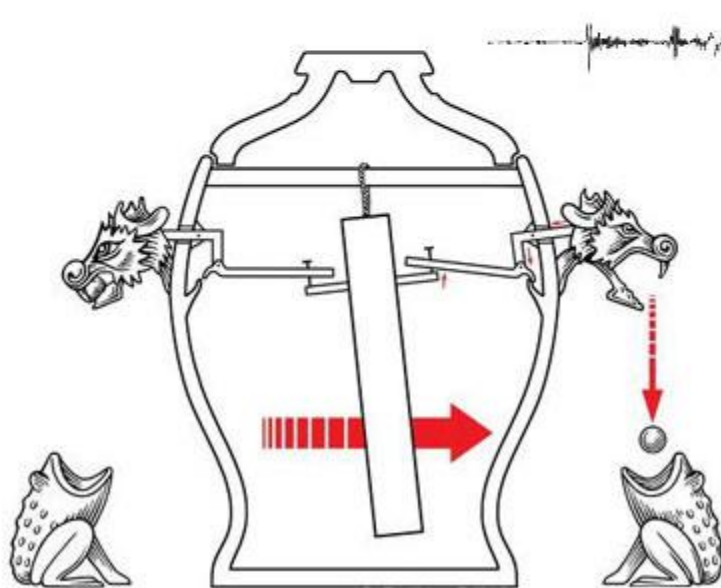
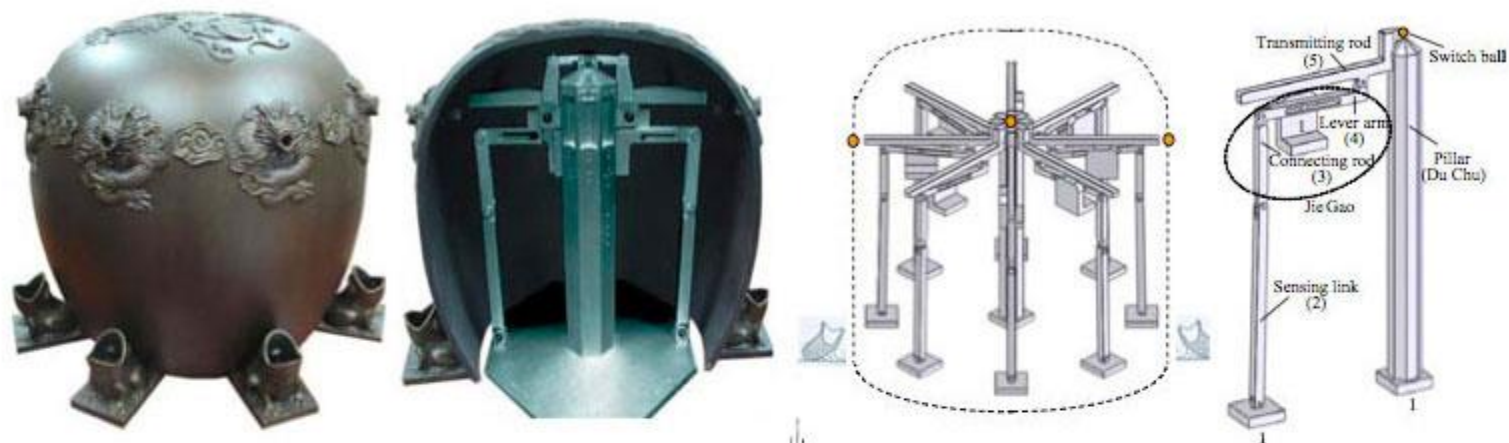
$x(t)$, base displacement



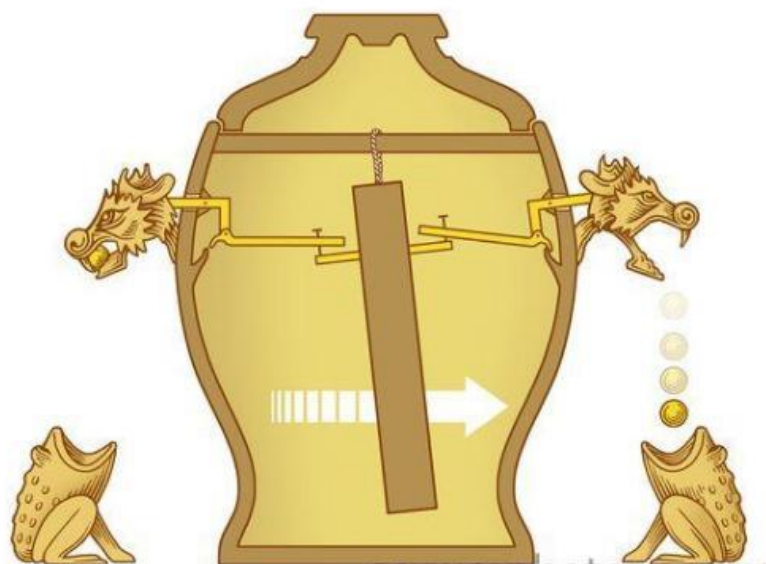
Chang Heng 132 a.c



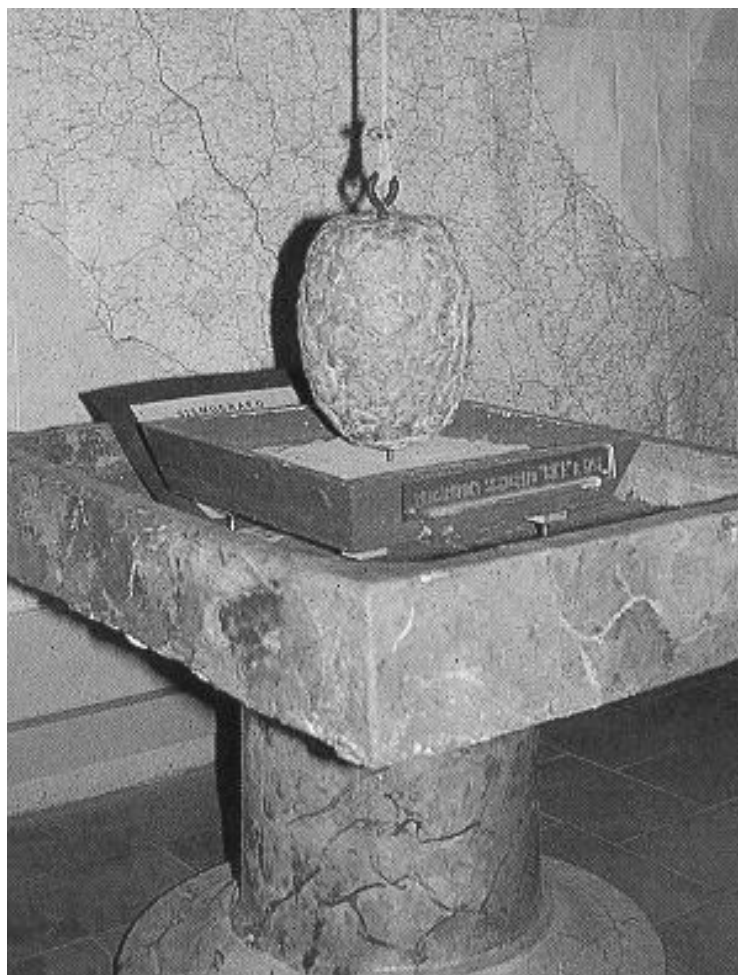
Chang Heng 132 a.c



Chang Heng 132 a.c



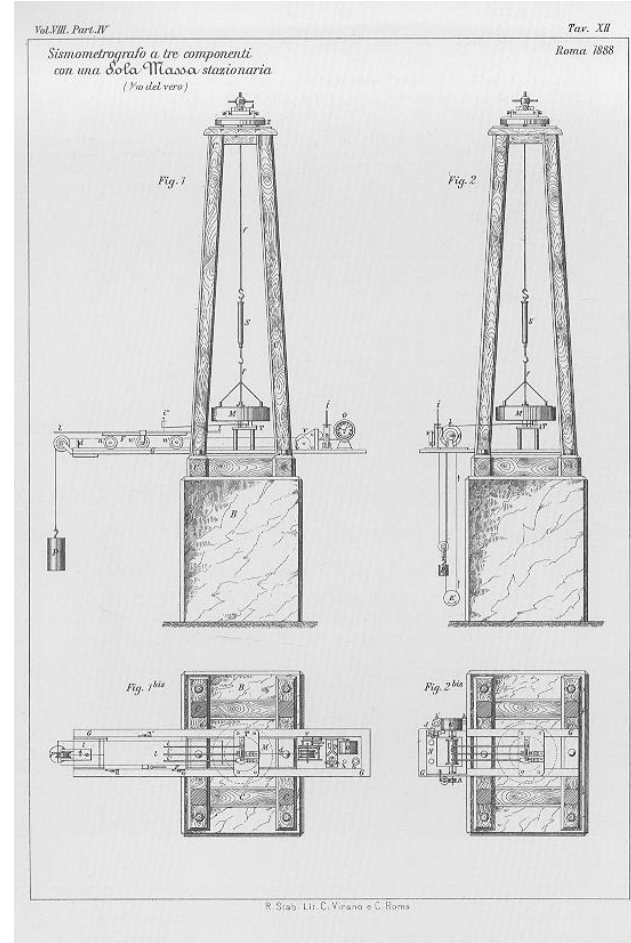
Bina 1751



Cacciatore 1818



Brassart 1888



Palmieri 1807

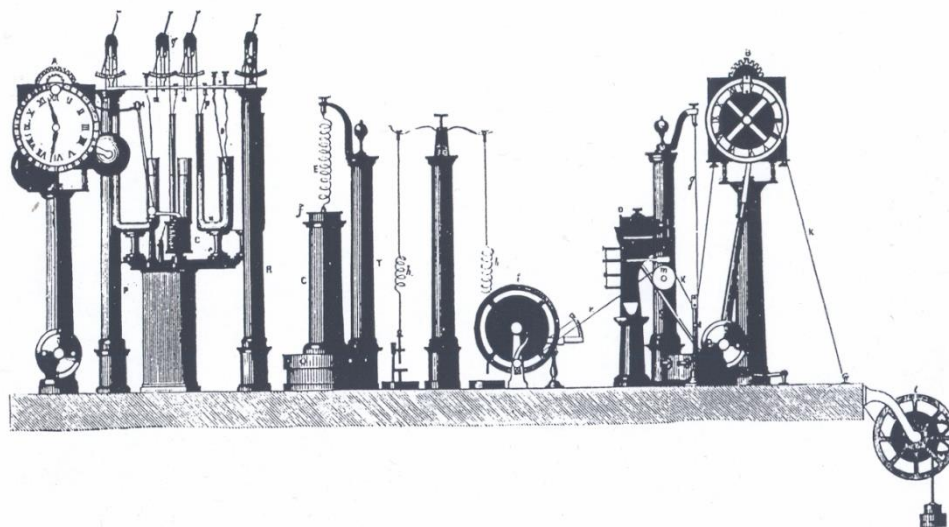
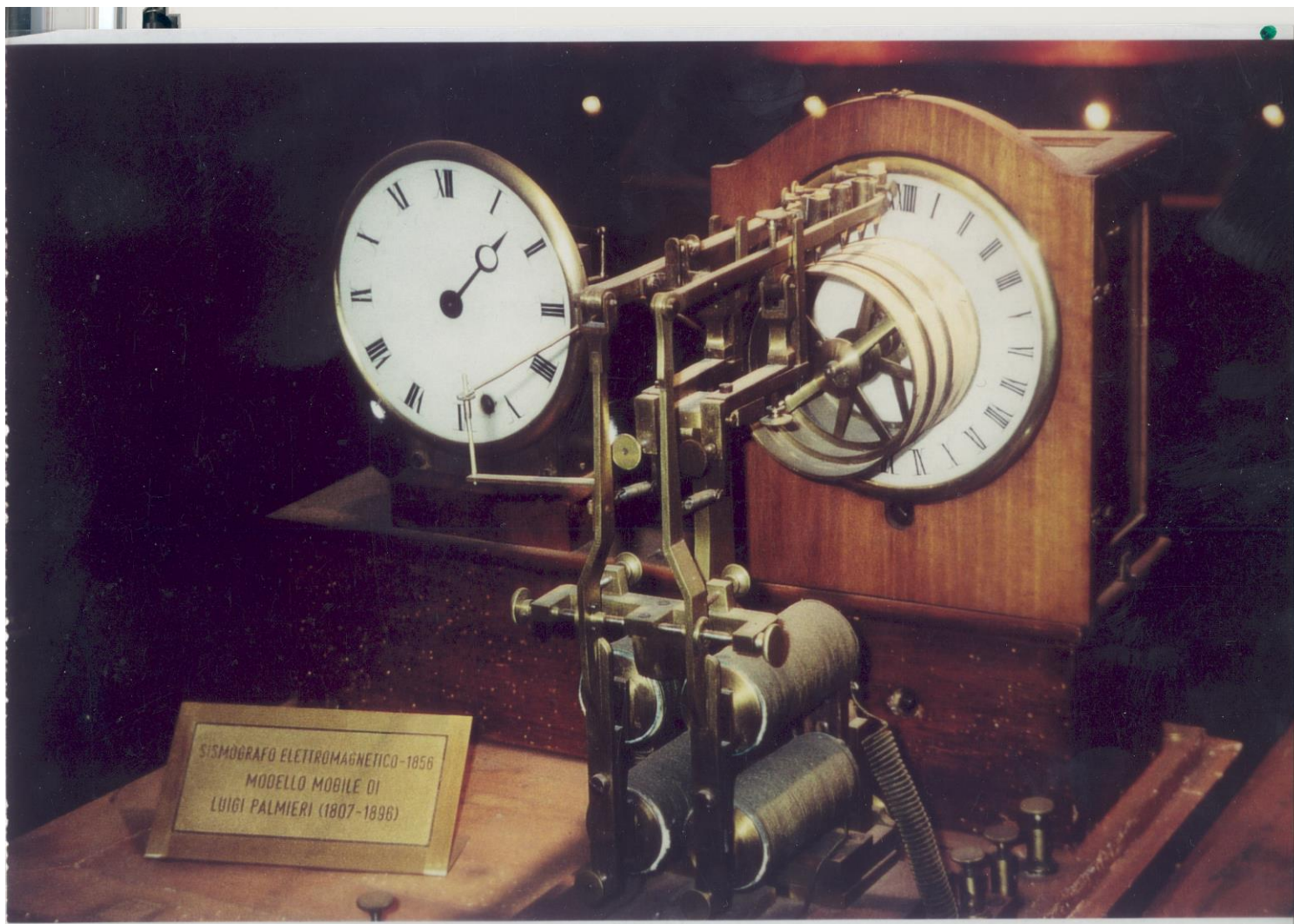
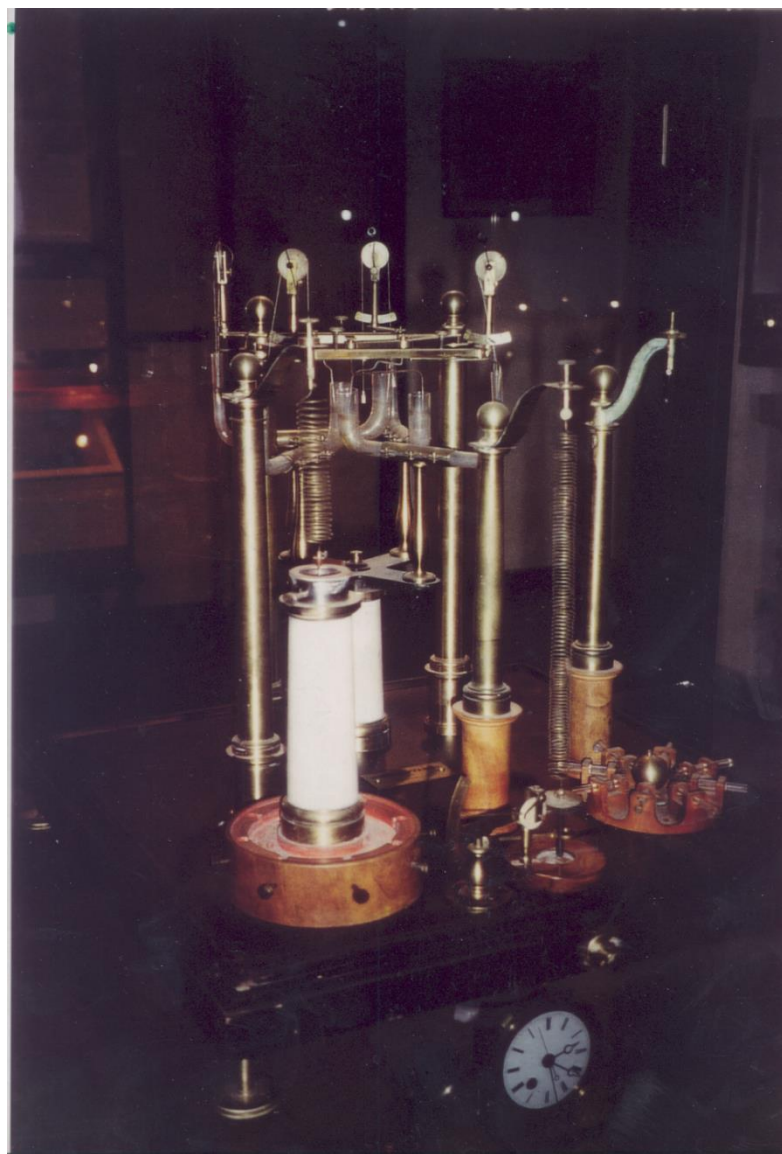


FIG. 4. Palmieri's "sismografo elettro-magnetico" (reproduced from *The Engineer*, 33, 1877, p. 407). Vertical motion is detected by a mass on a spiral spring *E*. The U-tubes *n* detect horizontal motion. Paper is unrolled from the drum *i* and a pencil mark put on the paper at *m*. The speed of the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

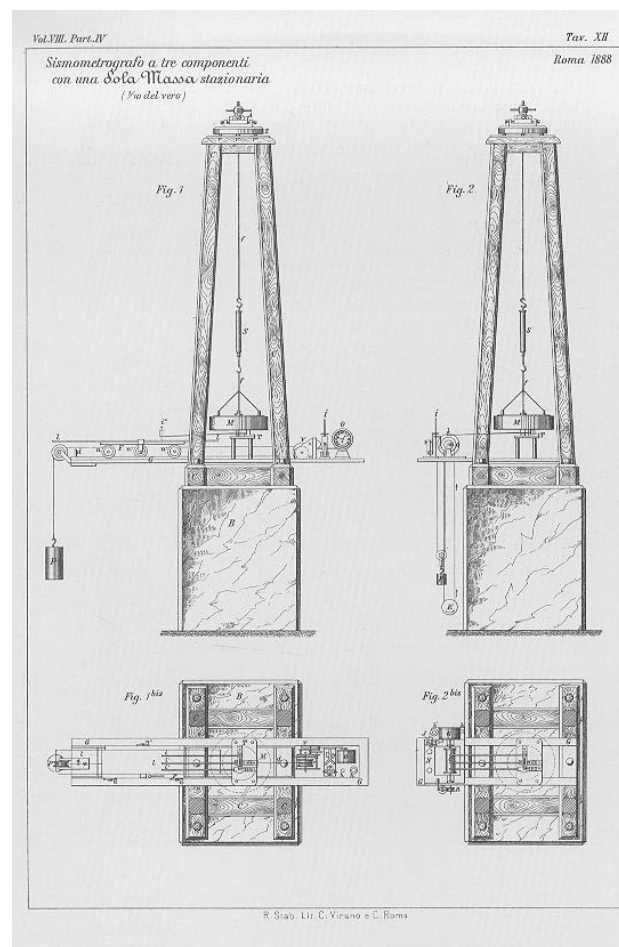
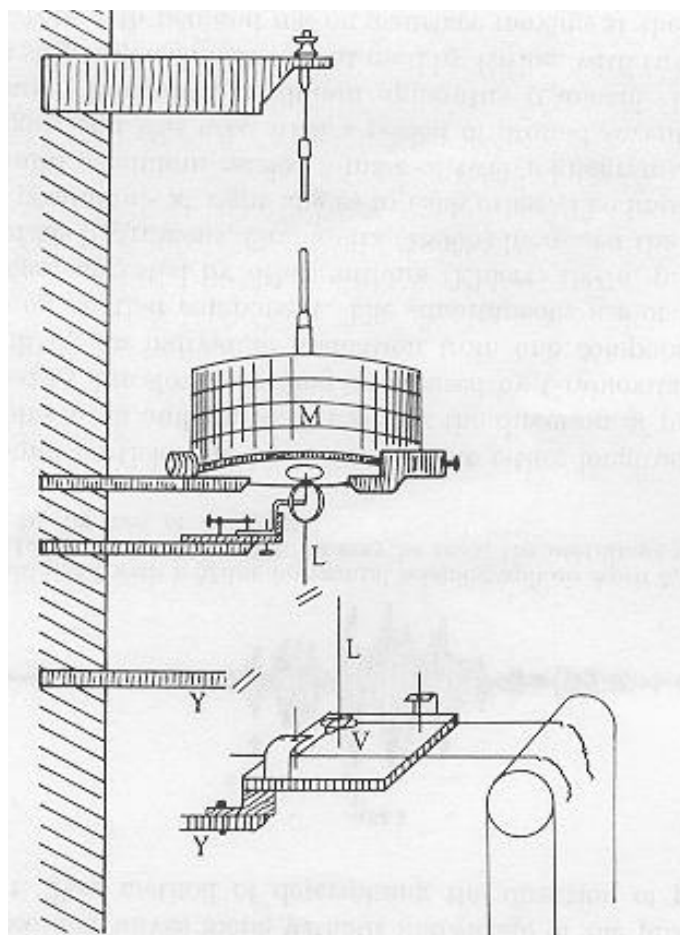
Palmieri 1807



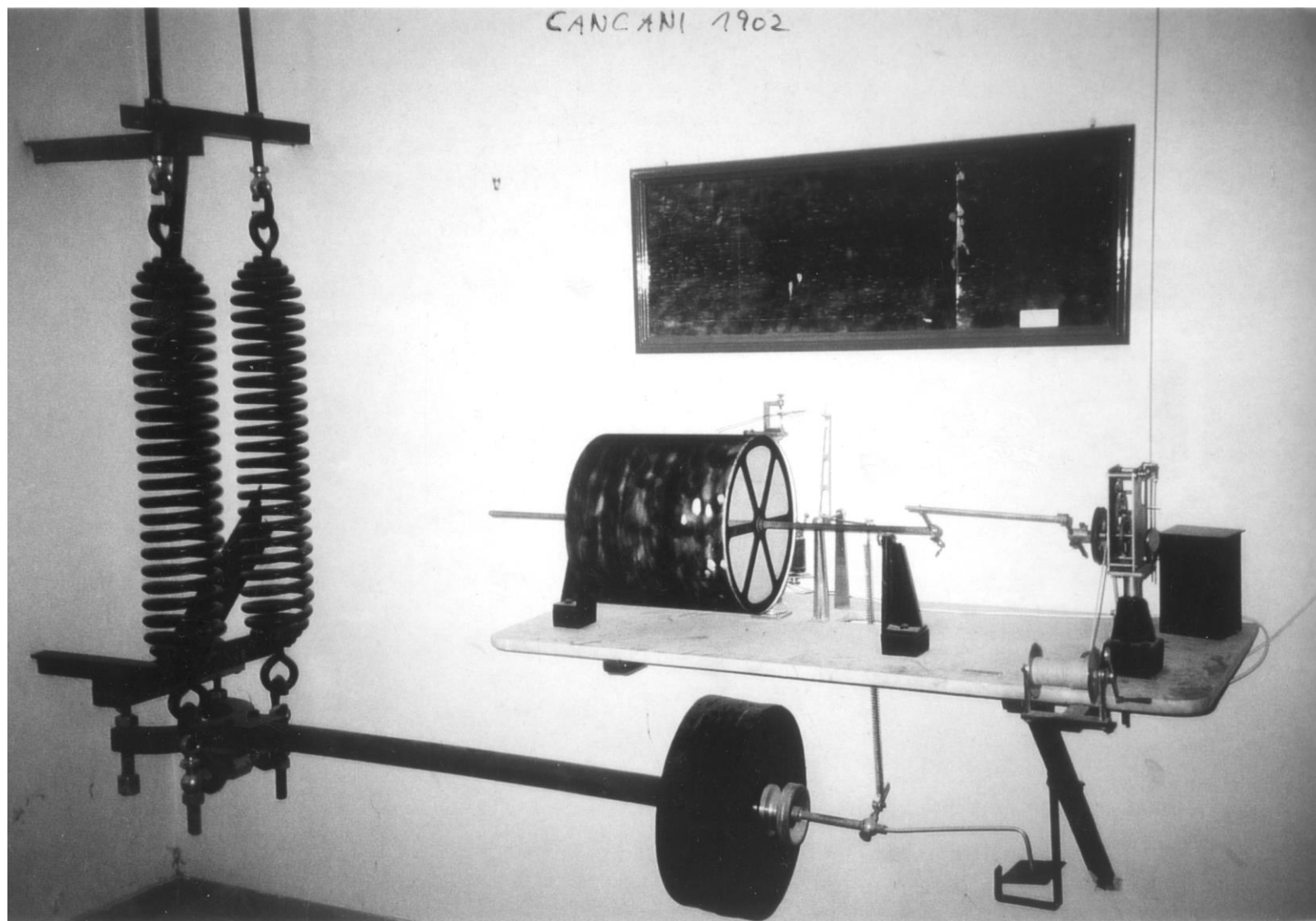
Palmieri 1807



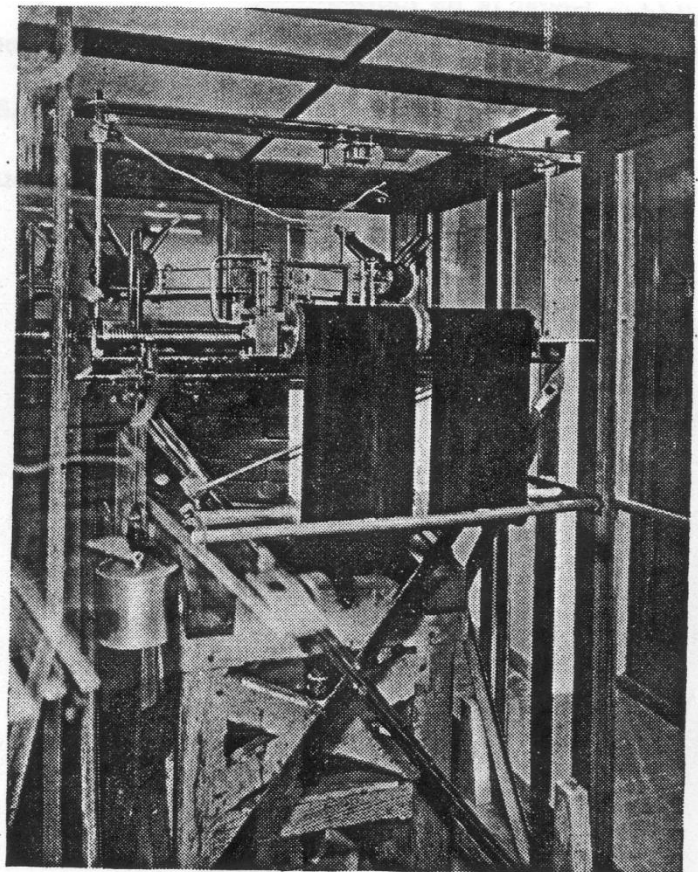
Brassart 1888



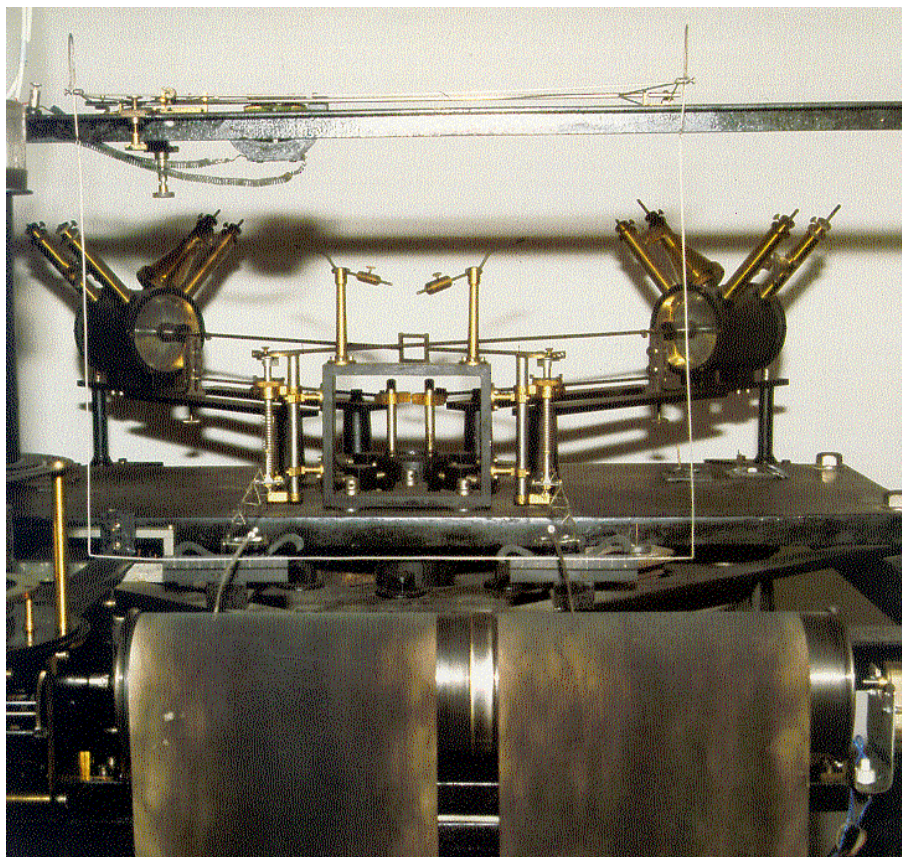
Cancani 1902



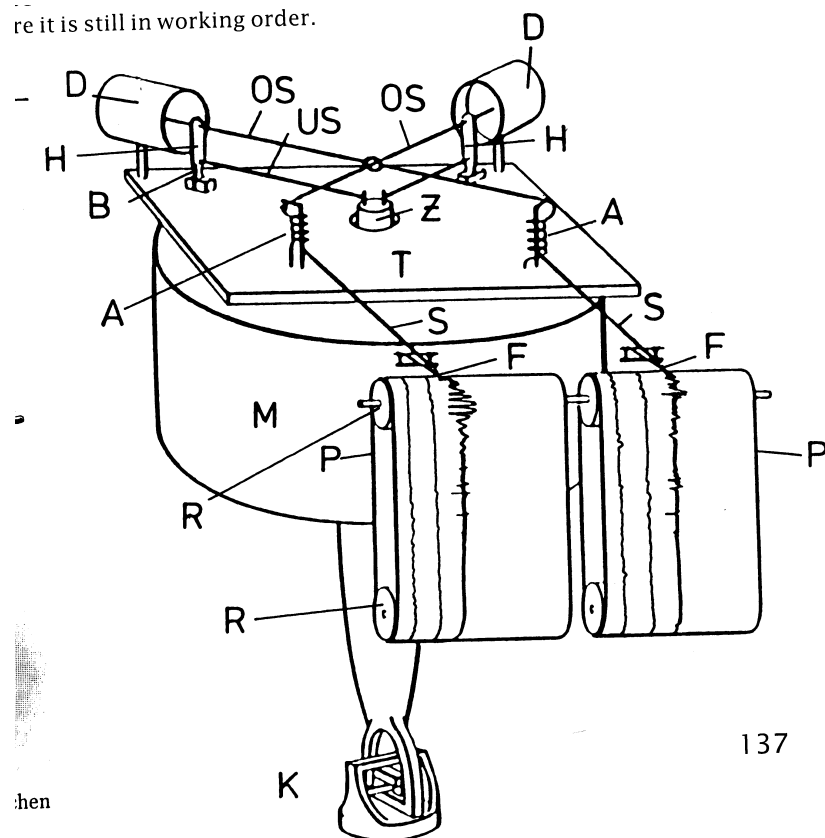
Wiechert 1903



Wiechert 1903



re it is still in working order.

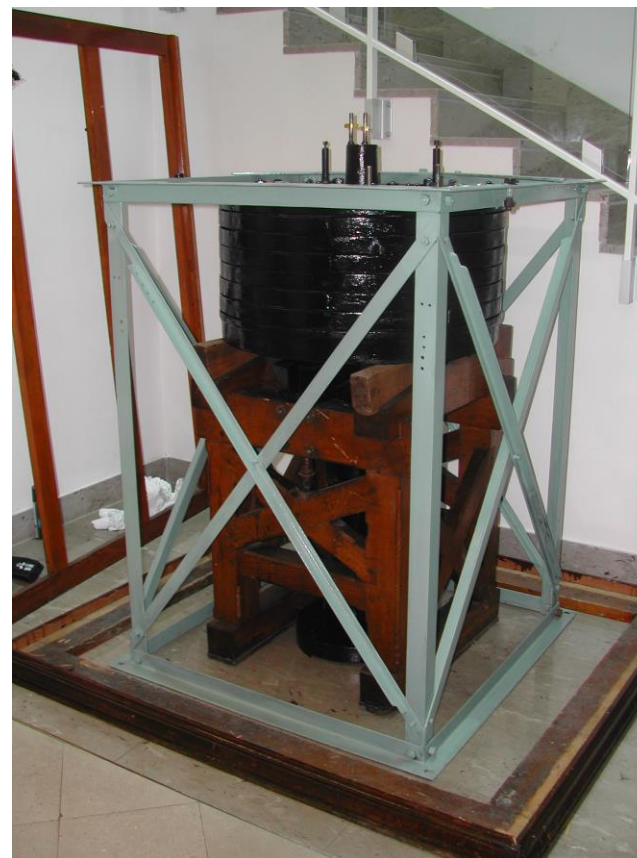


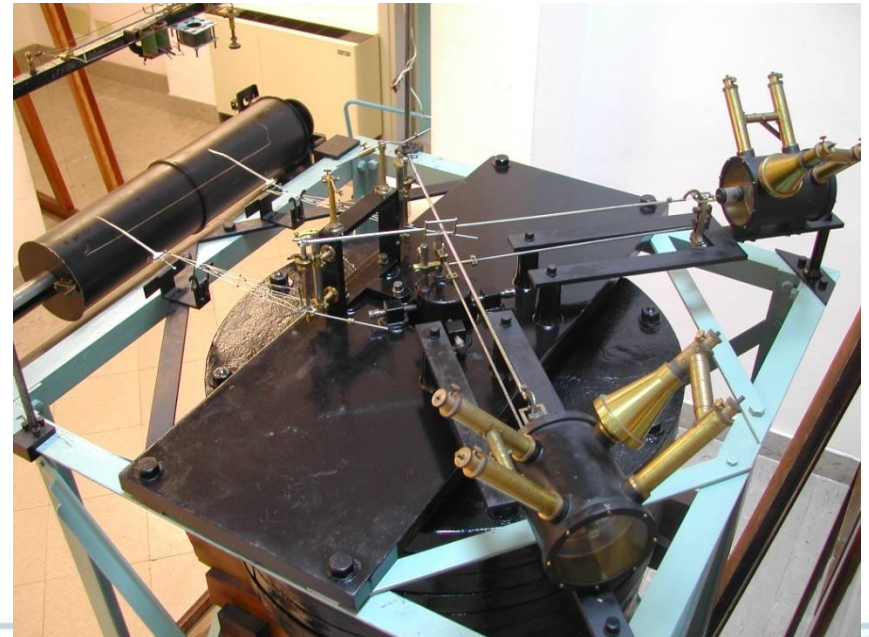
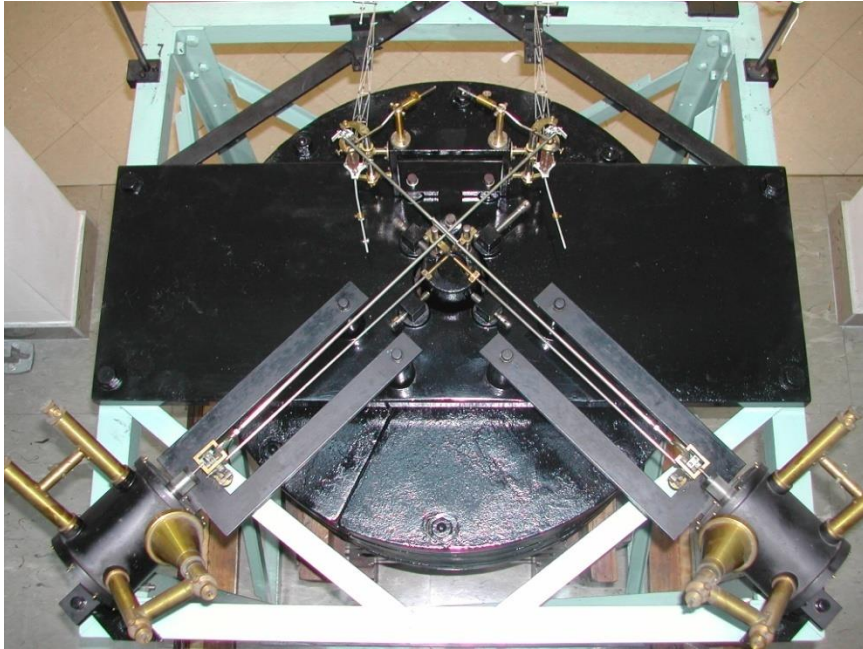
137

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

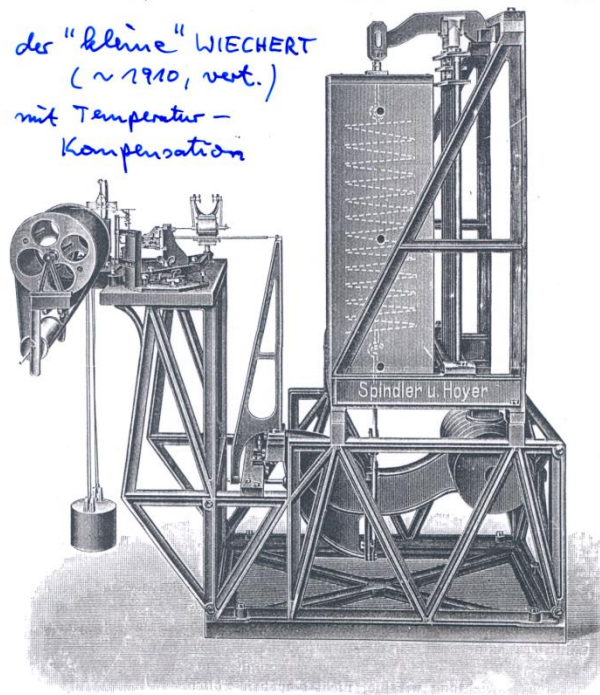
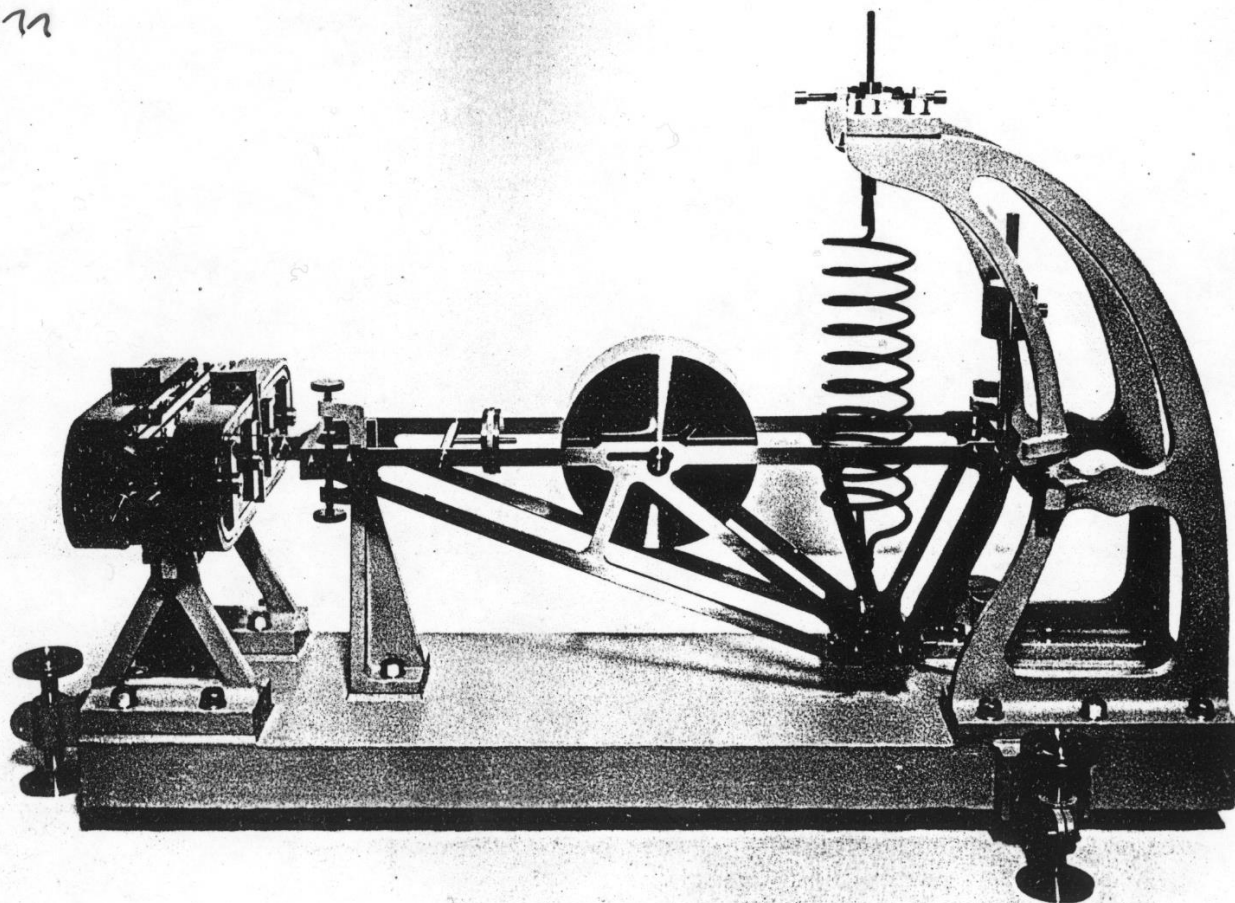


Fig. 74

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

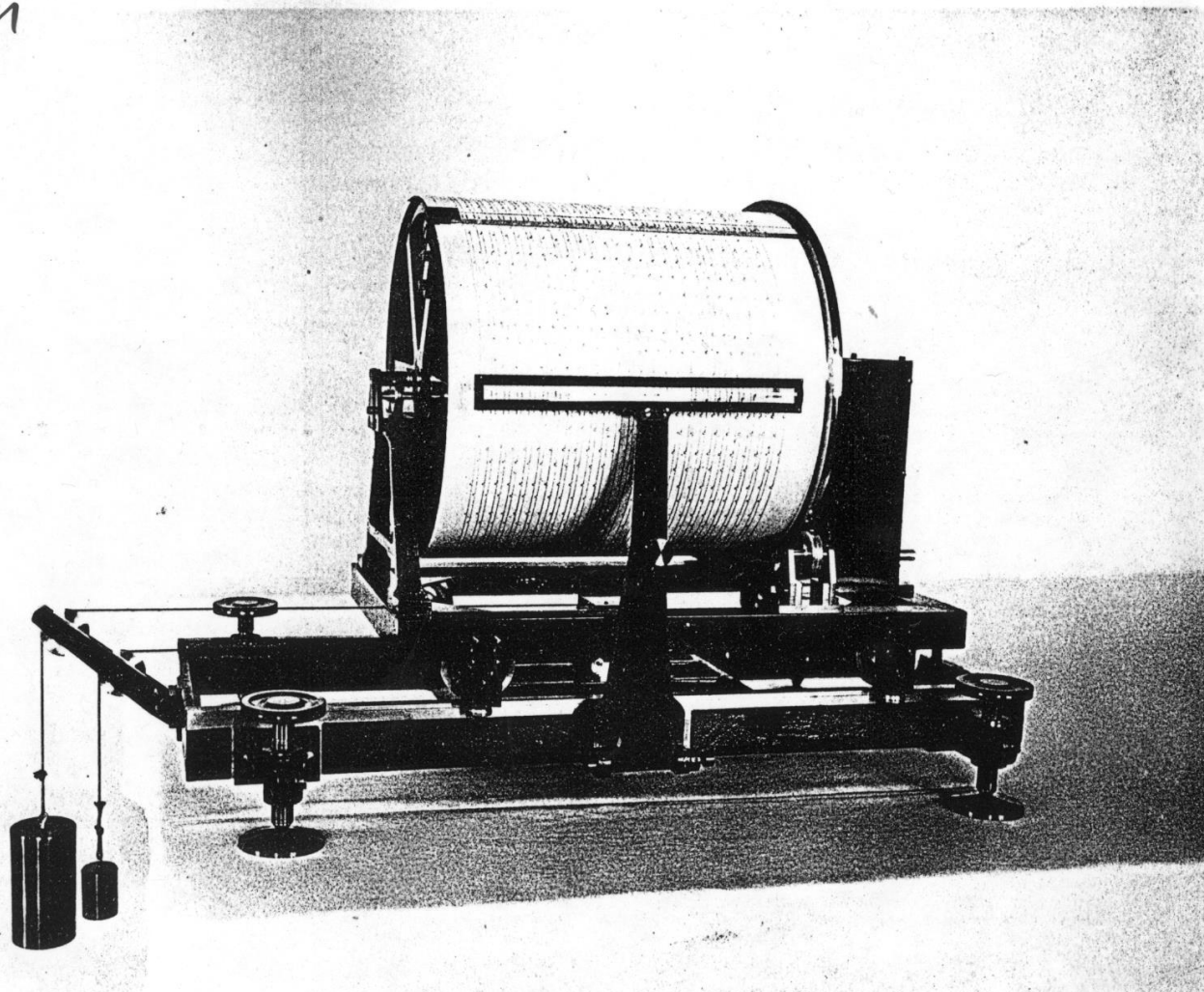
Fig. 84.

GALITZIN
1904-1911



GALITZIN
1904-1911

Рис. 85.



Фигура А. В. Державина, Спб.

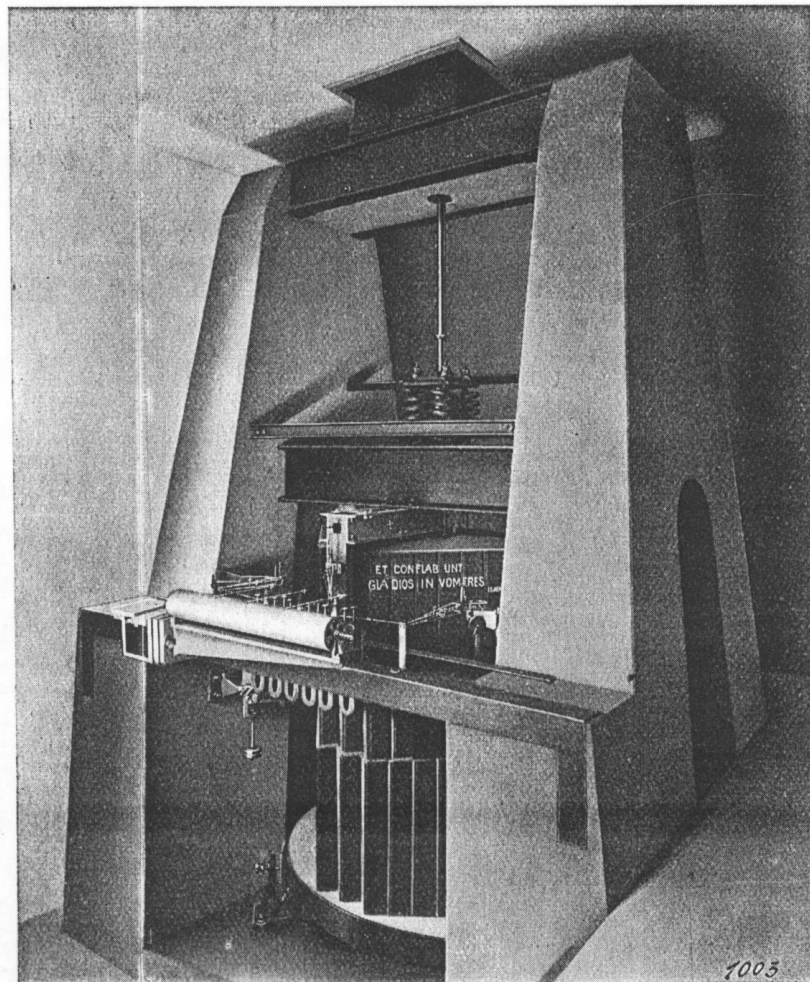
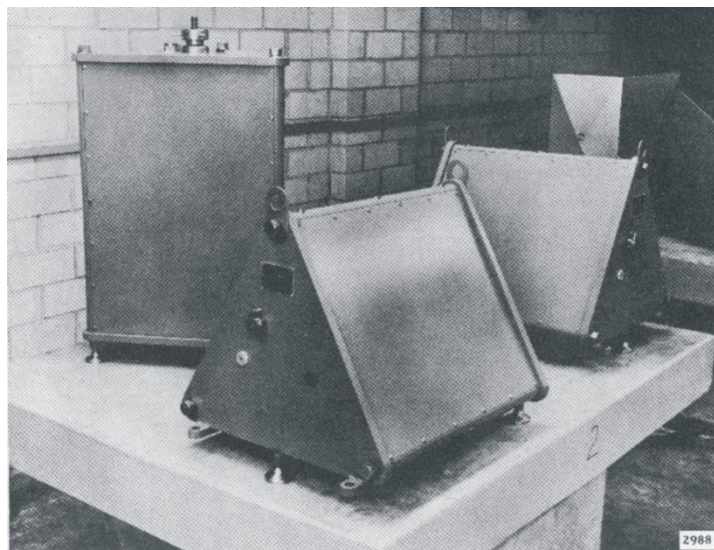


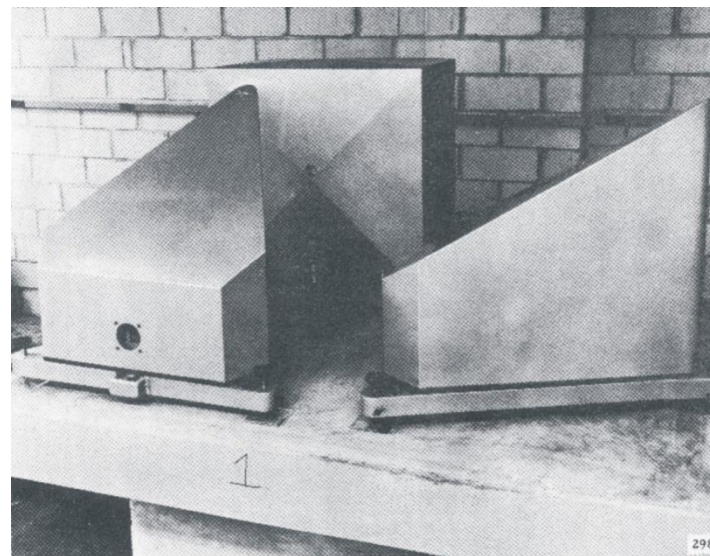
Fig. 4. Rohbau.

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

The TRI-117 WWSSN Trieste station seismometers



(a)

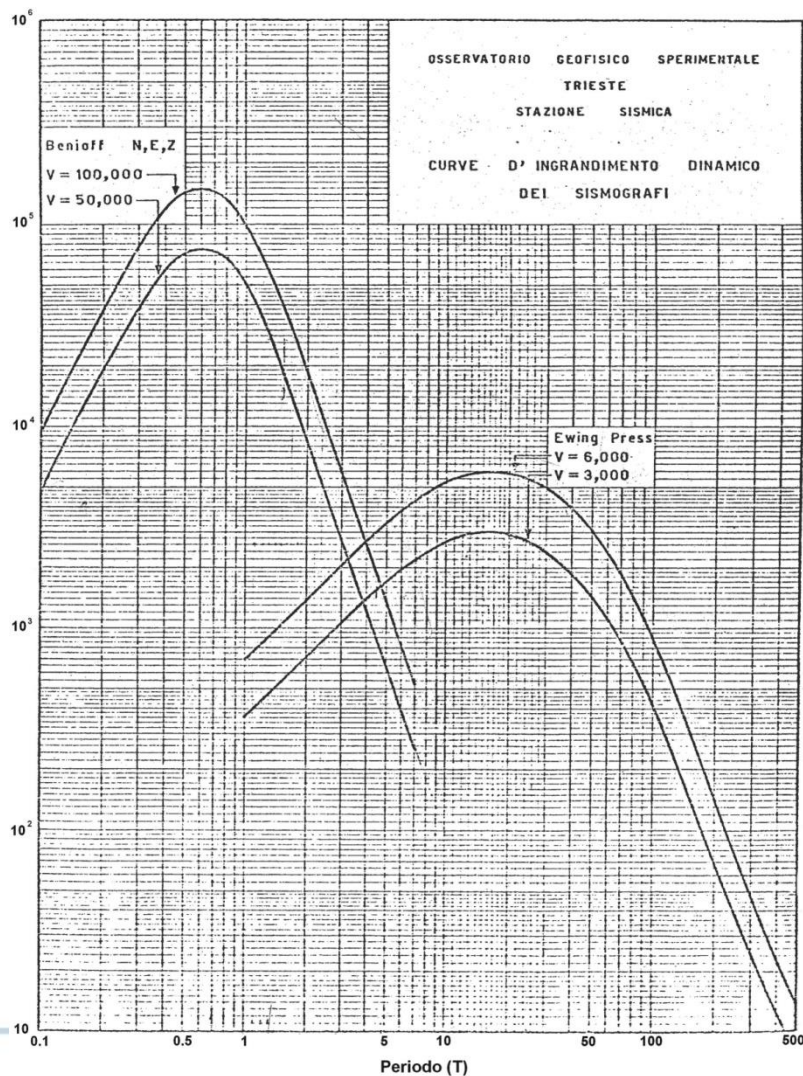


(b)

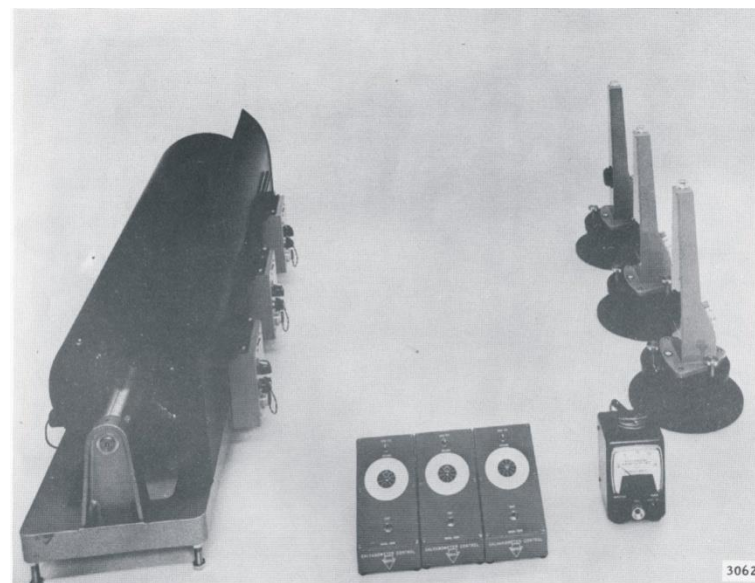
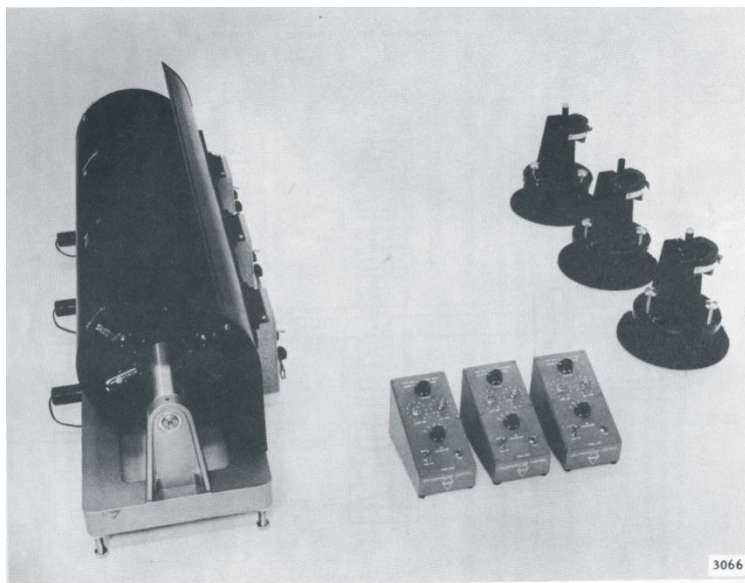
(a): Short period Benioff seismometers; component: Z, N-S, E-W; magnification: 50000; period: 1 s.

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

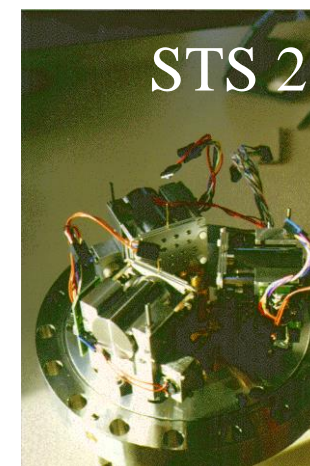
The dynamic magnification curves of the TRI-117 WWSSN station seismometers



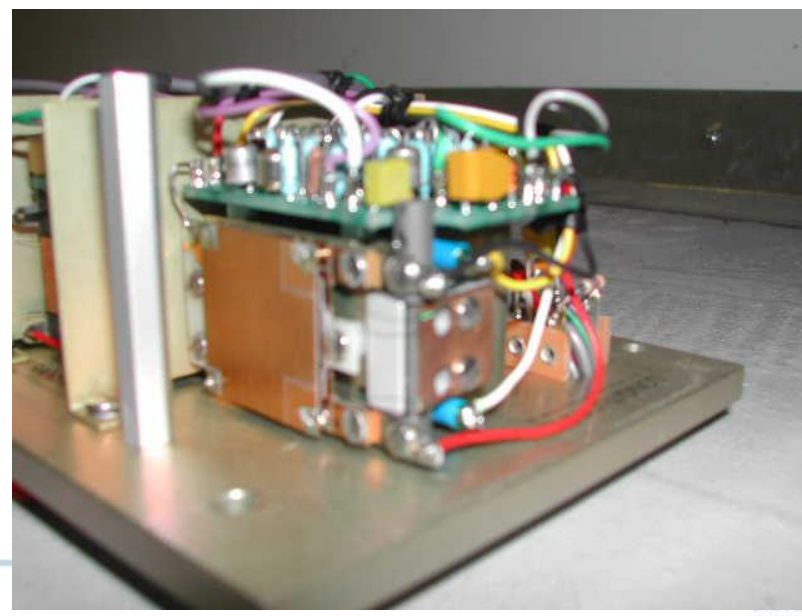
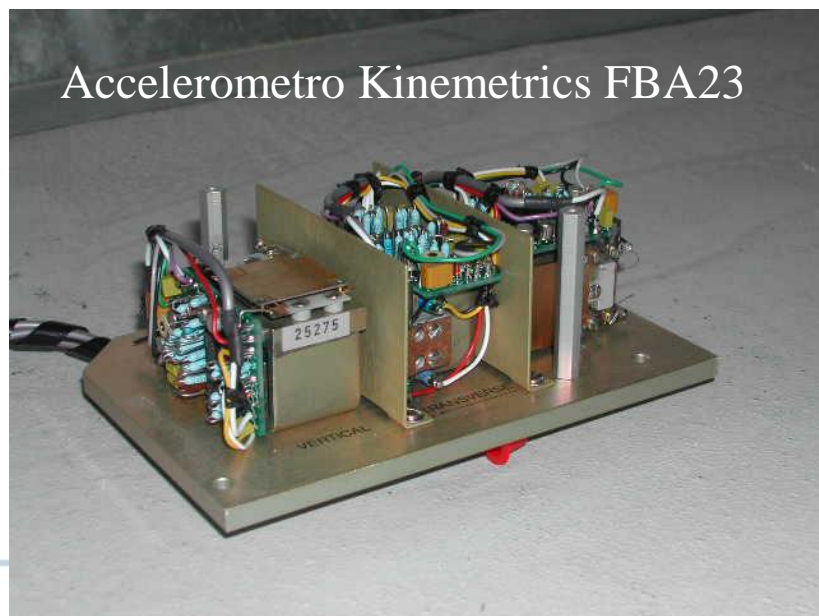
Surface equipment of TRI-117 WWSSN station



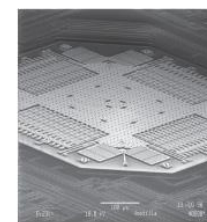
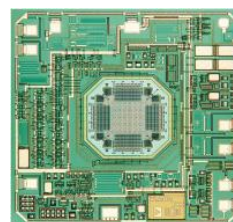
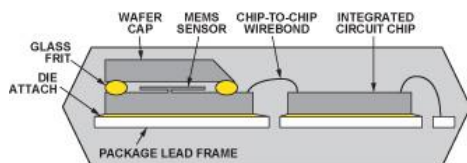
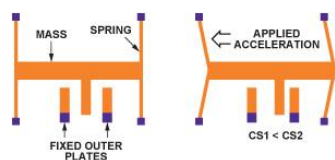
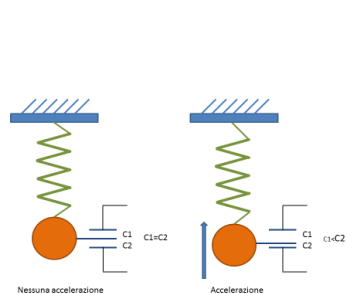
Short period (on the left) and long period (on the right) seismograph recording instruments

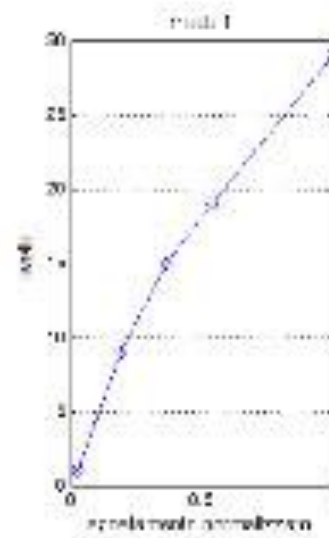
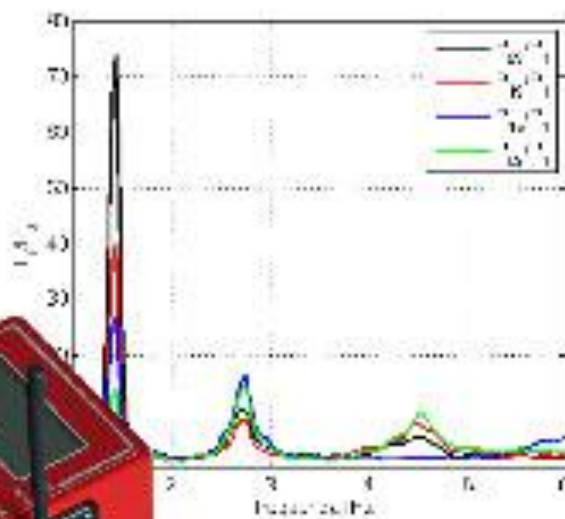




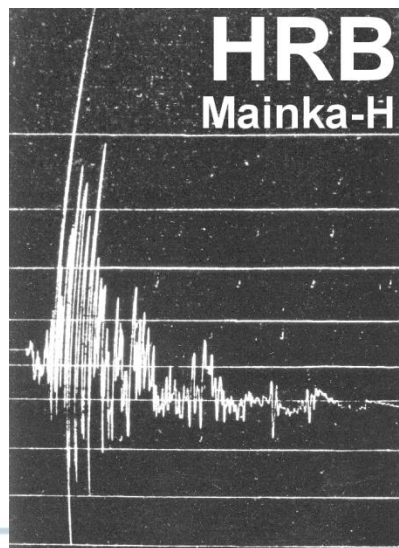
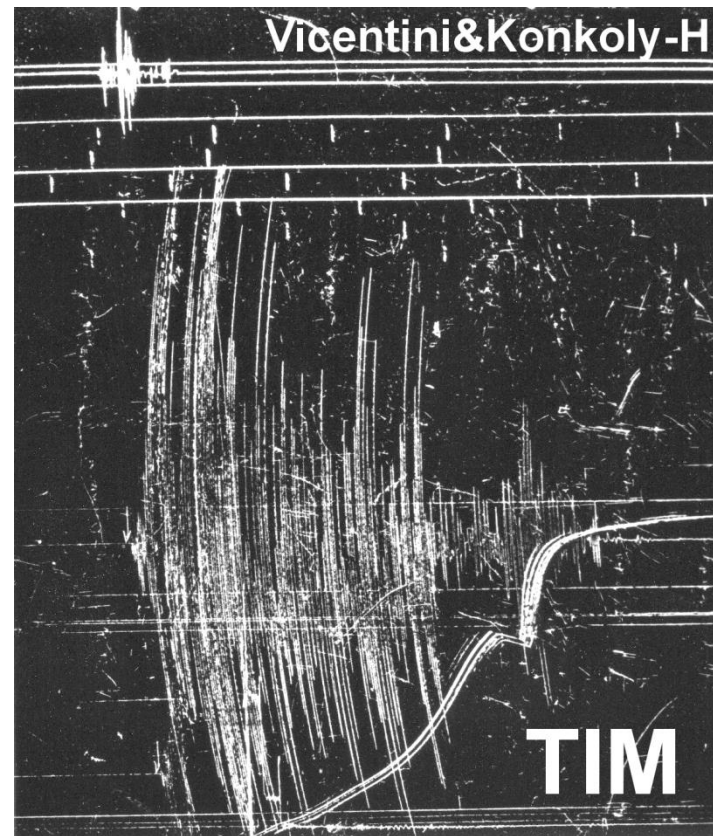
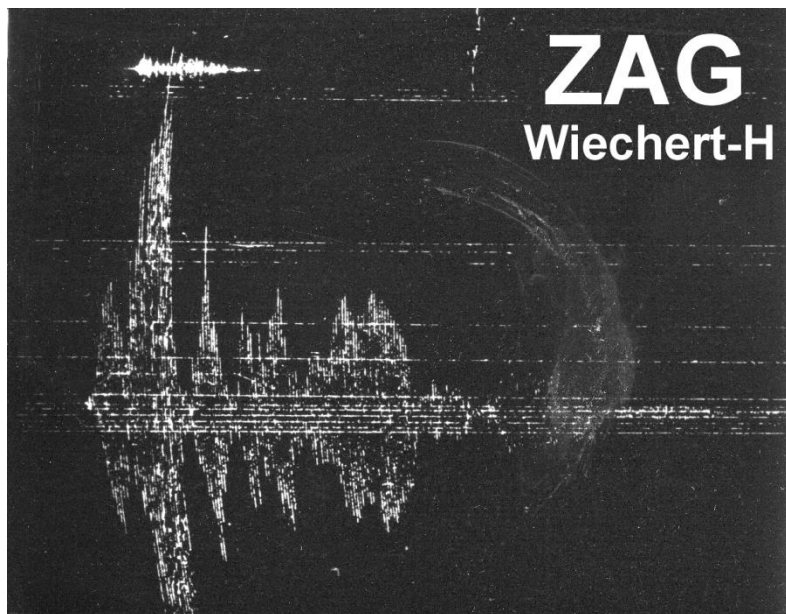


Accelerometri MEMS

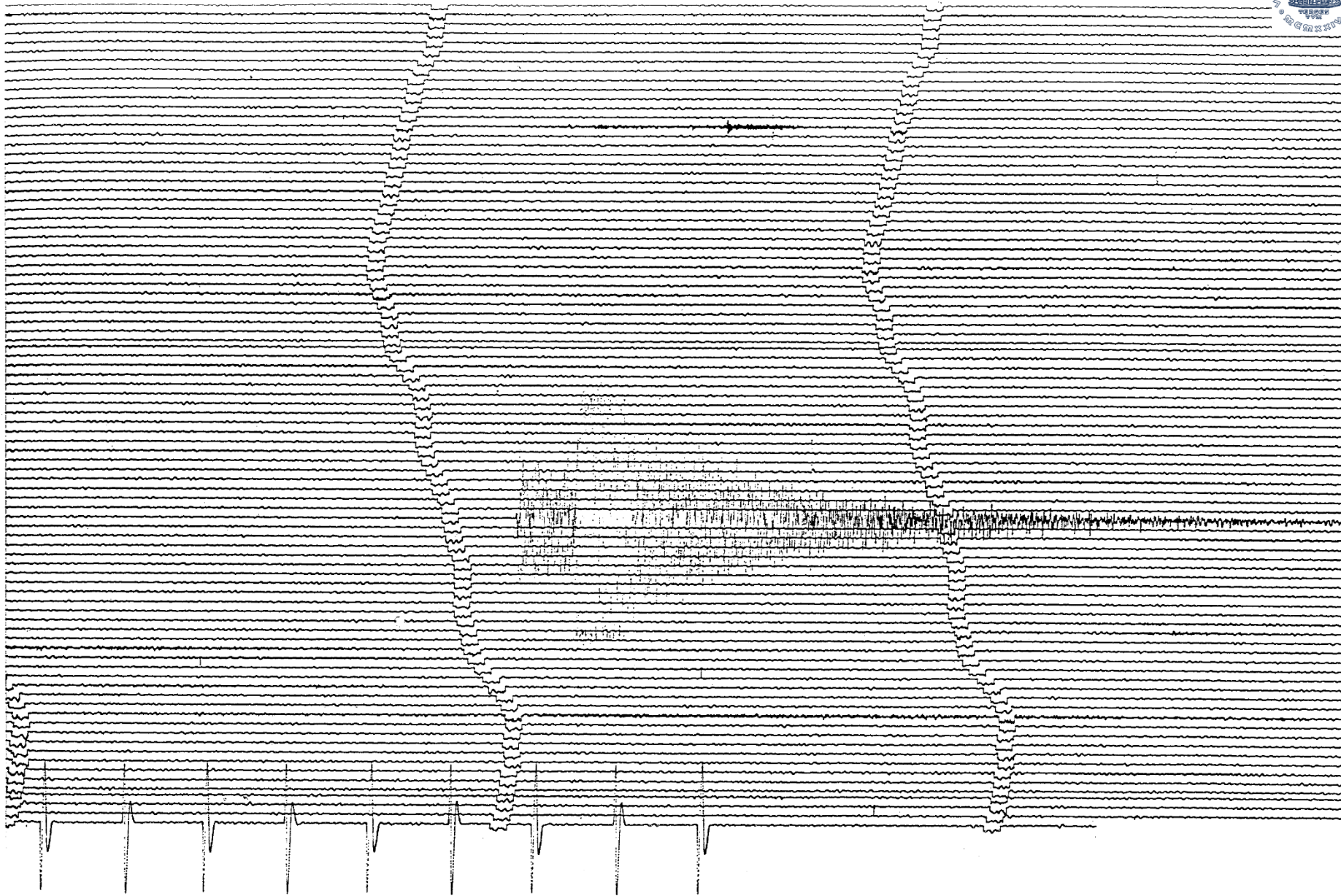






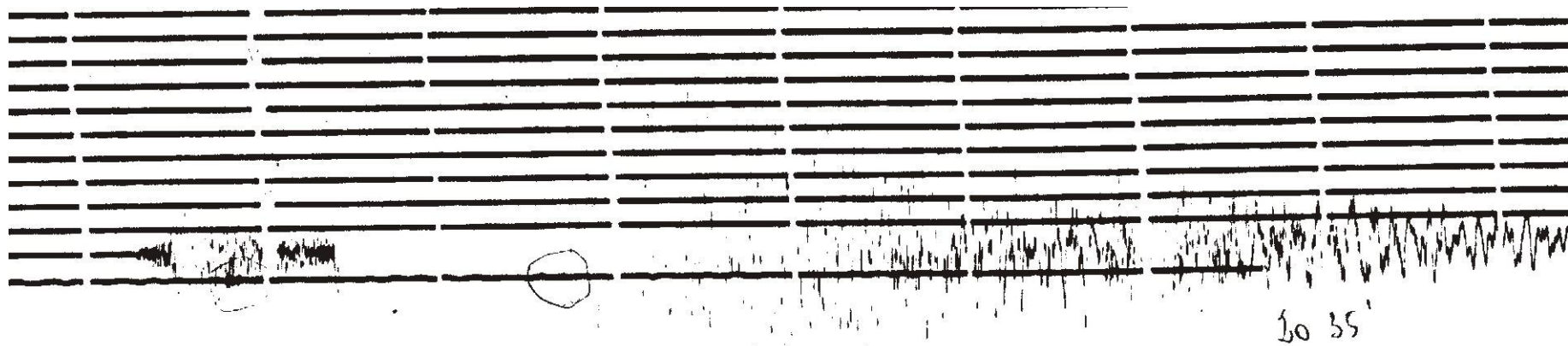


Kecskemét 1911, M 5.6



1999 08 20 00:00:00 - 00:00:05

Friuli 1976 MI 6.5 – Wood-Anderson

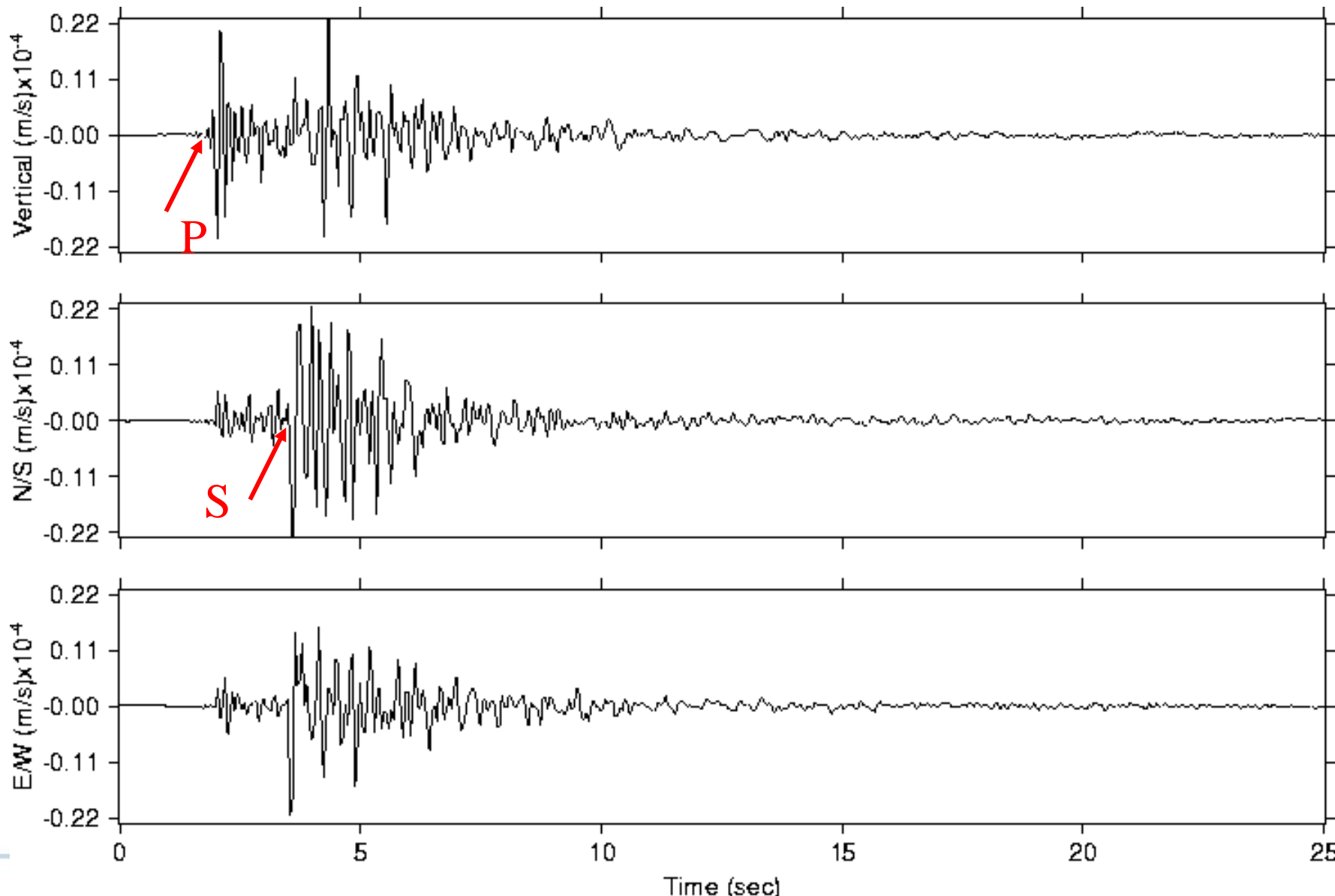




31/7/2000 19:01

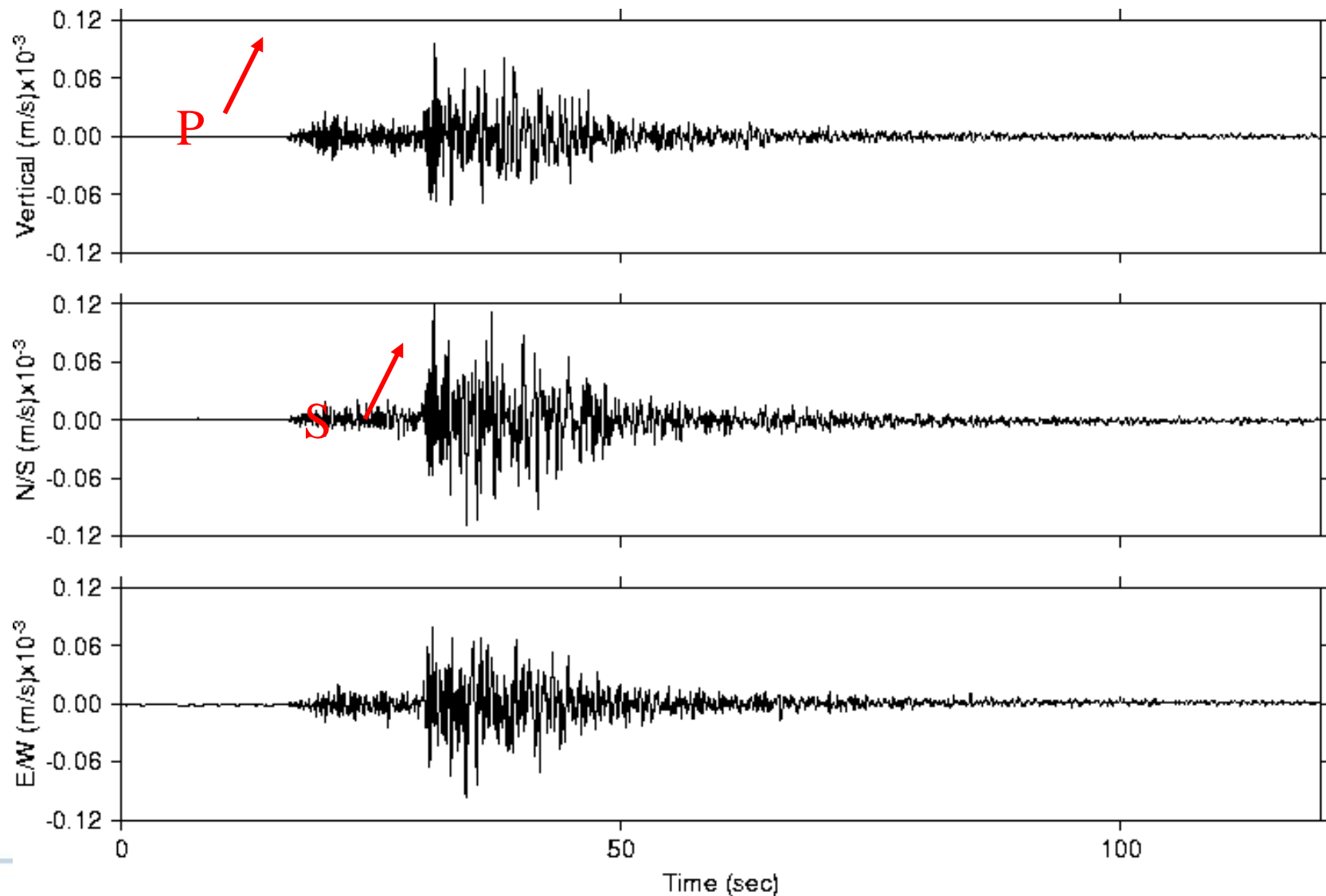
VINO

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



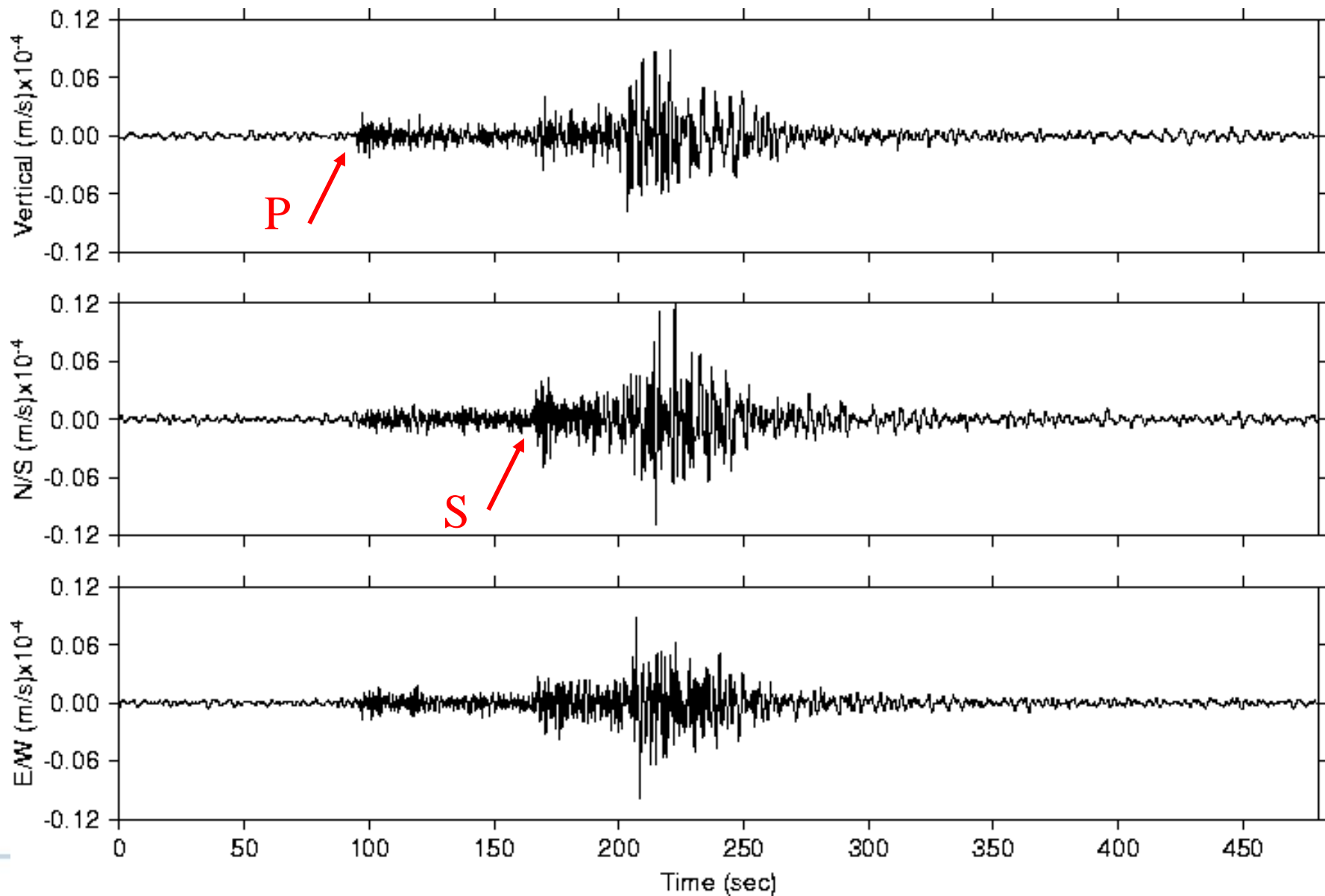
VINO

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



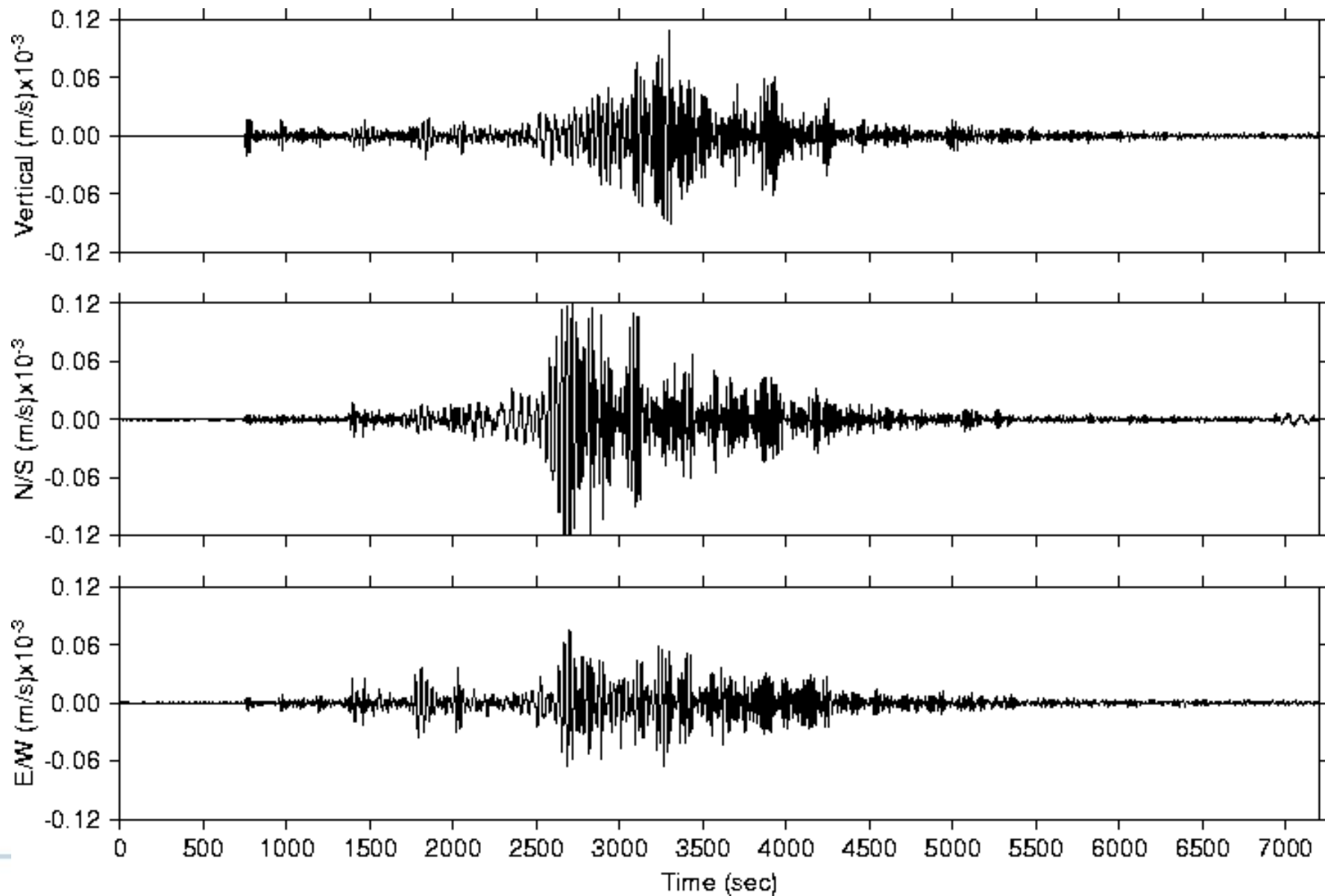
VINO

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

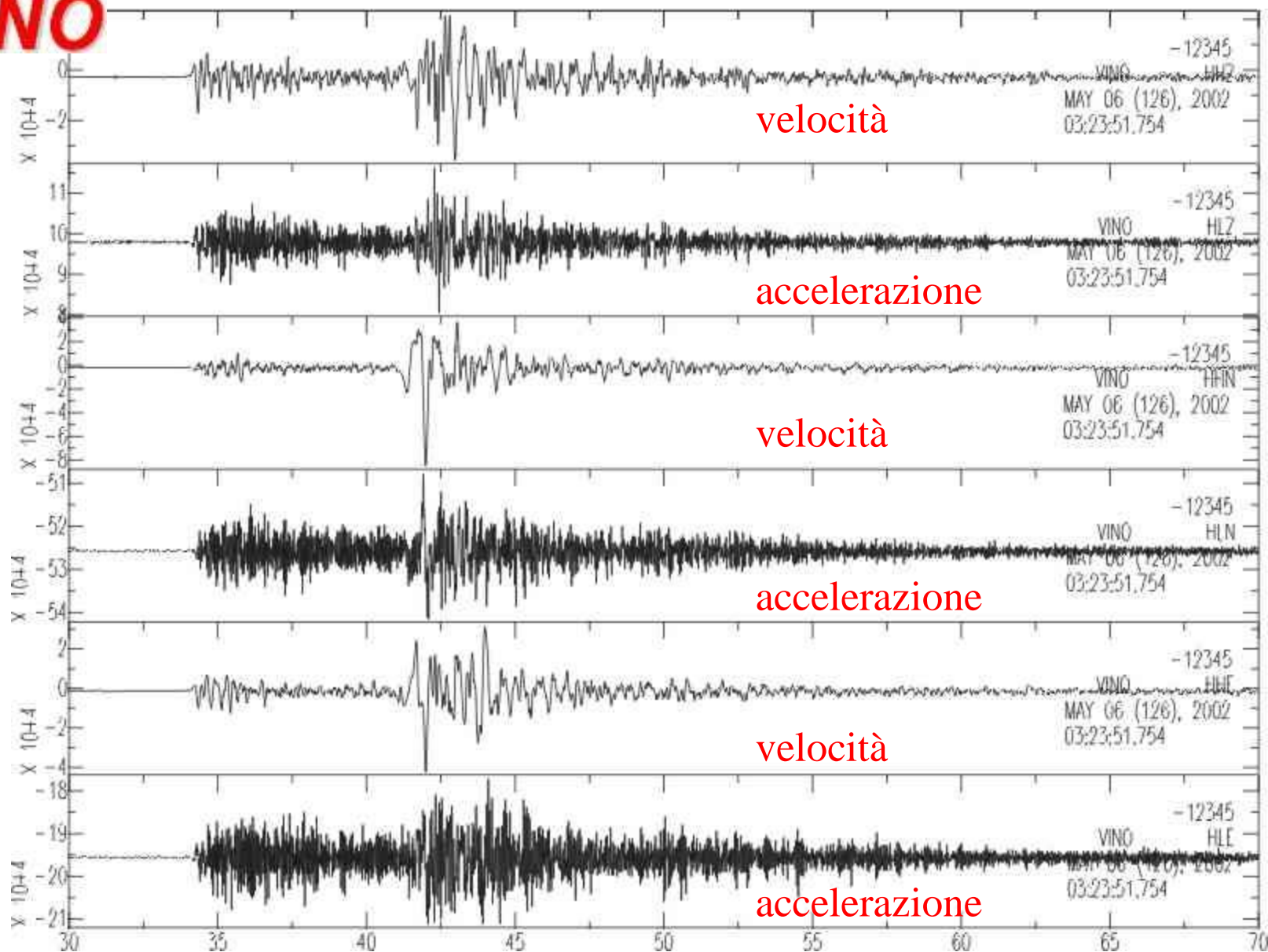


VINO

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

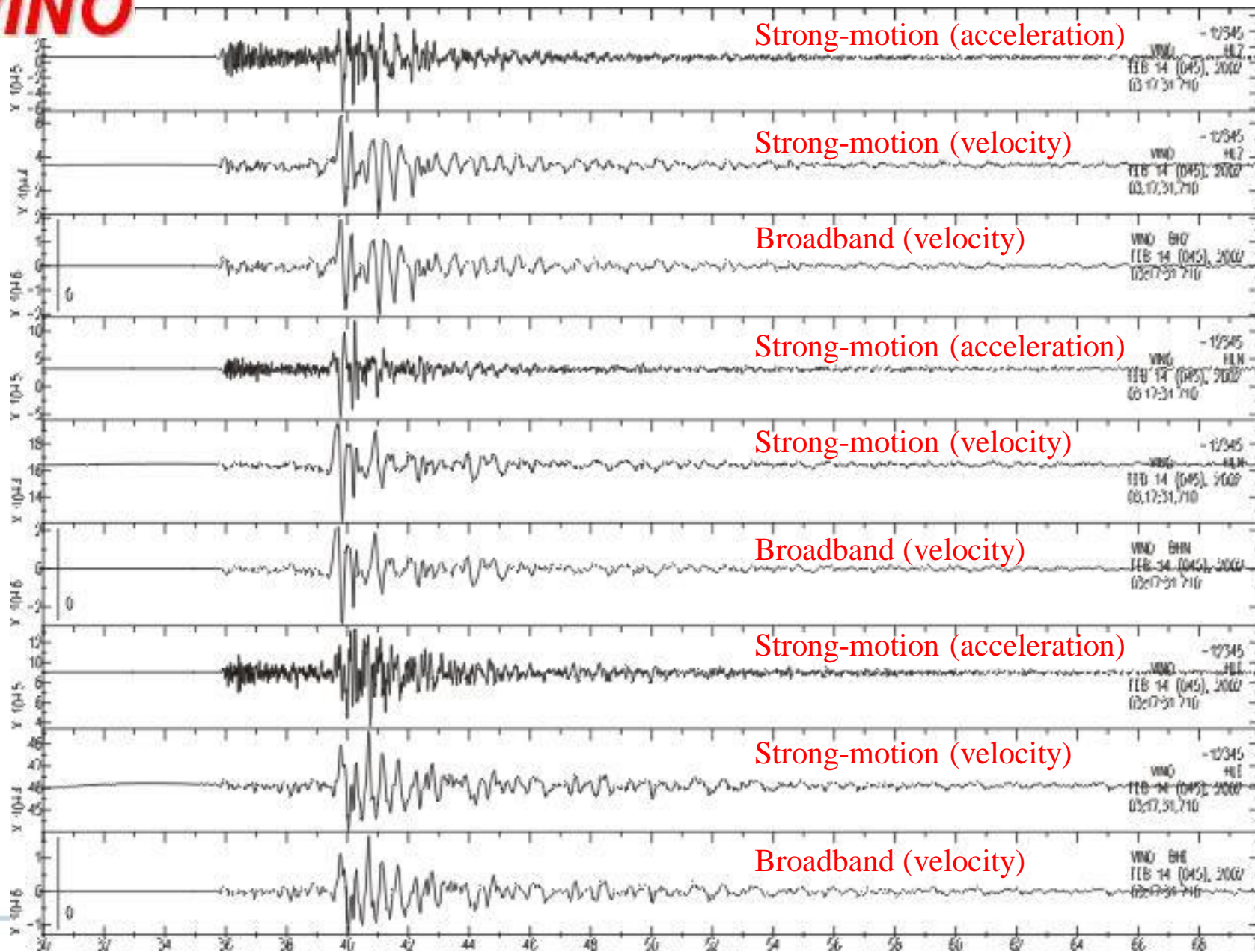


VINO





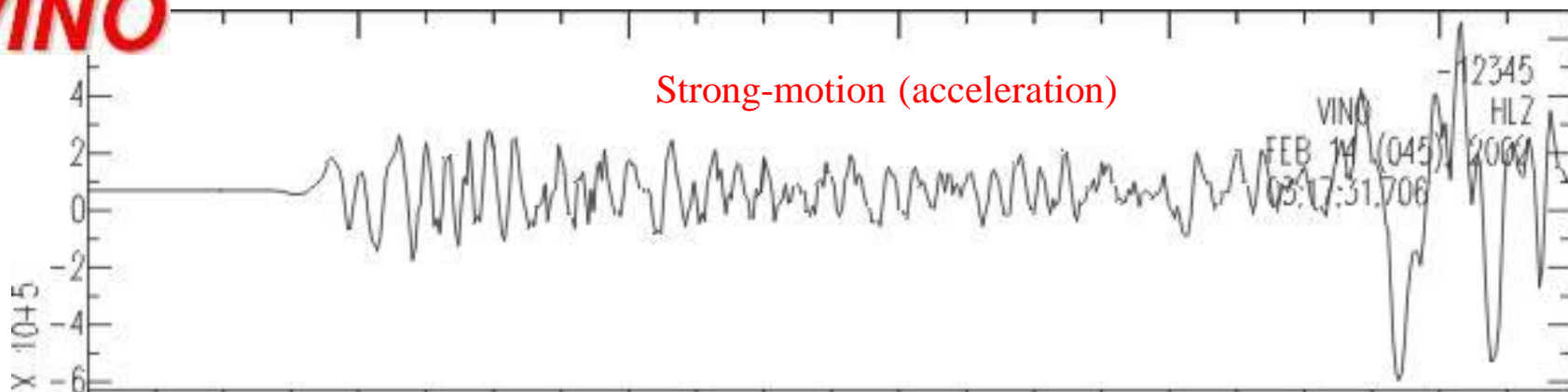
VINO



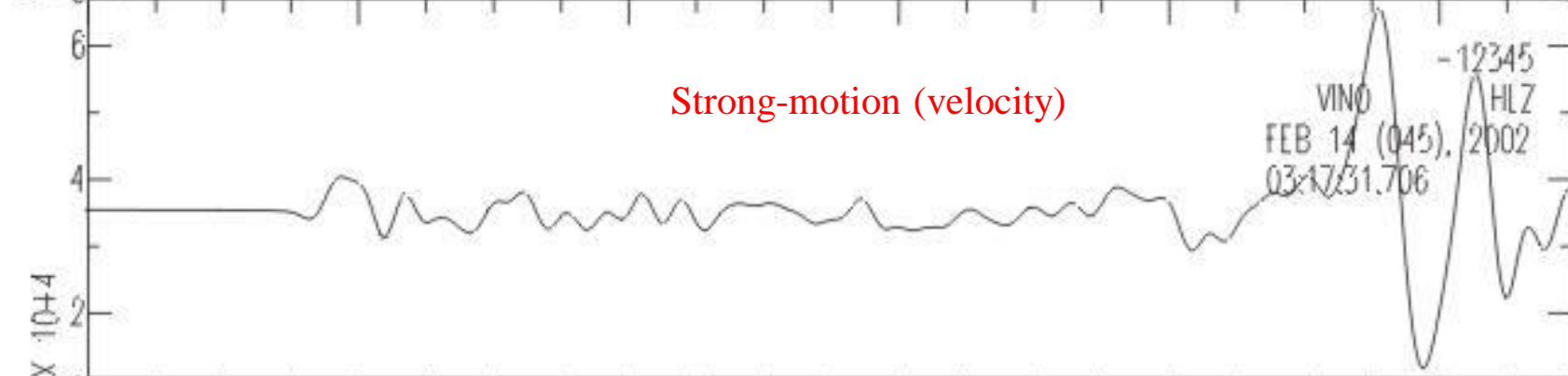


VINO

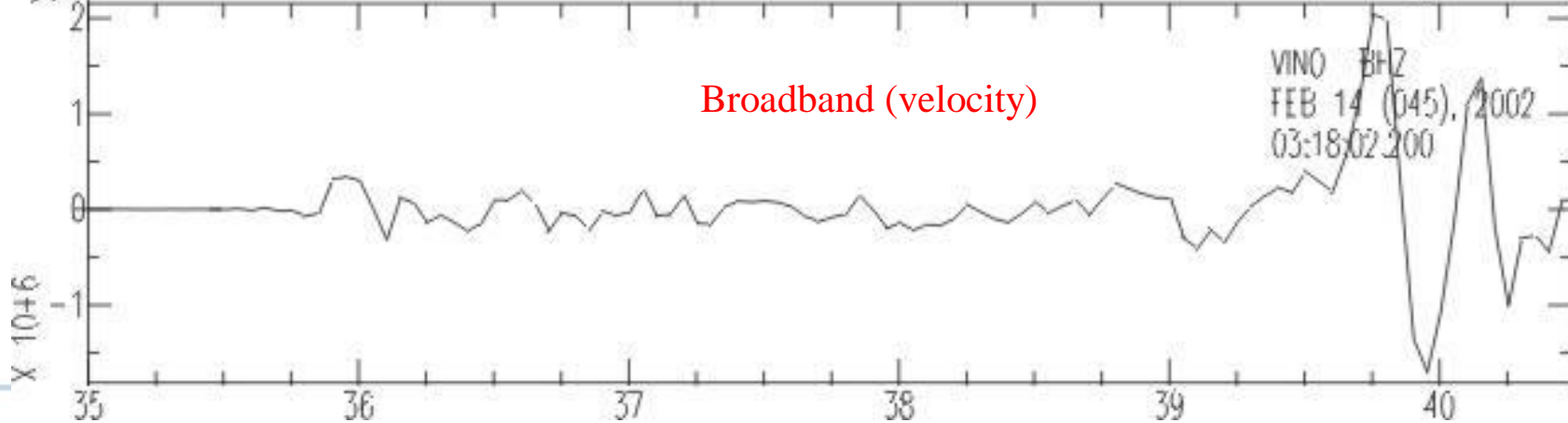
Strong-motion (acceleration)

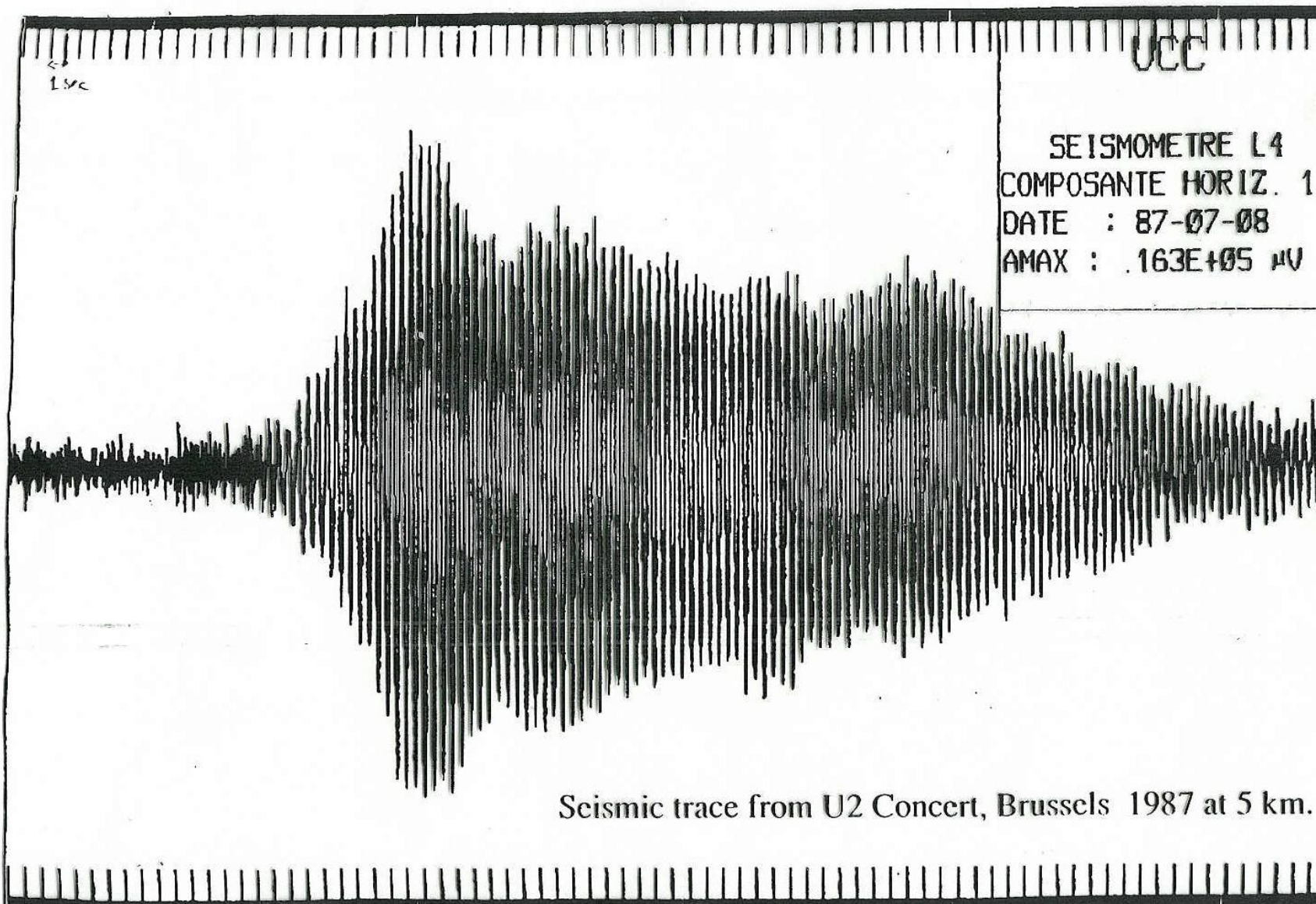


Strong-motion (velocity)

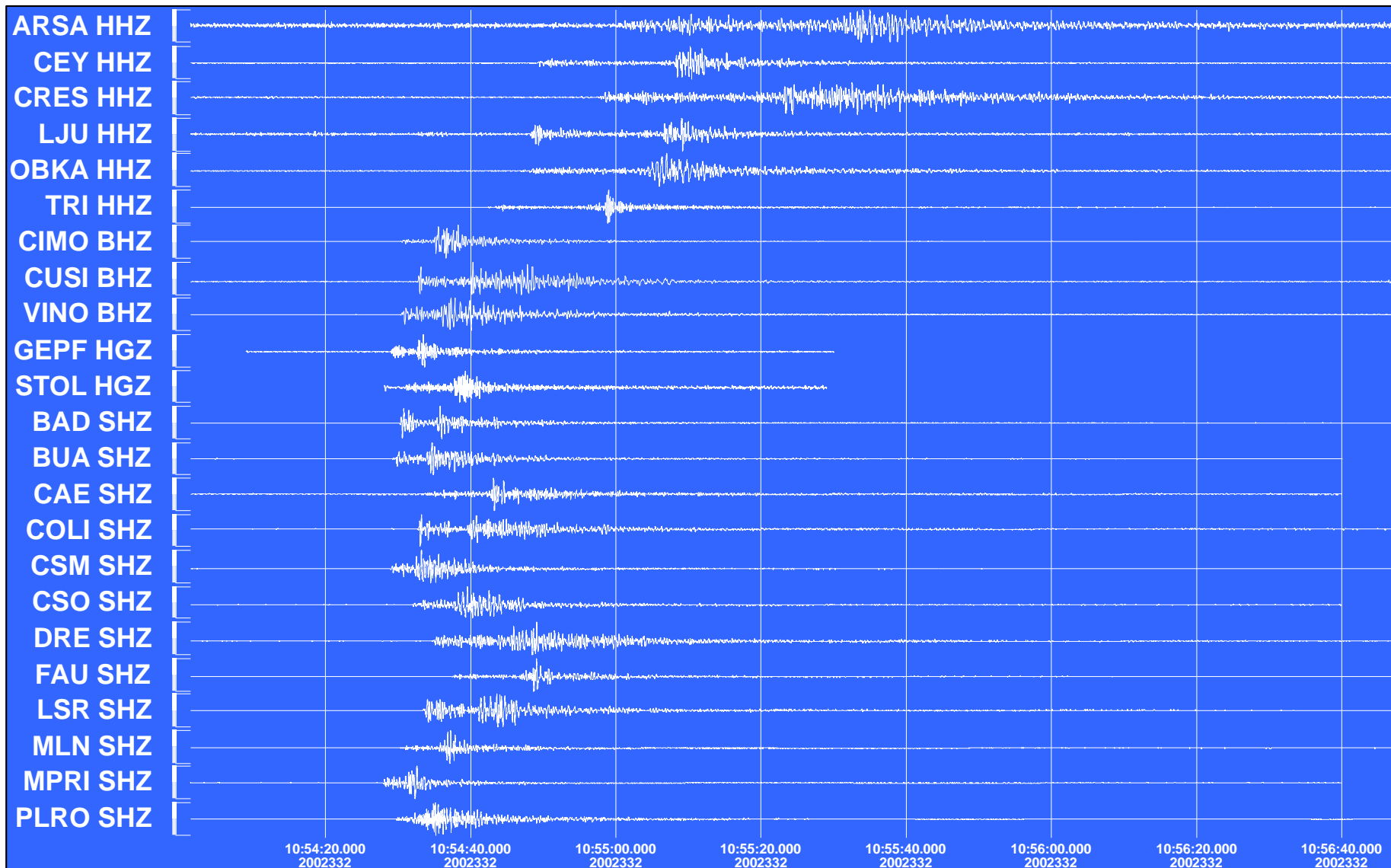


Broadband (velocity)





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



Effetti di sito



Effetti di sito



Effetti di sito

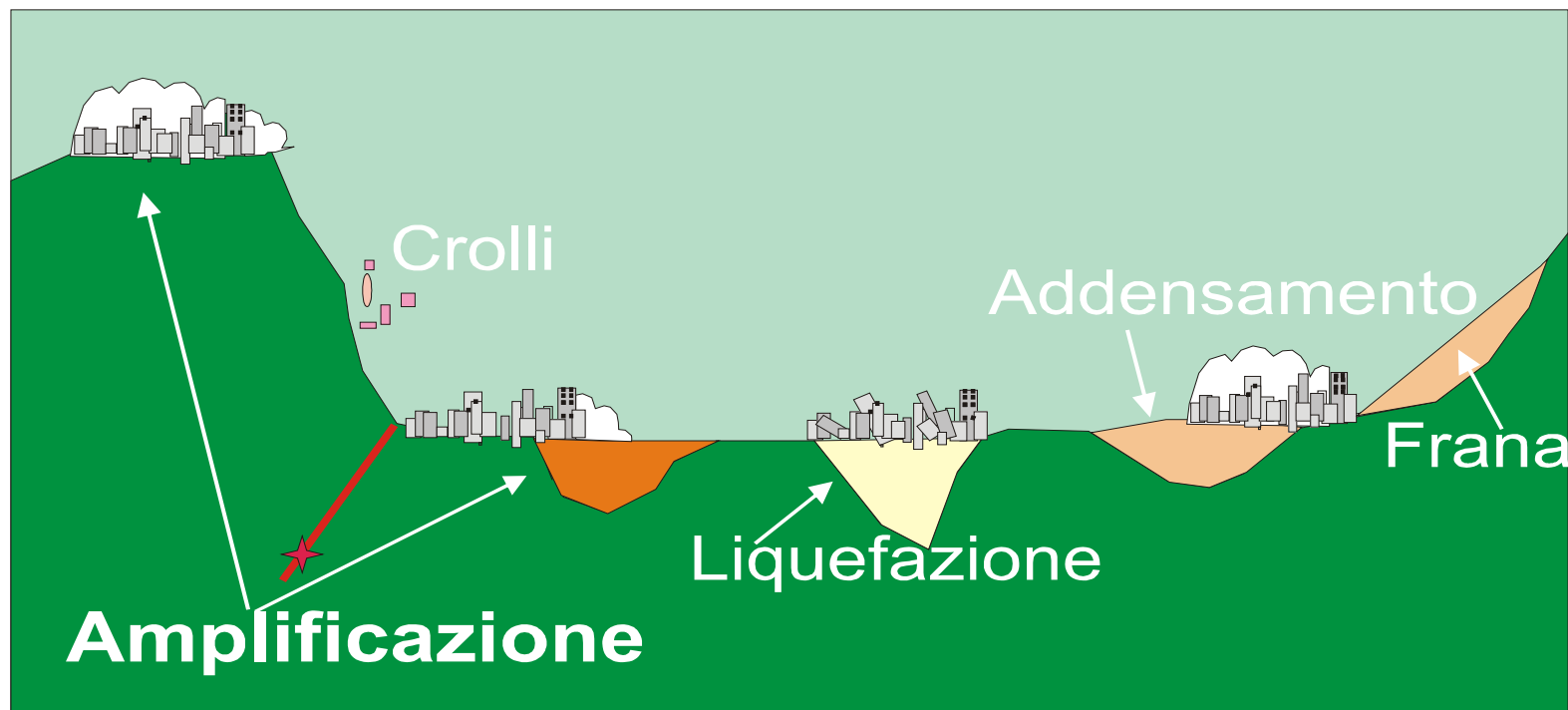
How will 3 buildings, engineered equally, on different bedrock react to an earthquake?



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



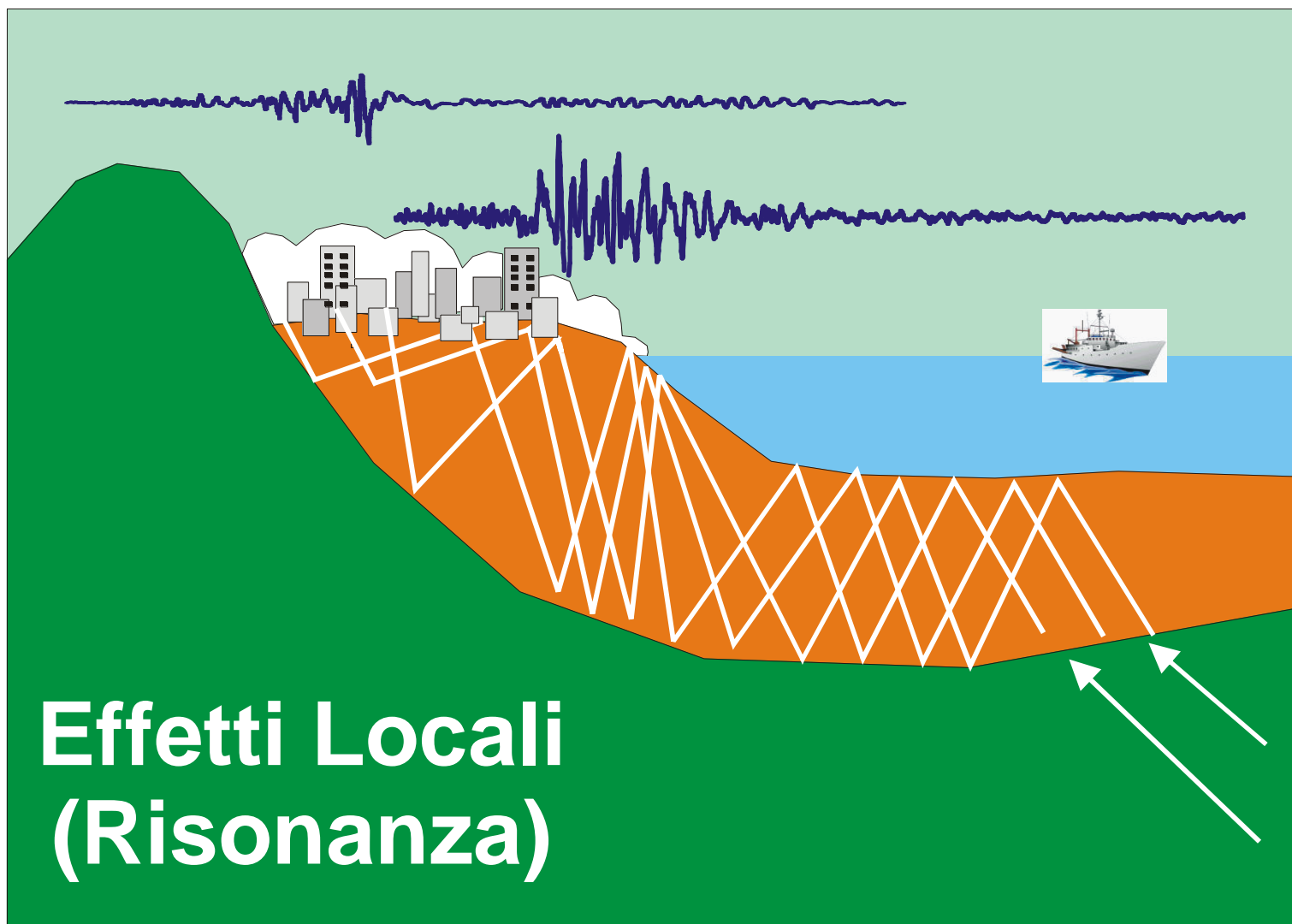
Emilia

20 maggio 2012 ore 04:03

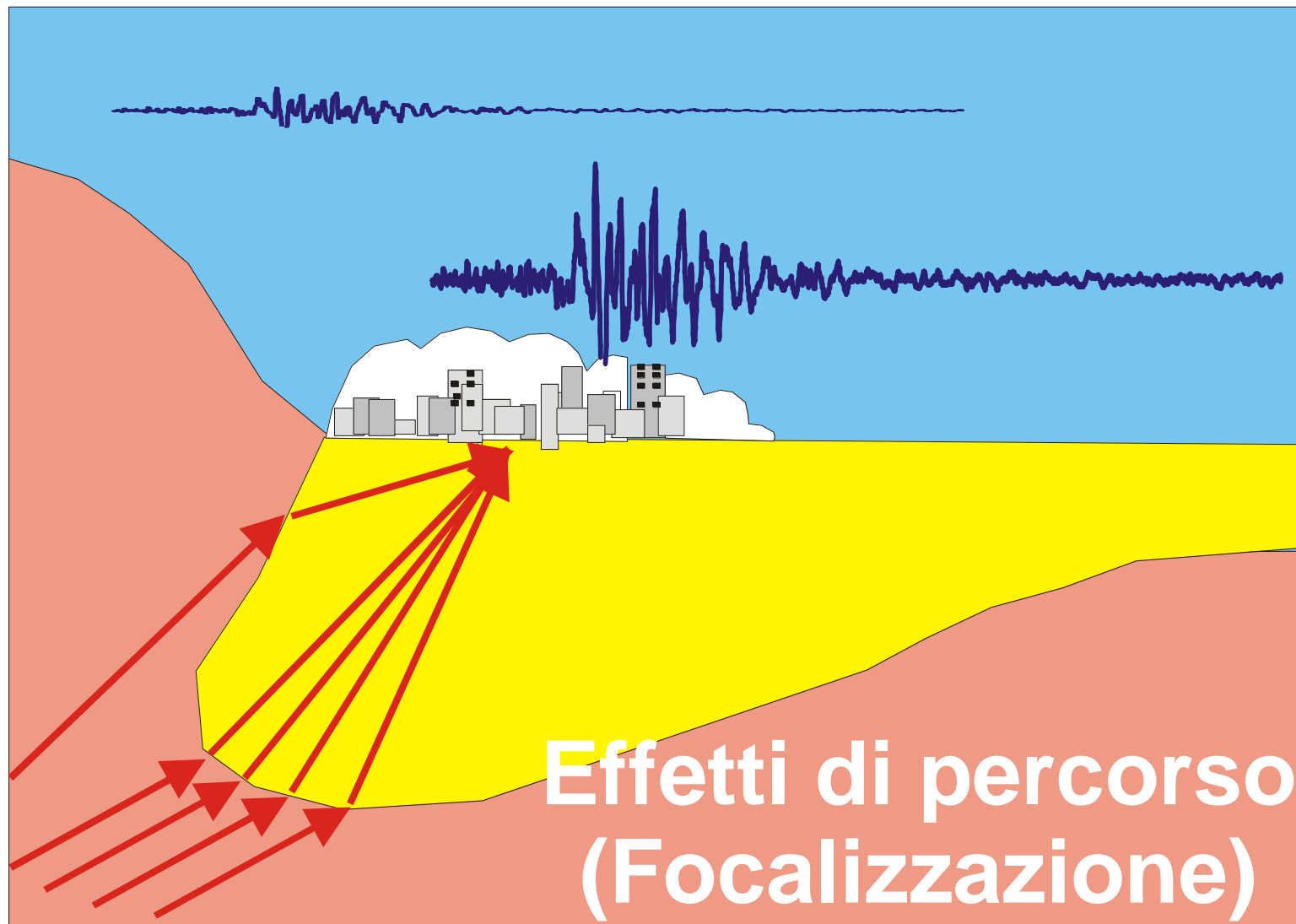
M=5.9



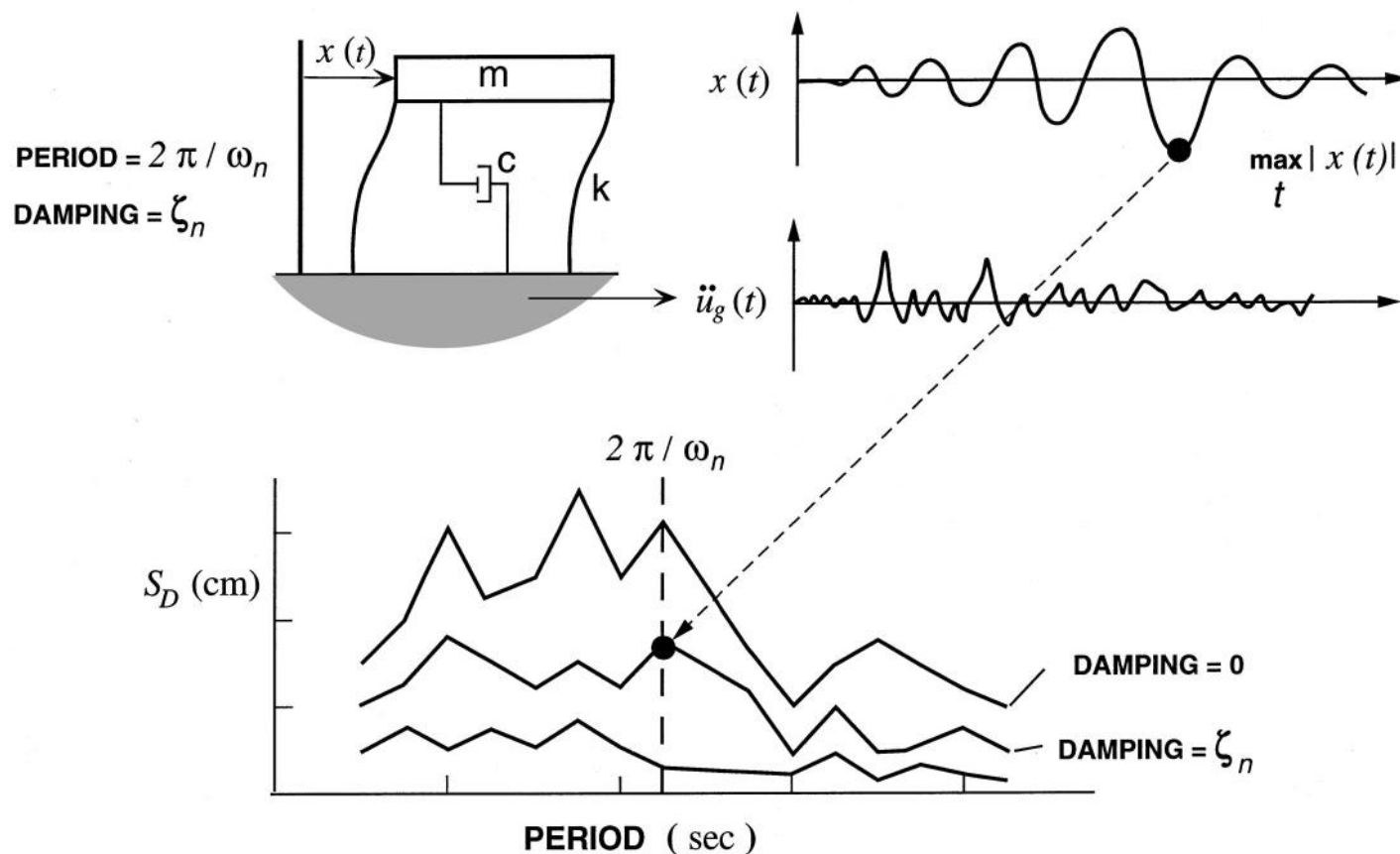
EFFETTI LOCALI INDOTTI DA UN EVENTO SISMICO

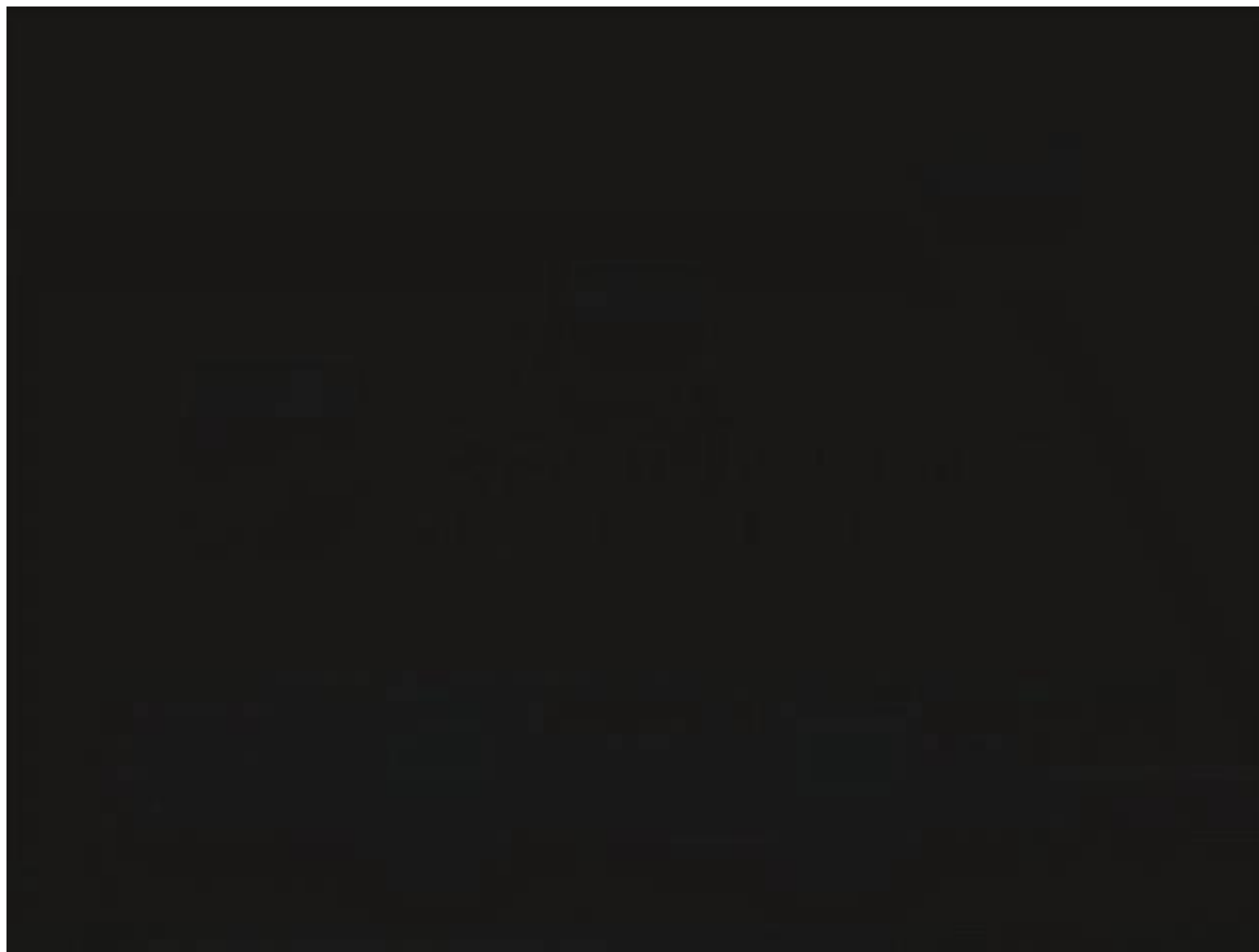


EFFETTI LOCALI INDOTTI DA UN EVENTO SISMICO



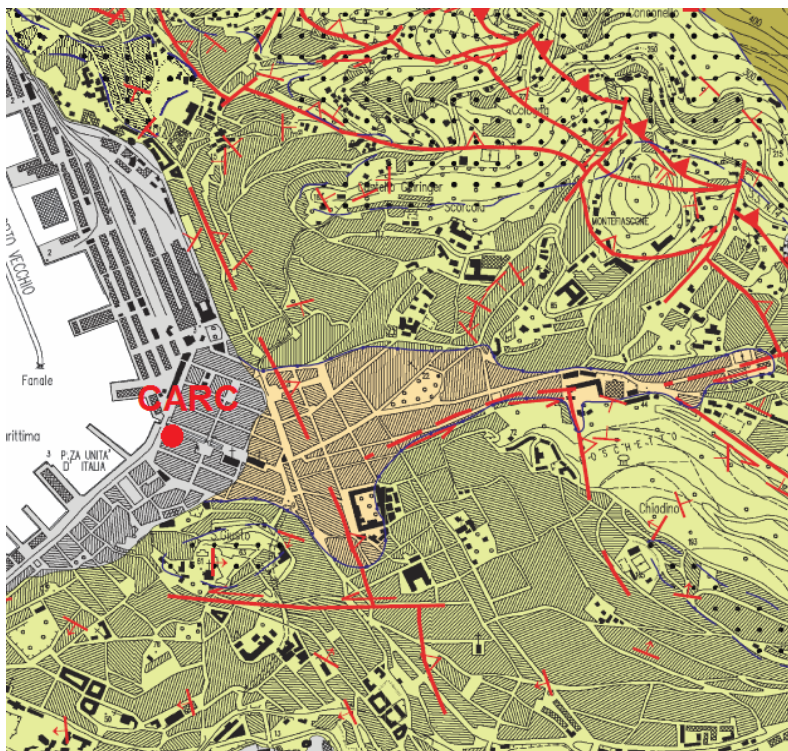
SPETTRI DI RISPOSTA





Il terremoto, a 40 anni dall'evento del Friuli

Palazzo Carciotti, Borgo Teresiano, Trieste



(Cucchi et al., 2013)



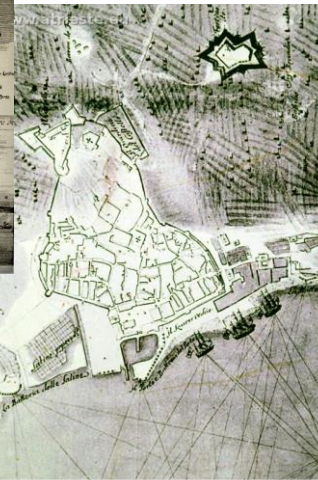
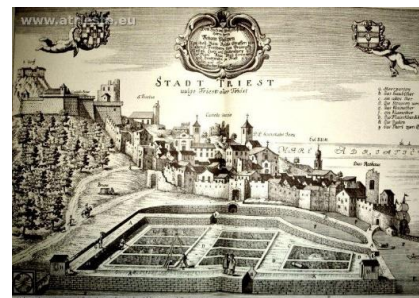
Antropico (Attuale)

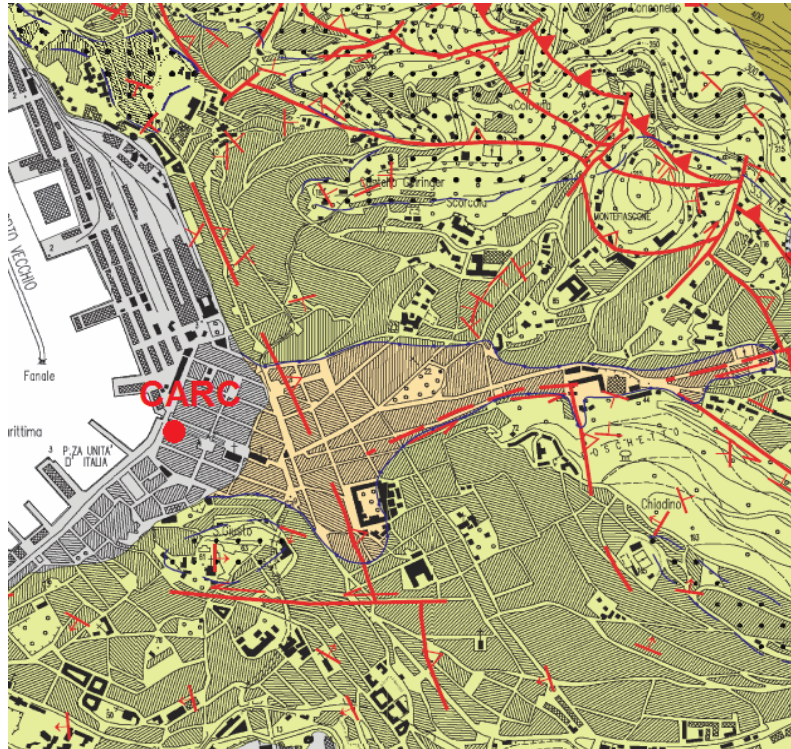


Unità dei depositi ubiquitari (Pleistocene sup. - Attuale) - UIN



Flysch di Trieste (Luteziano sup.) - FT

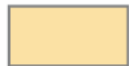




(Cucchi et al., 2013)



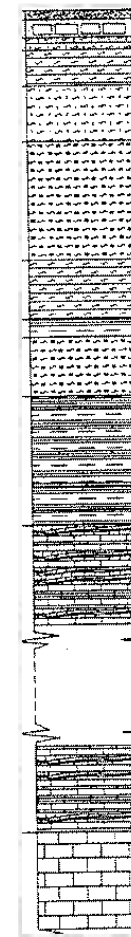
Antropico (Attuale)



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



Flysch di Trieste (Luteziano sup.) - FT

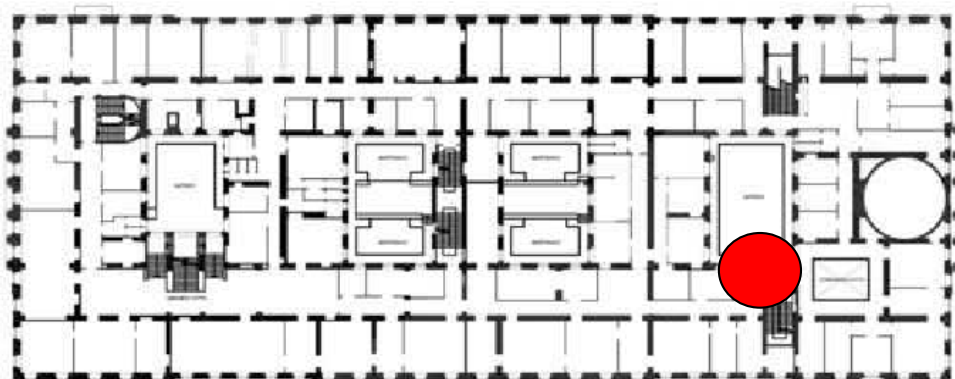


Argille e silts 27 m

Arenarie e Marne
Flysch – (Eocene) 770 m

Calcari (Mesozoico)

Palazzo Carciotti, Borgo Teresiano, Trieste



CARC

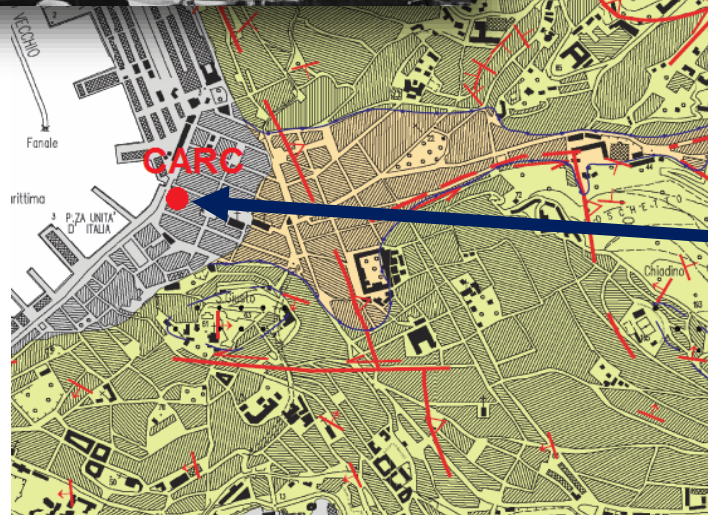
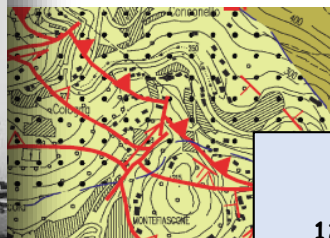





Argille e silts 27 m

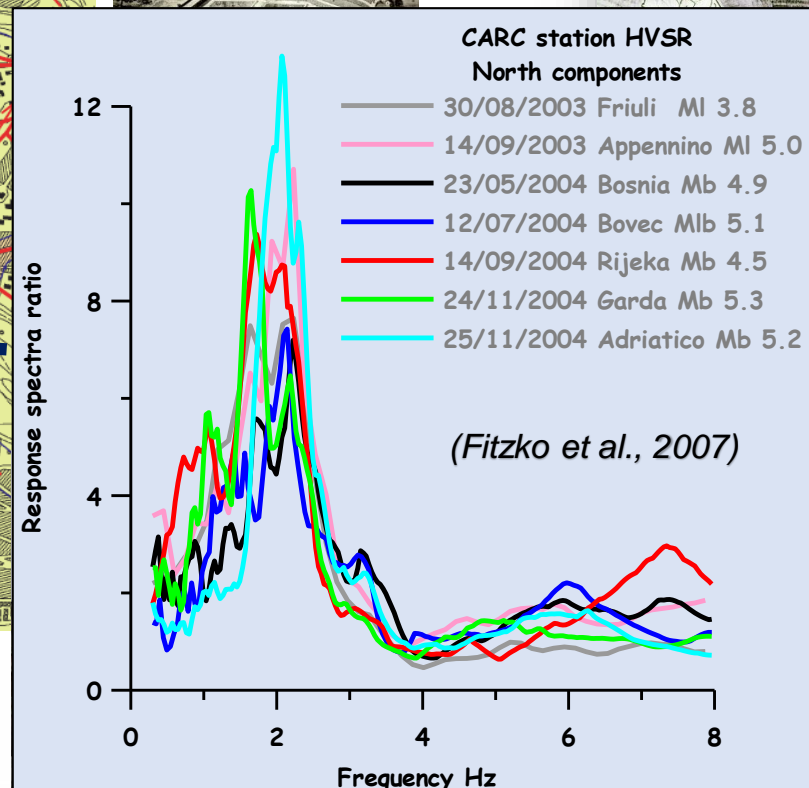
Arenarie e Marne
Flysh – (Eocene) 770 m

Calcari (Mesozoico)

Palazzo Carciotti, Borgo Teresiano, Trieste

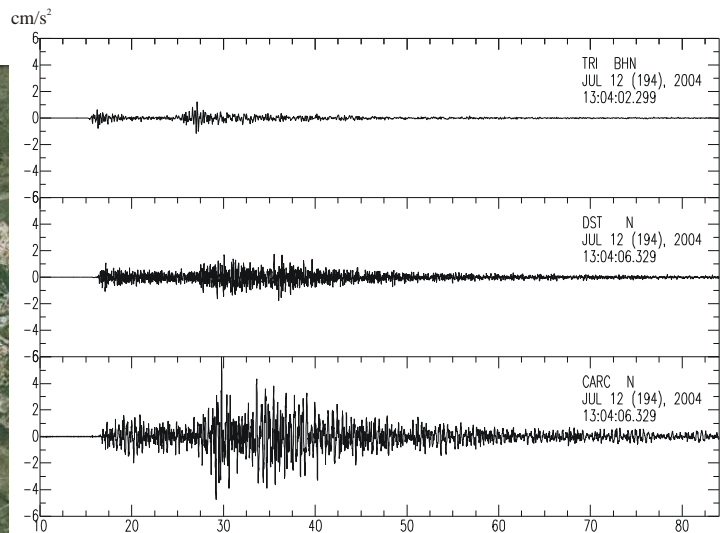
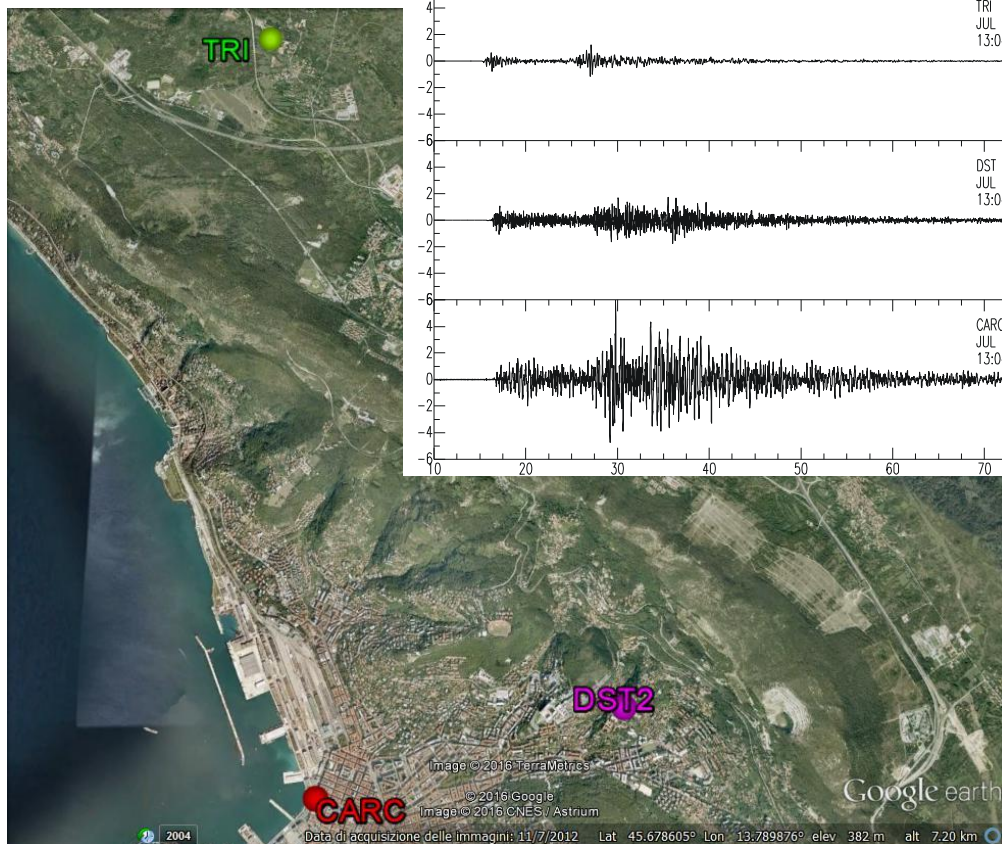


-  Antropico (Attuale)
-  Unità dei depositi ubiquitari (Pleistocene sup. - Attuale) - UIN
-  Flysch di Trieste (Luteziano sup.) - FT

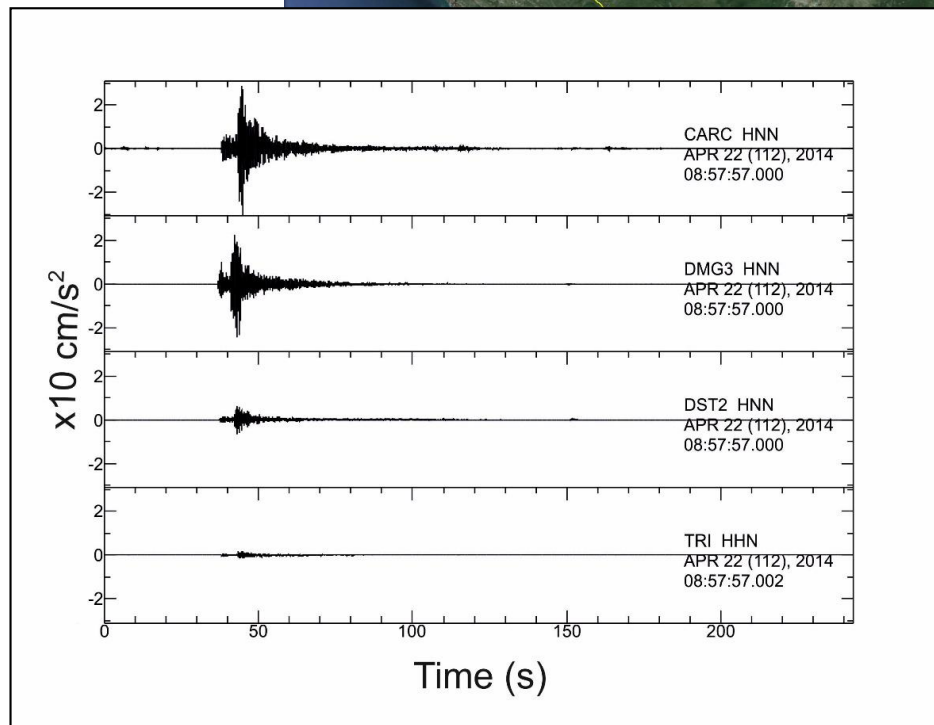
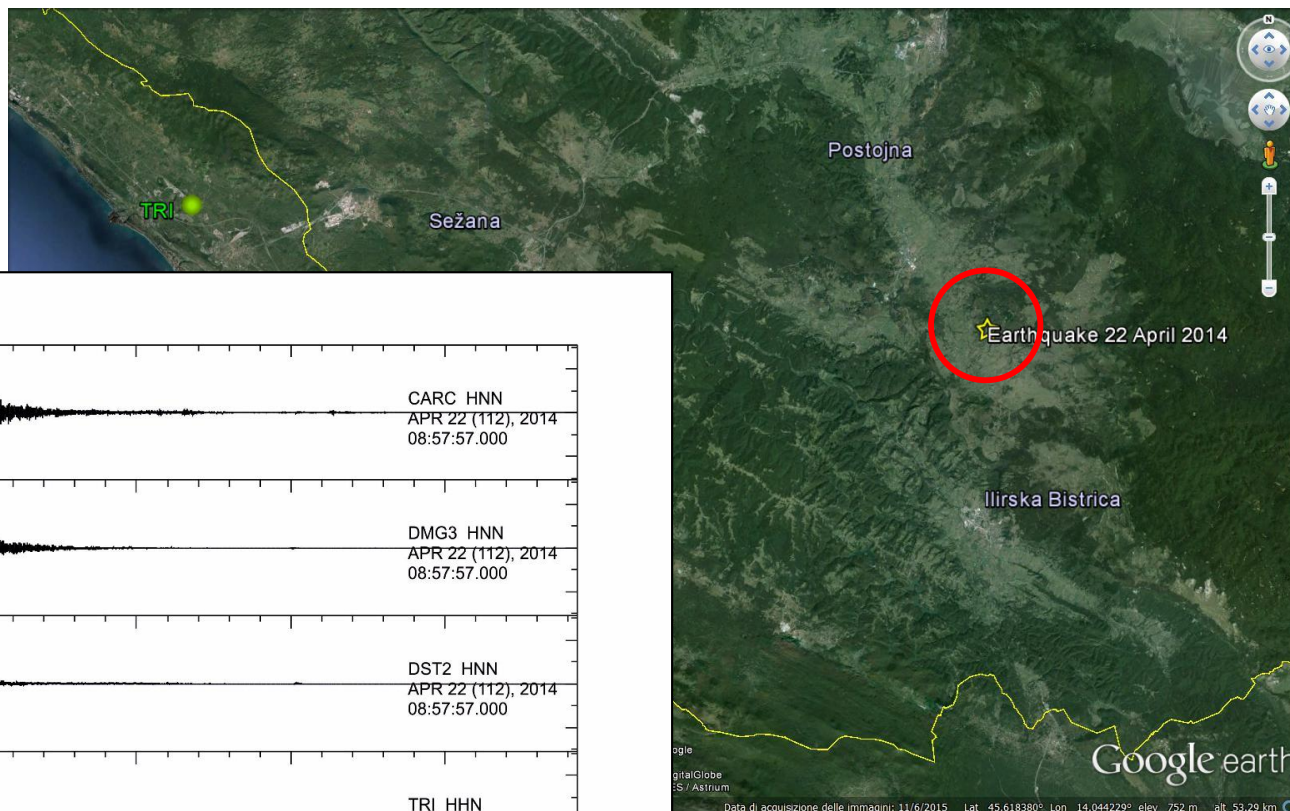


Stazione CARC - Borgo Teresiano - Trieste

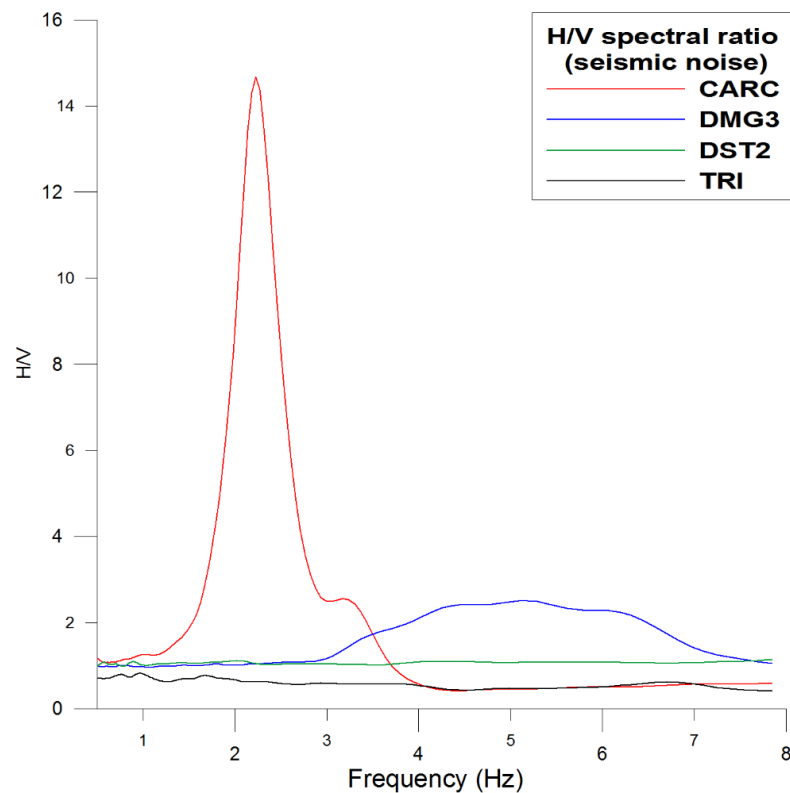
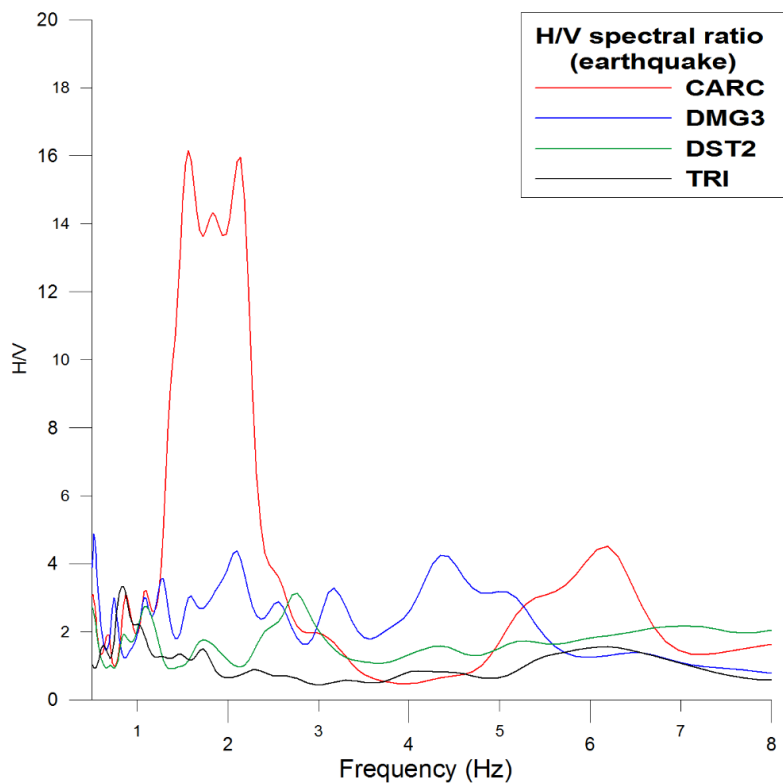
Palazzo Carciotti, Borgo Teresiano, Trieste



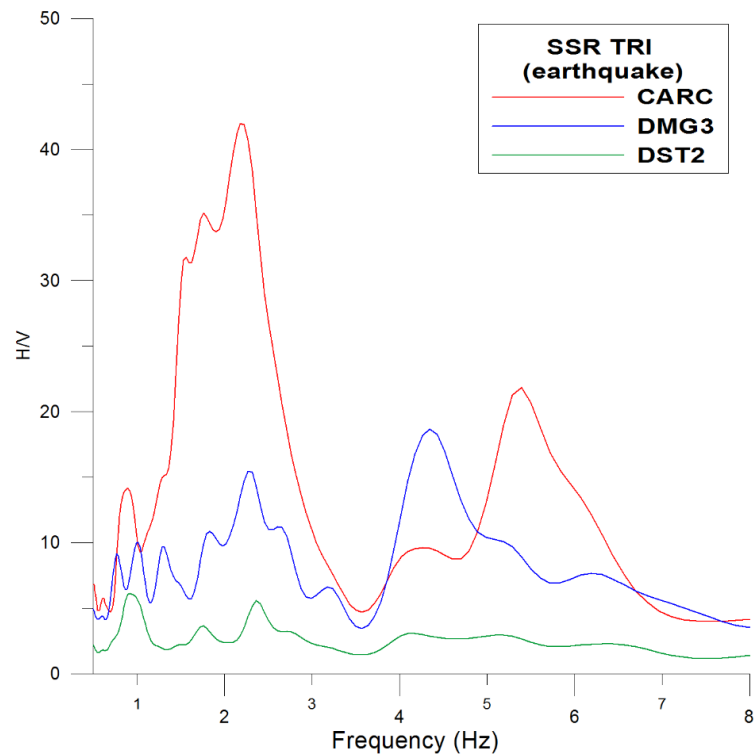
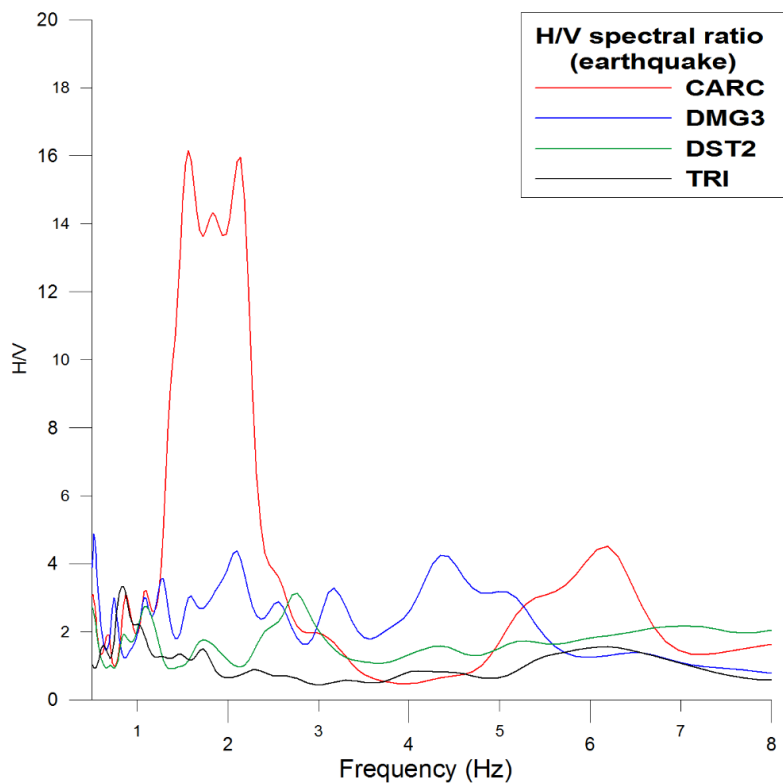
Evento Monte Nevoso - 22 Aprile 2014 – MI 4.7



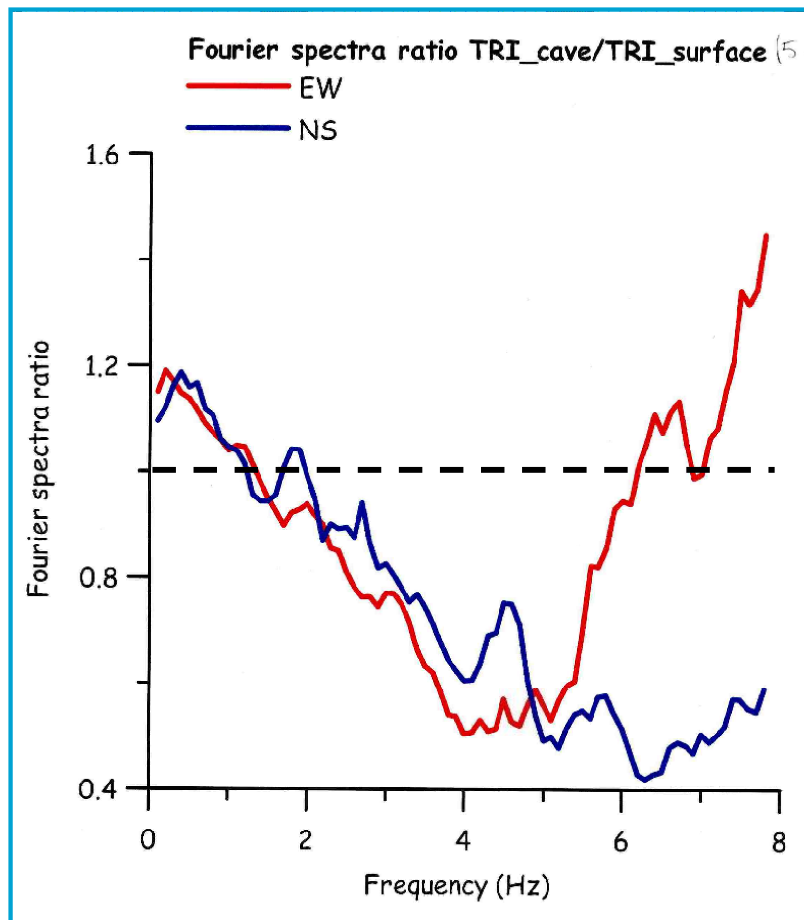
Evento Monte Nevoso - 22 Aprile 2014 – MI 4.7



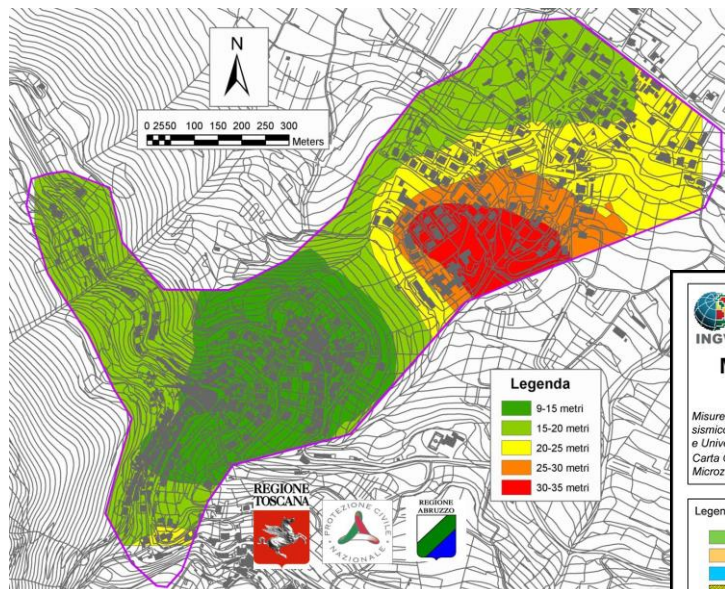
Evento Monte Nevoso - 22 Aprile 2014 – MI 4.7



TRI station Grotta Gigante, Trieste



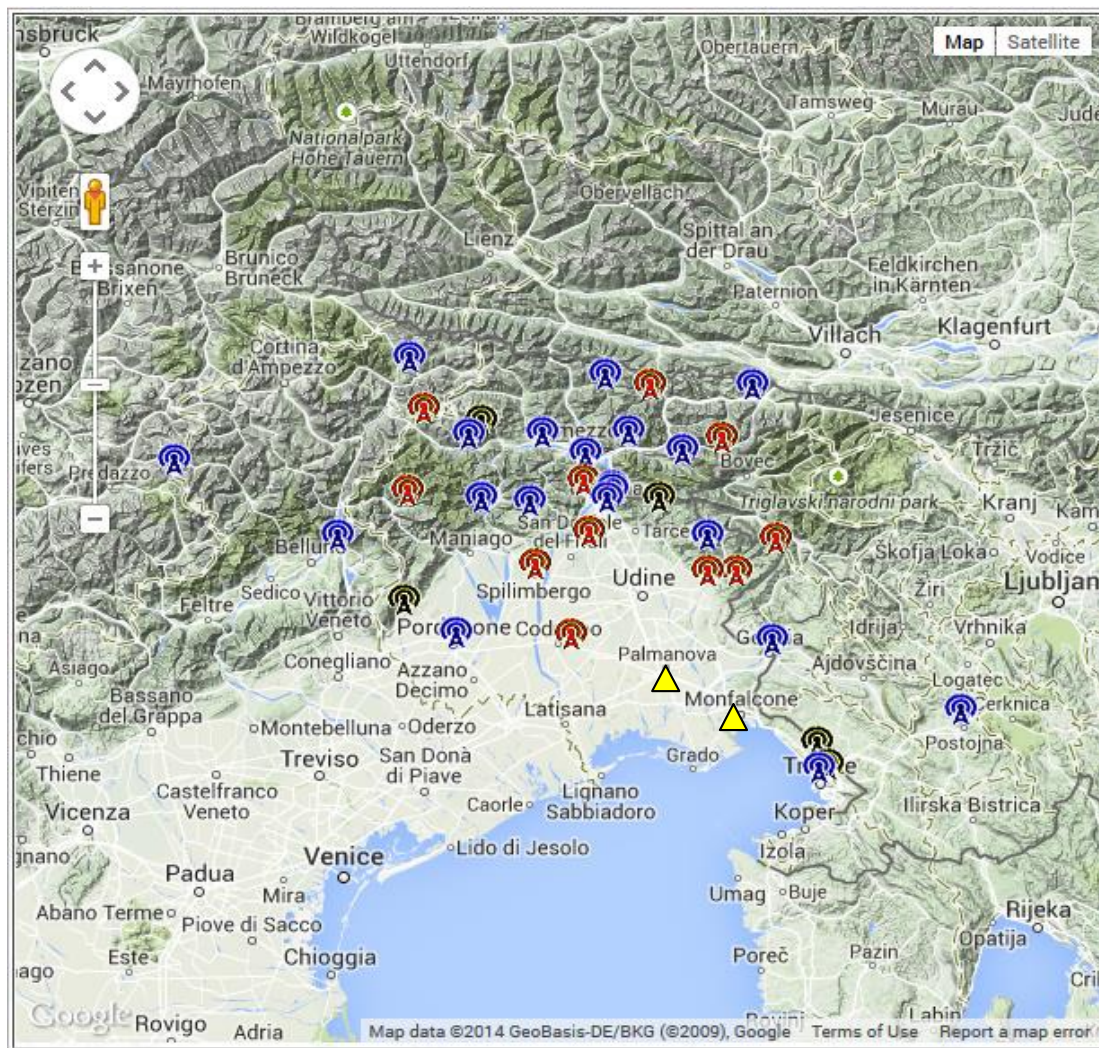
Microzonazione sismica



(*) La carta rappresenta i valori di fo ricavati dalle analisi dei rapporti H/V del rumore sismico. I valori di fo ottenuti sono stati divisi in 6 classi rappresentate con cerchi di colore diverso a seconda del valore. Nei casi in cui sia presente un secondo picco separato, la frequenza corrispondente viene indicata con f1 (assumendo f1 > fo), ed è rappresentata con un simbolo triangolare. Per entrambe le frequenze la dimensione dei simboli utilizzati è proporzionale all'ampiezza del picco.

(**) R.M. Azzara, P. Bordoni, F. Cara, R. Cogliano, G. Cultrera, G. Di Giulio, A. Fodarella, G. Milano, S. Pucillo, G. Riccio; (***) S. Marcucci; (****) F. Capaldi, M. Manetta.

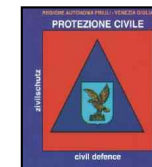
Rete Accelerometrica del FVG-Veneto



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

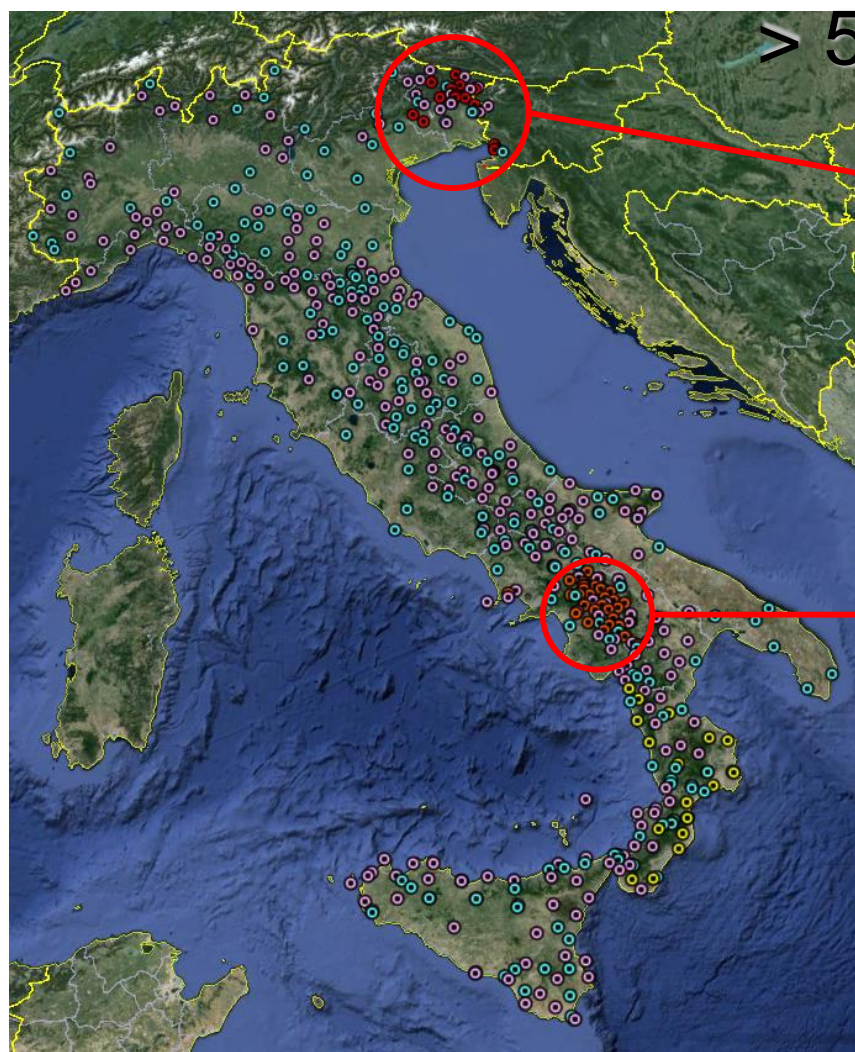
Rete Accelerometrica del FVG-Veneto



Rete Accelerometric Nazionale



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



> 500 stations

Friuli Venezia Giulia
Accelerometric Network – RAF

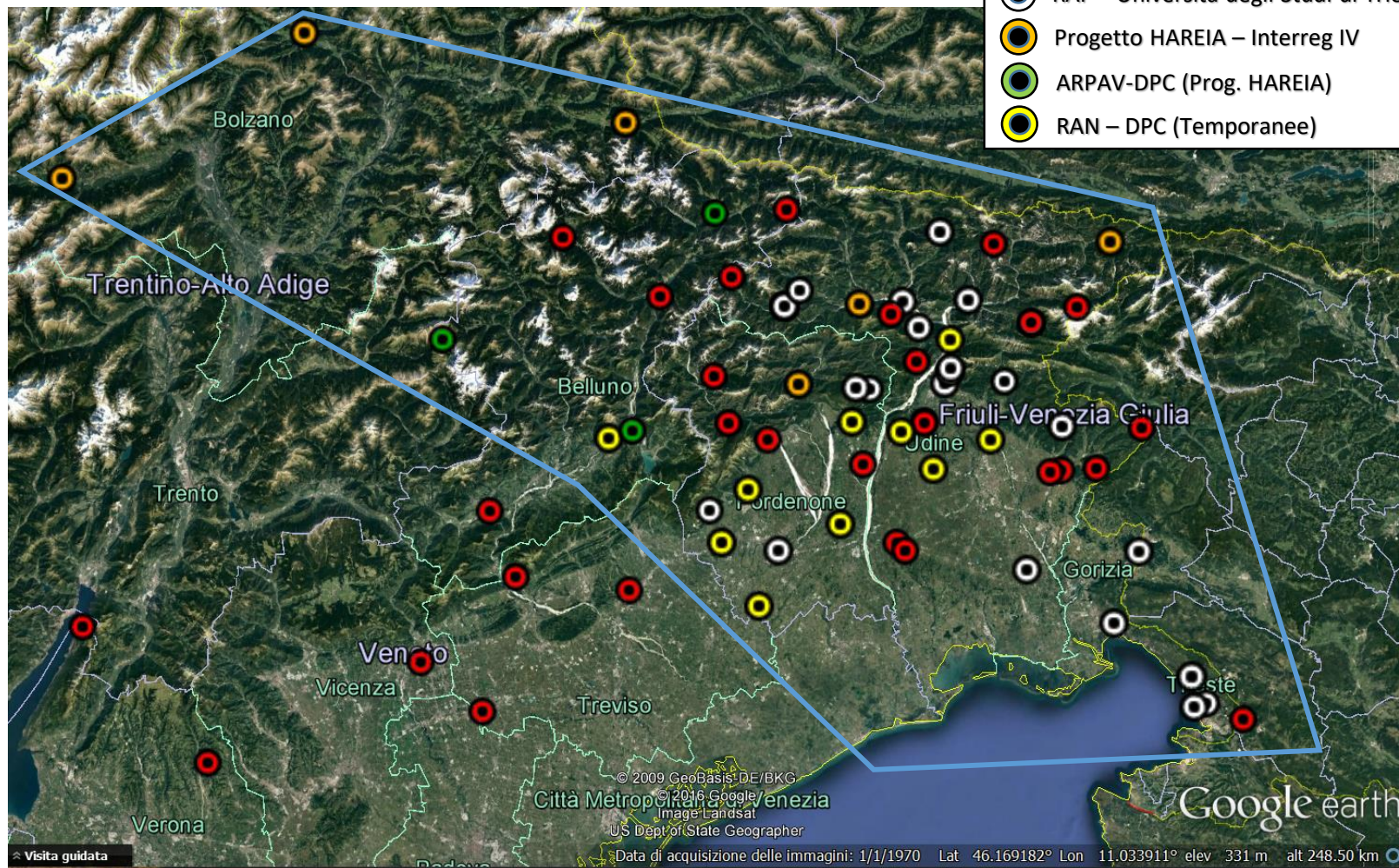


Irpinia
Seismic Network – ISNET

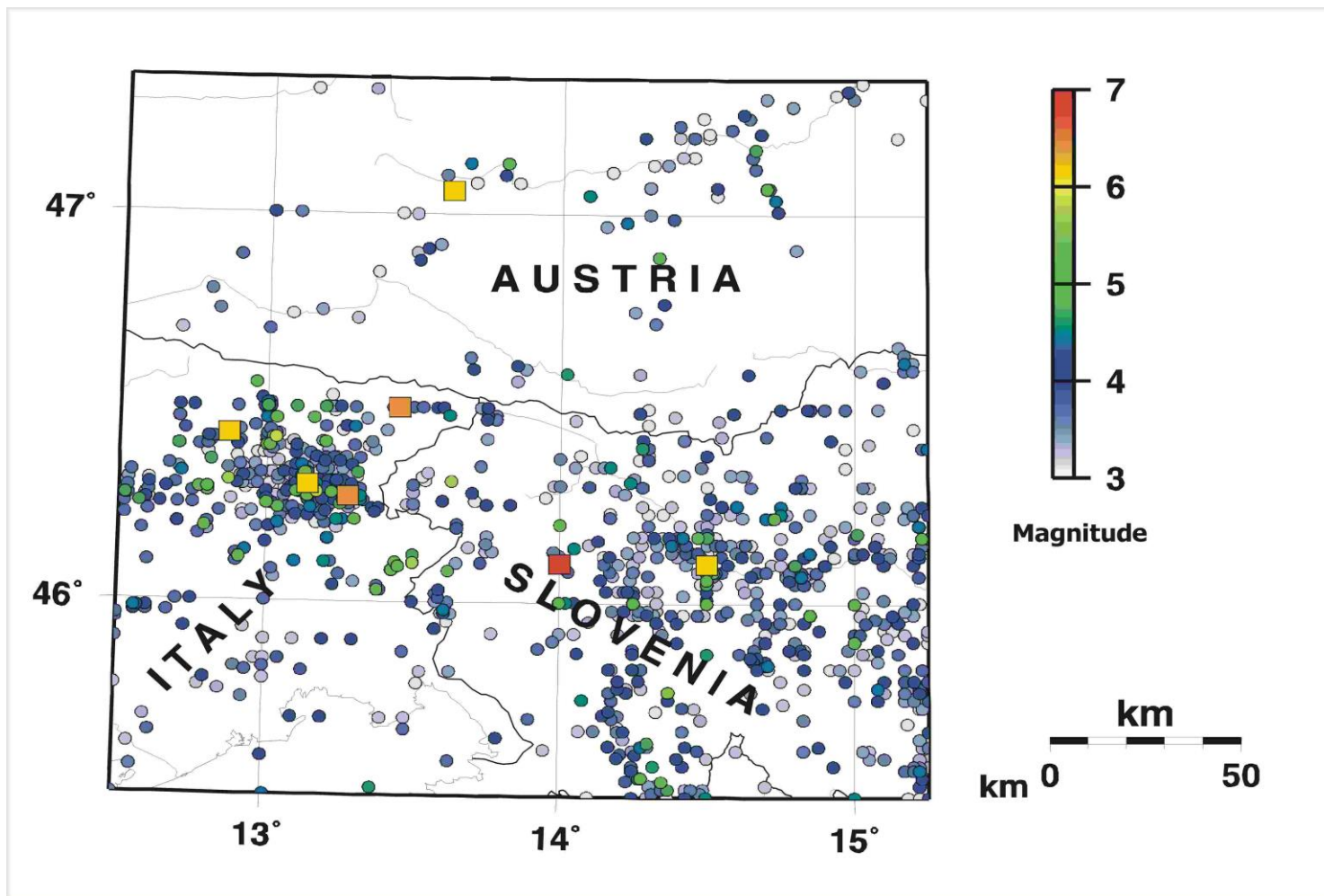


Rete Accelerometrica Integrata

- 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



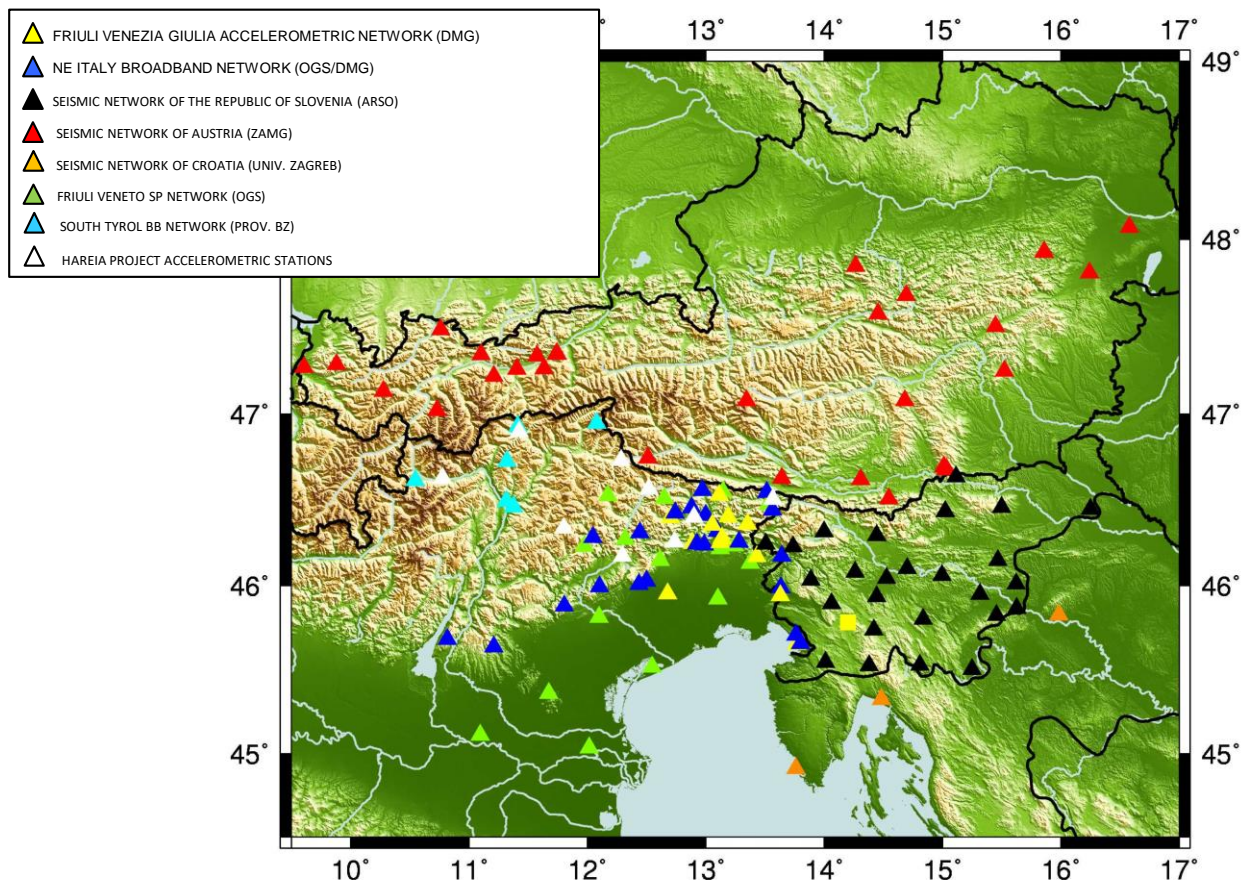
Central and Eastern European Earthquake Research Network CE³RN

Interreg IIIa Italia-Austria 2001-2006 projects

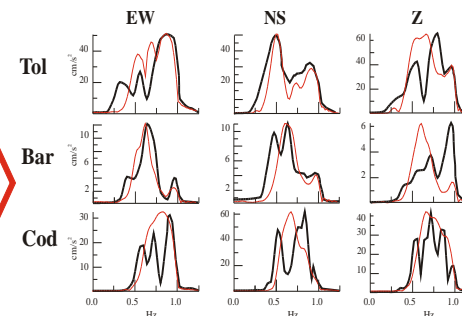
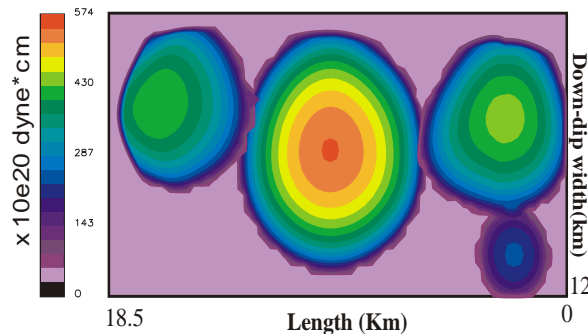
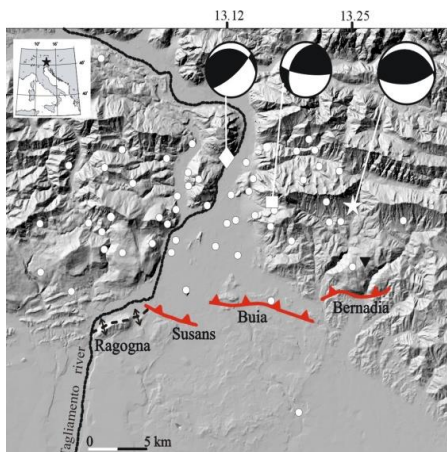
“Trans-National Seismological Networks in the South-Eastern Alps” and “FASTLINK”



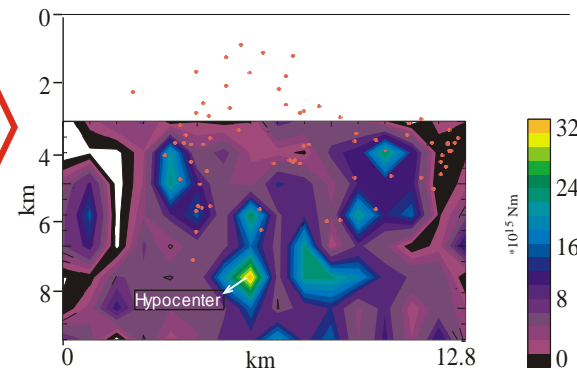
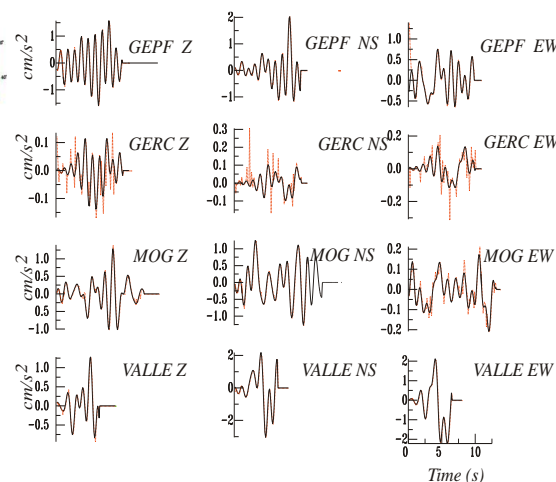
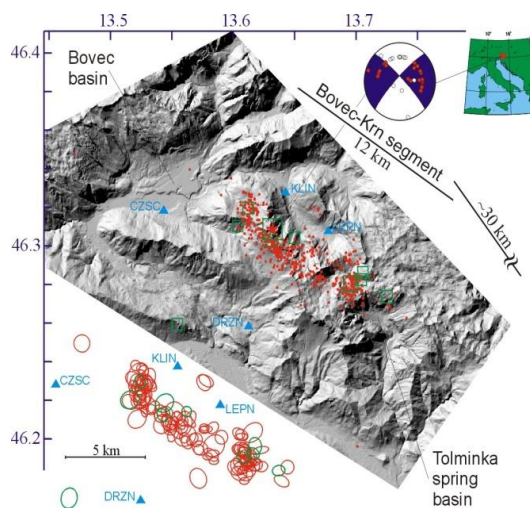
ZAMG



Fault slip models: the 1976 and 1998 main shocks

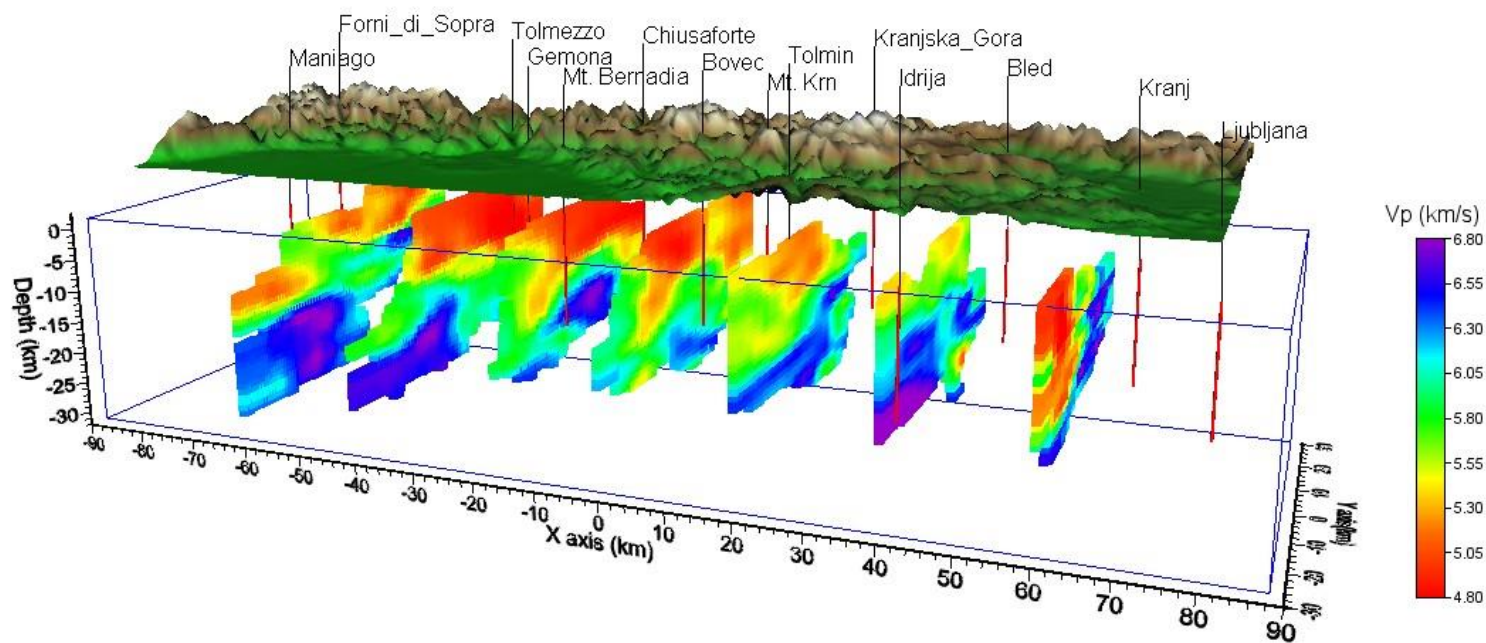


Aoudia et al., GRL, 2000

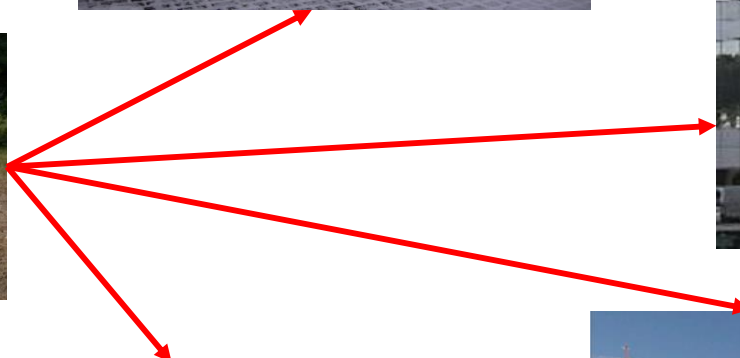


Bajc, et al. GRL, 2001

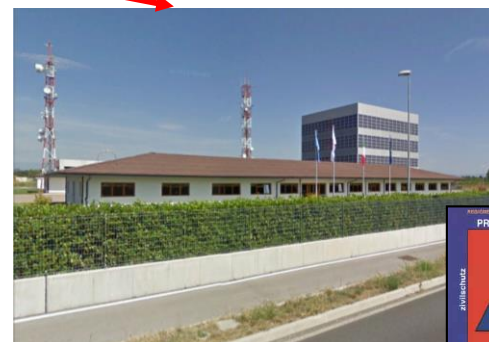
Tomografia



Rete Accelerometrica del FVG-Veneto

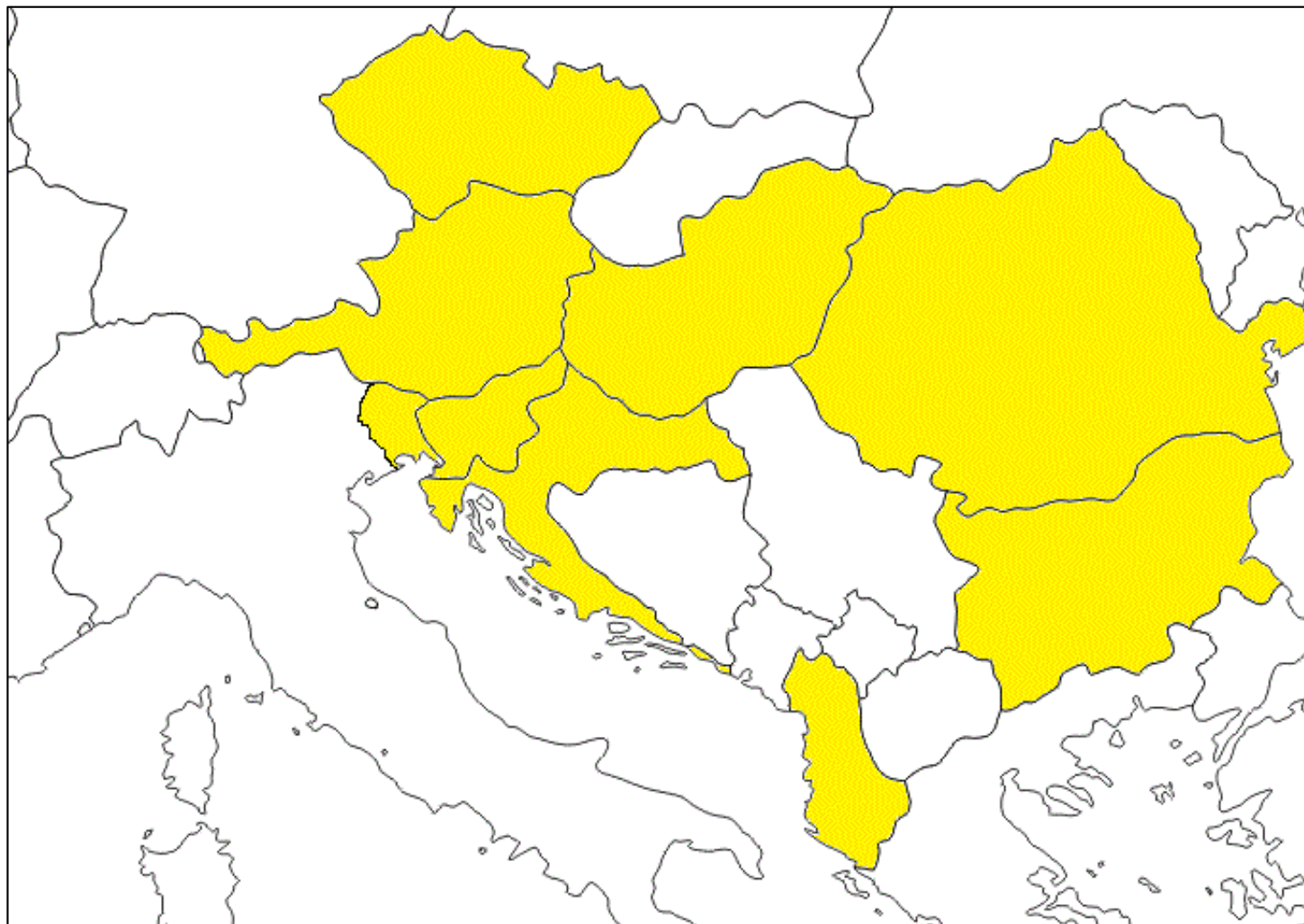


CE³RN
Central and Eastern European
Earthquake Research Network



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
ROT	HGE	18	0.2-50.0	188.81	115.67	5.36	0.77	169.52	49.68	9.30	B*	Arquata_Del_Tronto
ROT	HGN	18	0.2-50.0	147.80	109.77	5.64	1.03	255.30	64.97	14.20	B*	Arquata_Del_Tronto
ROT	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	79.02	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
FOC	HGE	23	0.2-50.0	606.13	477.17	19.60	0.90	1252.98	47.27	7.49	C*	Foligno_Colfiorito
FOC	HGN	23	0.2-50.0	365.33	215.49	9.57	1.10	426.11	56.75	9.40	C*	Foligno_Colfiorito
FOC	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	82.29	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	6.23	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

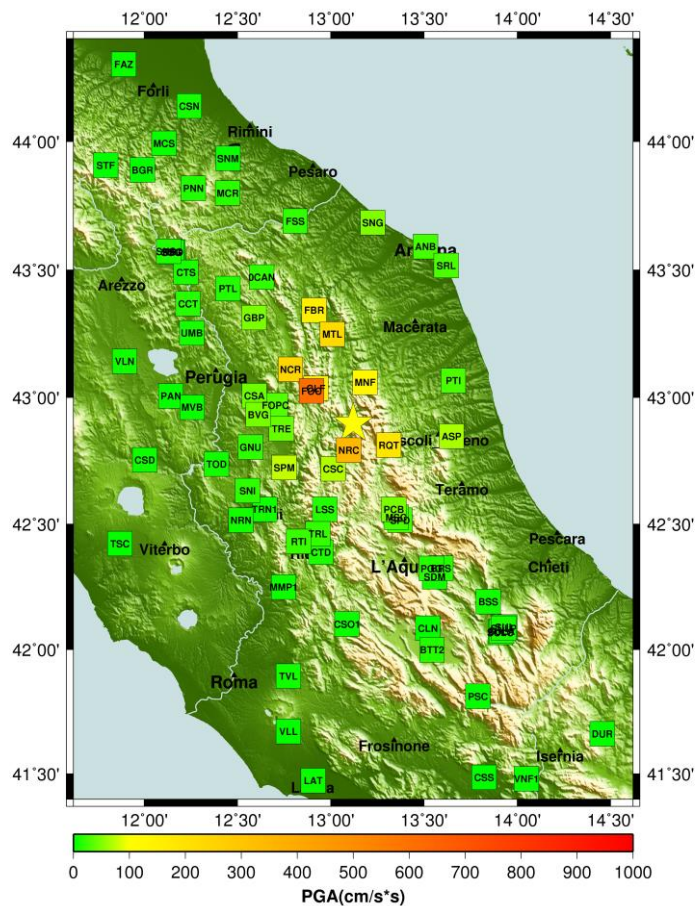
dista = epicentral distance
filter = automatic band pass butterworth filter
EC8 = site classification (Eurocode from ITACA)

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)

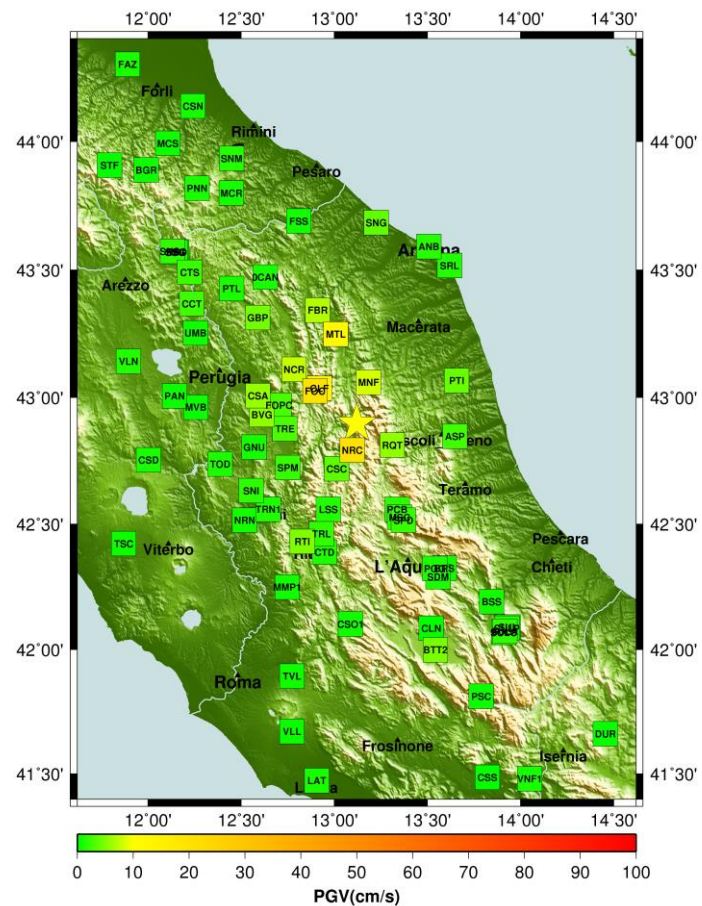


Analisi automatica, in tempo reale, dei dati accelerometrici per la protezione civile

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

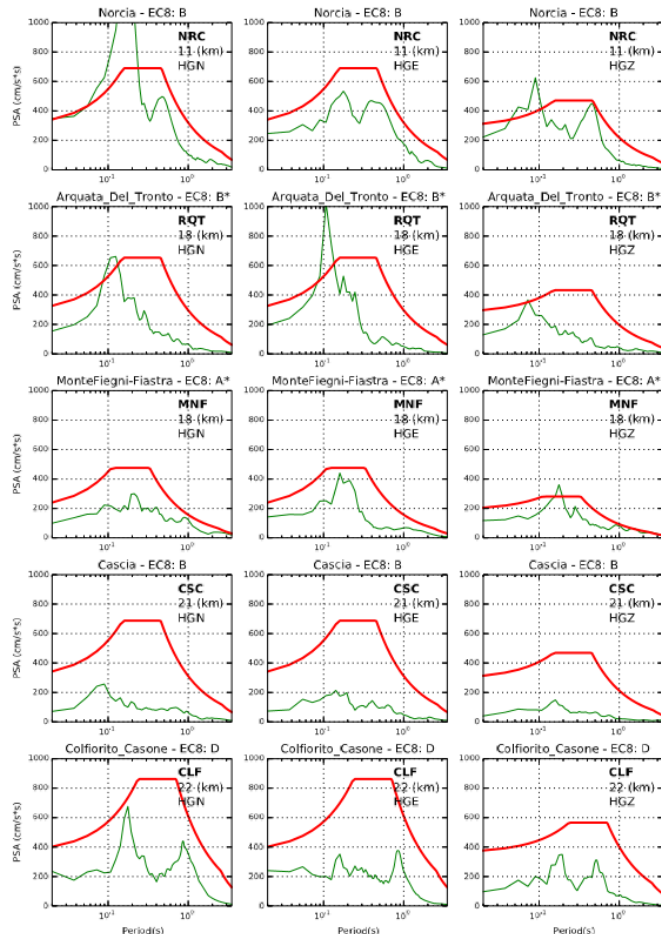


2016/10/26 19:18:06 MI:6.0 Castelsantangelo_sul_Nera

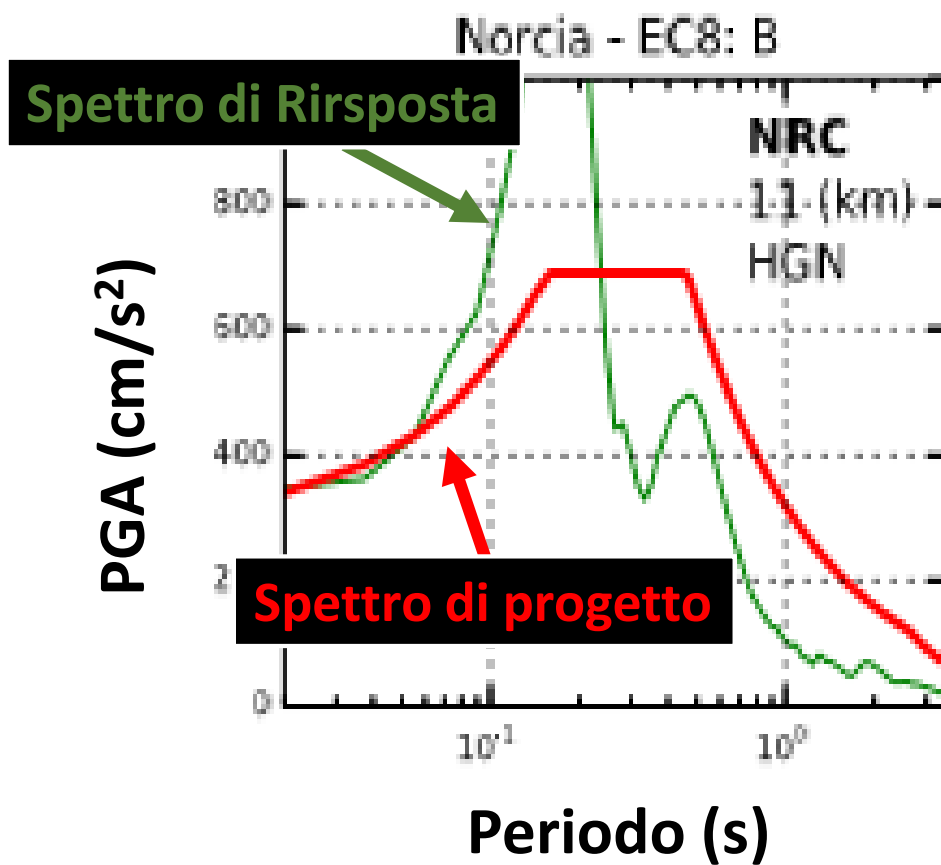


Rapporto automatico, in tempo reale per la protezione civile

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



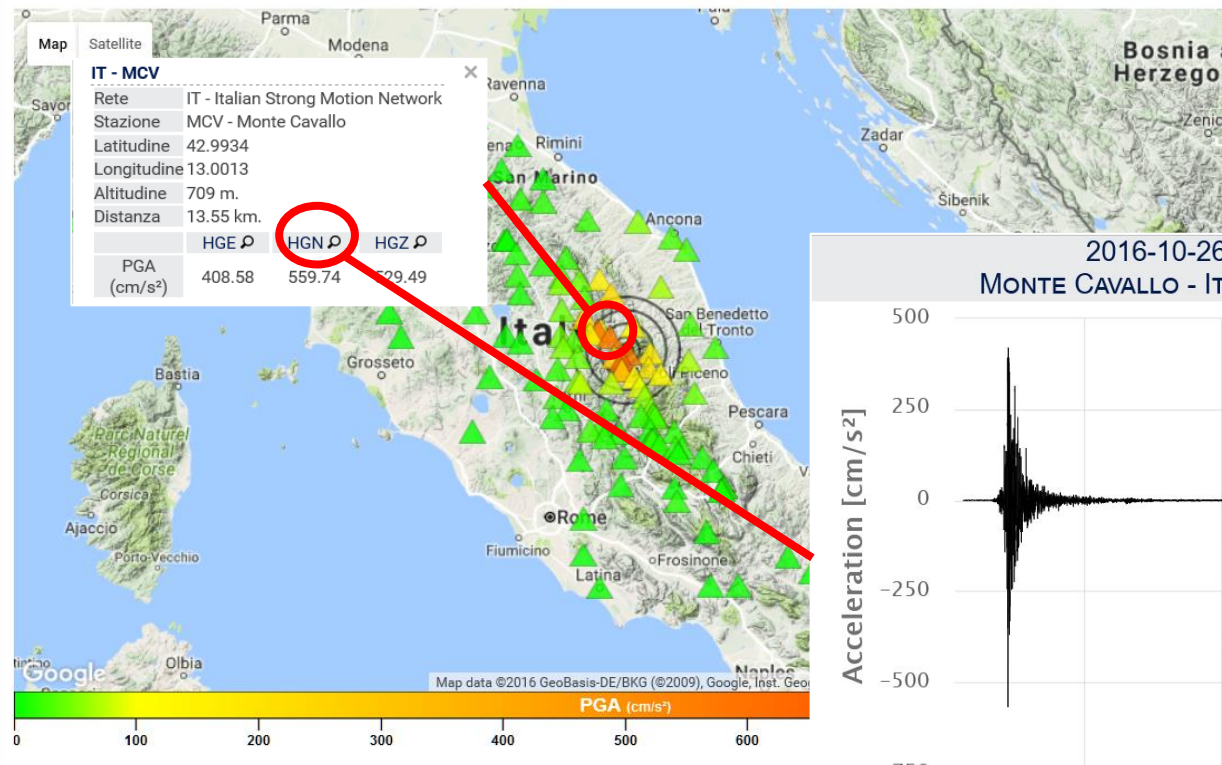
Spectral Acceleration SA (camping 5%) (thin green line)
Predicted SA - return period of 475 years as in the Italian Technical norms for buildings (NTC08) (red line)
Recorded smoothed spectral acceleration following the criteria suggested by Working Group MS (2008) (thick green line)



http://ran.protezionecivile.it



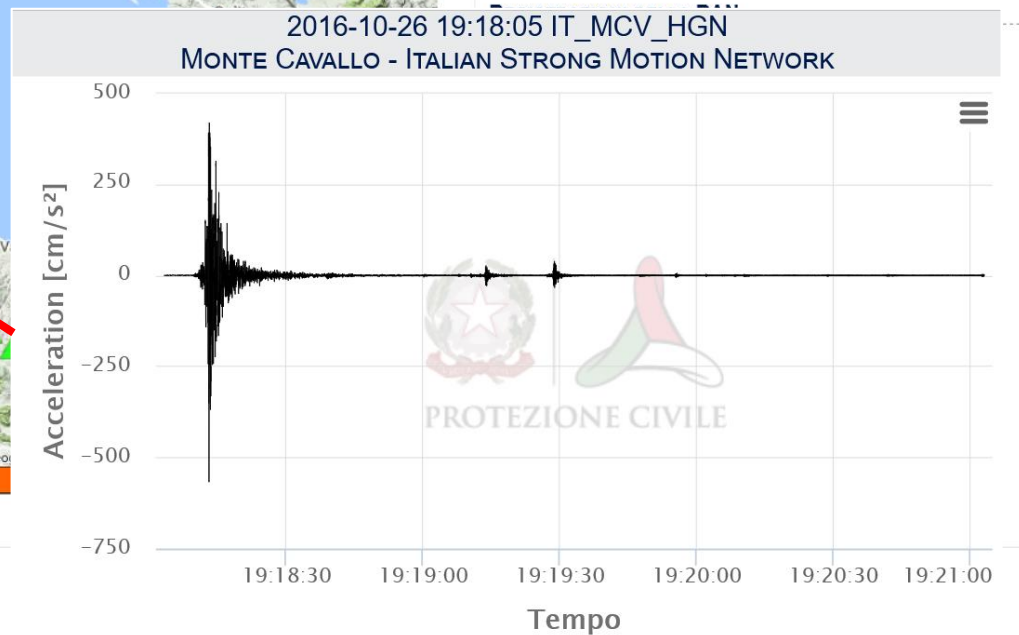
RETE ACCELEROMETRICA NAZIONALE - RAN DOWNLOAD



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

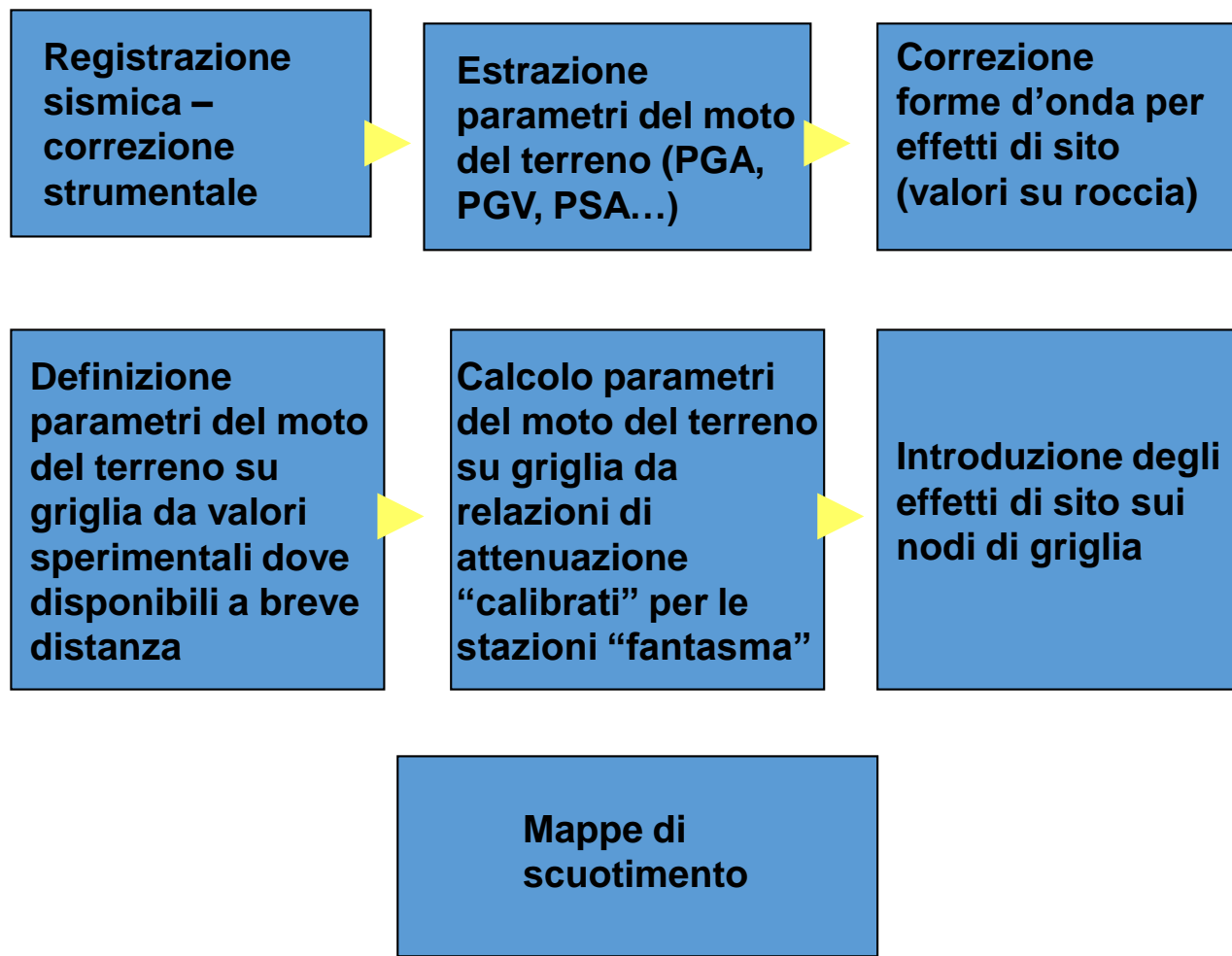
Parametri

Download

LLA RAN

- :3.4 Prof.08.2km Nrecs:43
- :3.3 Prof.10.7km Nrecs:35
- :3.1 Prof.07.1km Nrecs:29
- :3.5 Prof.07.7km Nrecs:36
- :3.3 Prof.08.7km Nrecs:35
- :3.0 Prof.08.3km Nrecs:29
- :3.3 Prof.09.6km Nrecs:40
- :3.1 Prof.08.6km Nrecs:36
- :2.8 Prof.10.2km Nrecs:21
- :3.1 Prof.10.7km Nrecs:26
- :2.8 Prof.10.5km Nrecs:16
- :3.1 Prof.09.1km Nrecs:30
- :3.4 Prof.08.8km Nrecs:38
- :4.0 Prof.08.4km Nrecs:26
- :4.2 Prof.08.6km Nrecs:59

Mappe di scuotimento in tempo reale









Classi NEHRP

A CURA DEL

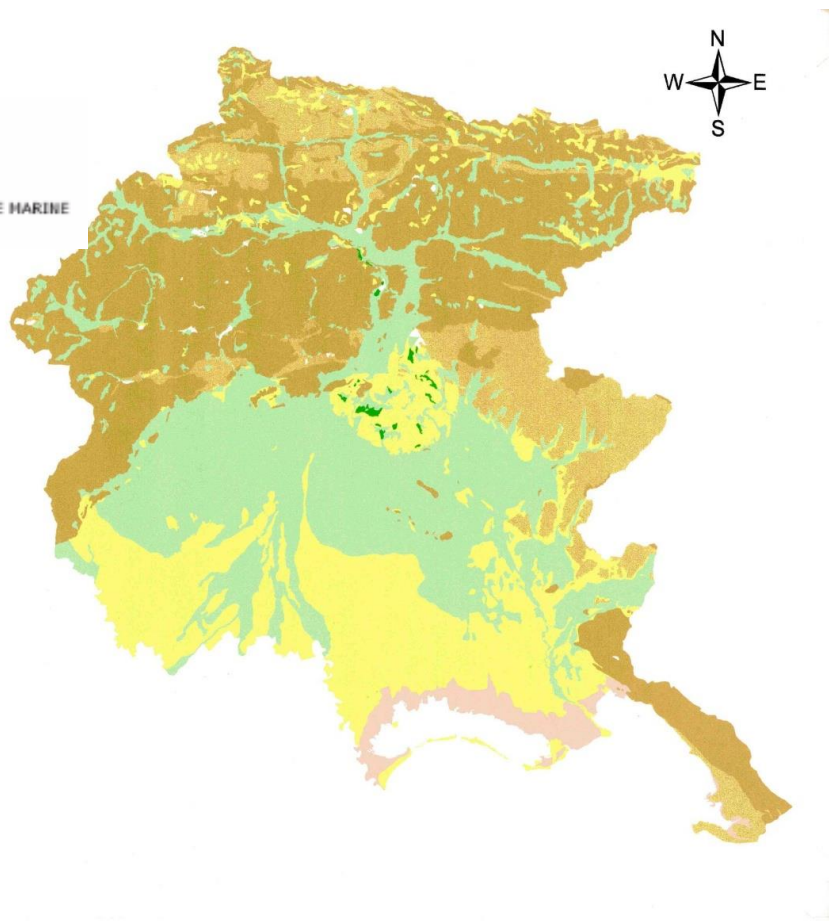


DIPARTIMENTO DI SCIENZE GEOLOGICHE, AMBIENTALI E MARINE
UNIVERSITÀ DEGLI STUDI DI TRIESTE

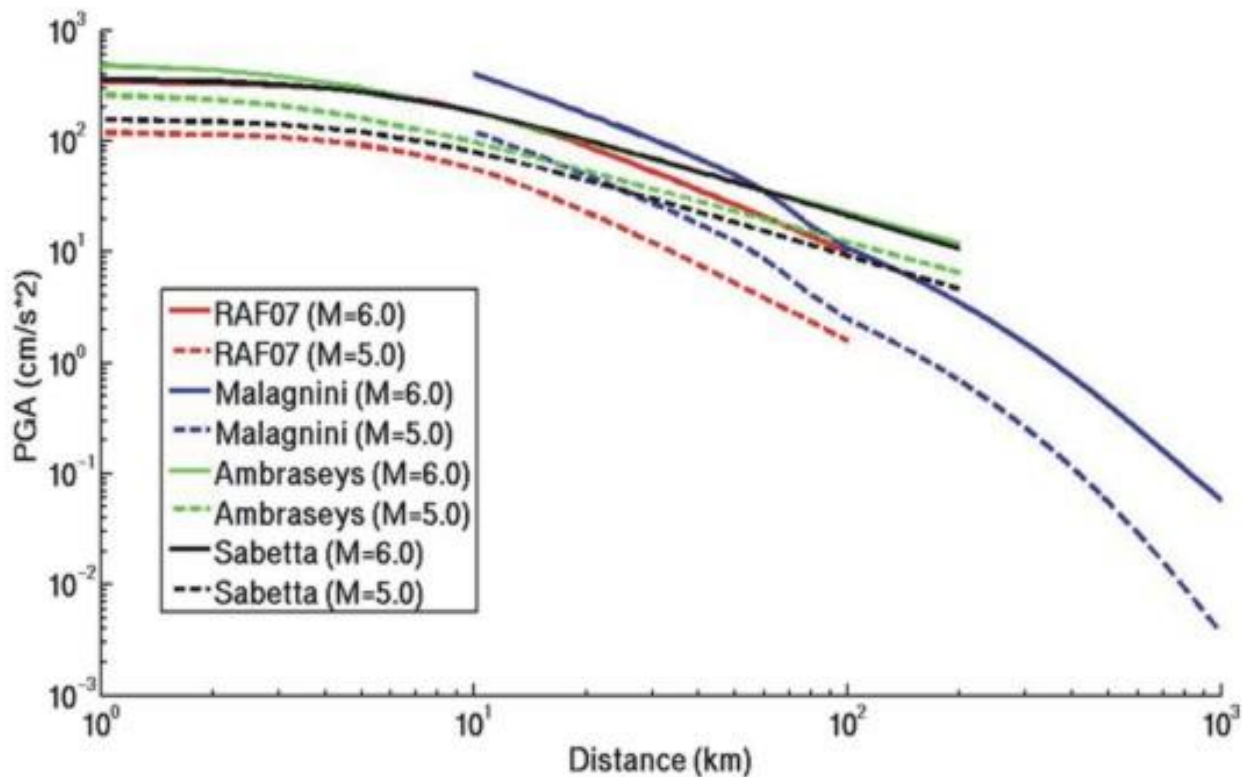
Legenda

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

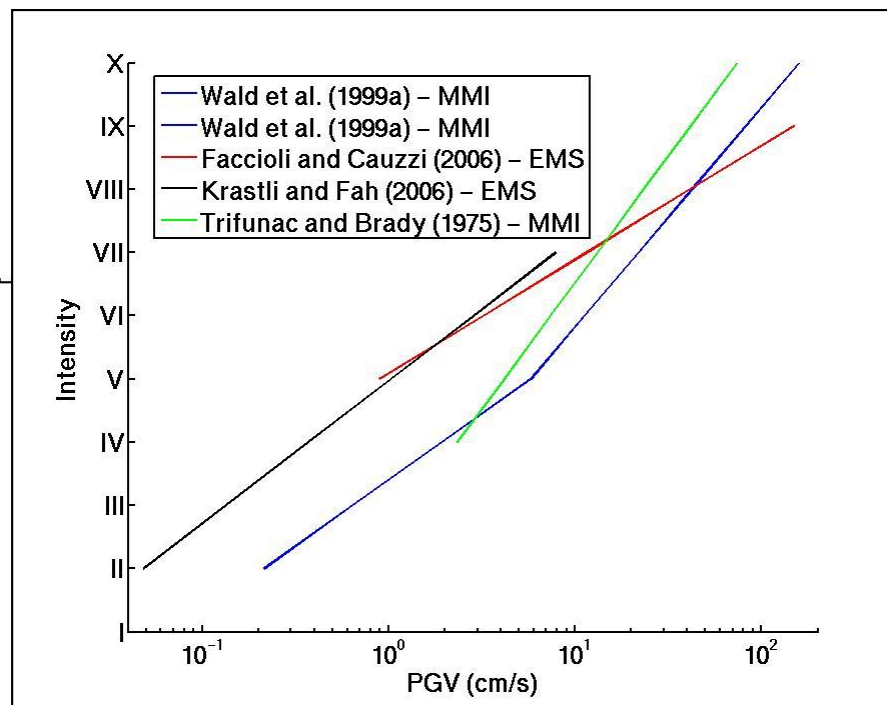
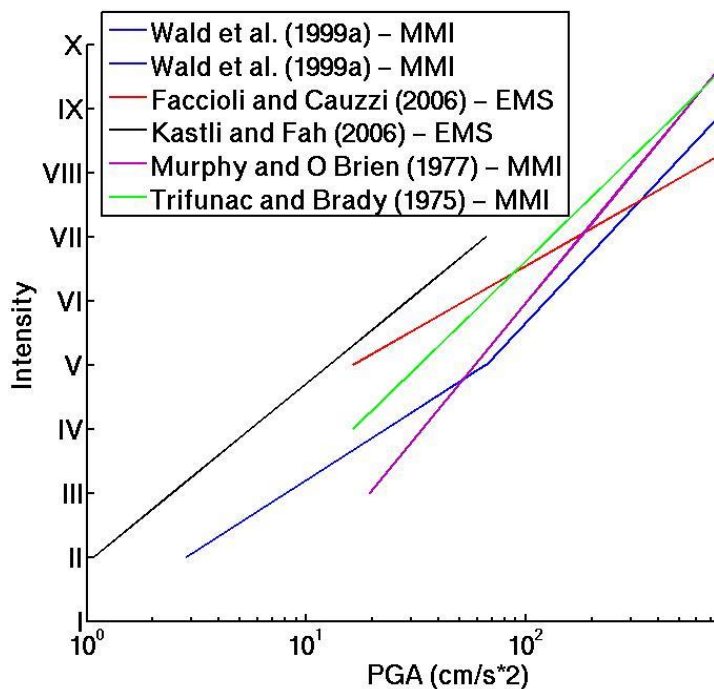
0 12.5 25 50 km



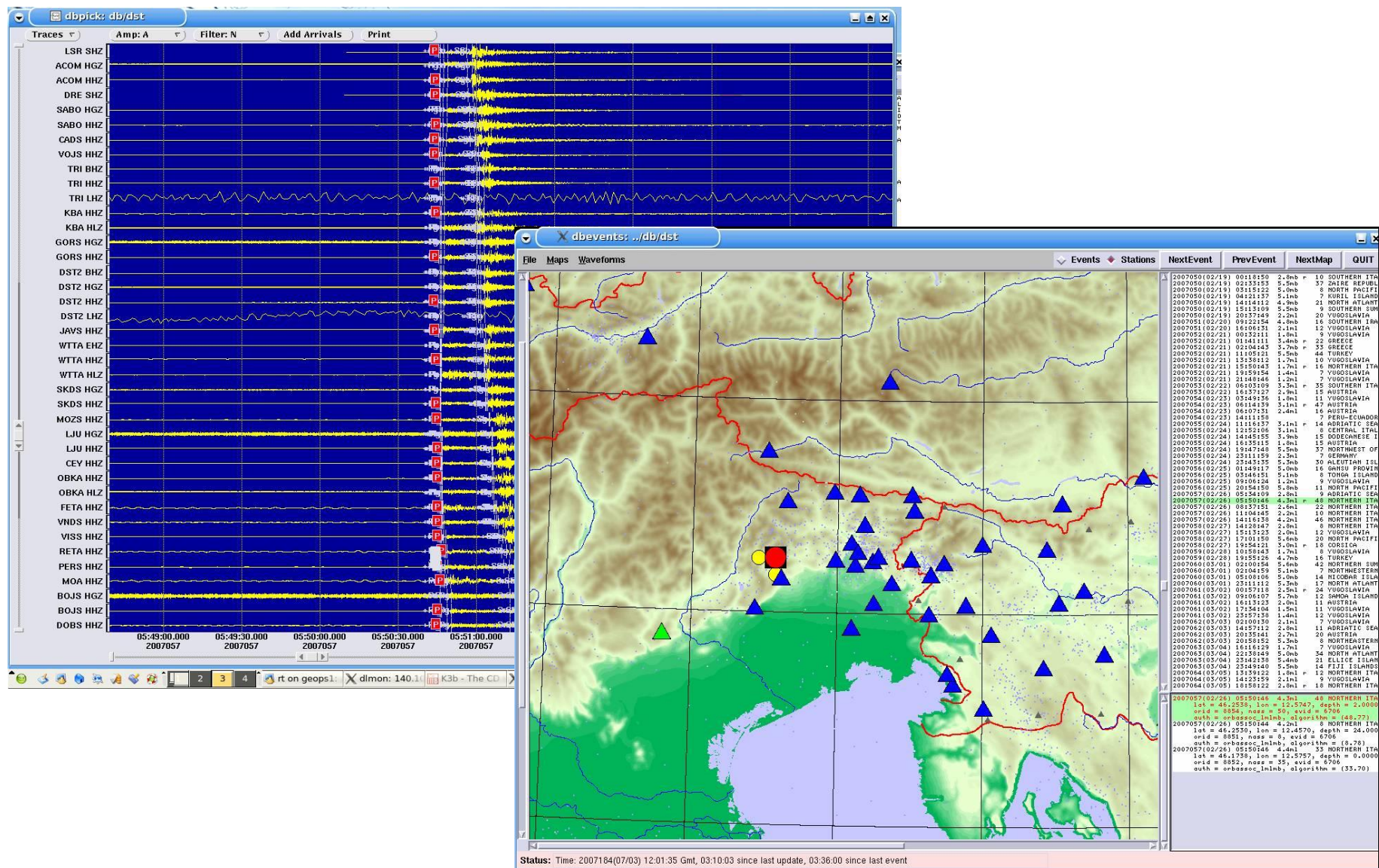
Relazioni di attenuazione

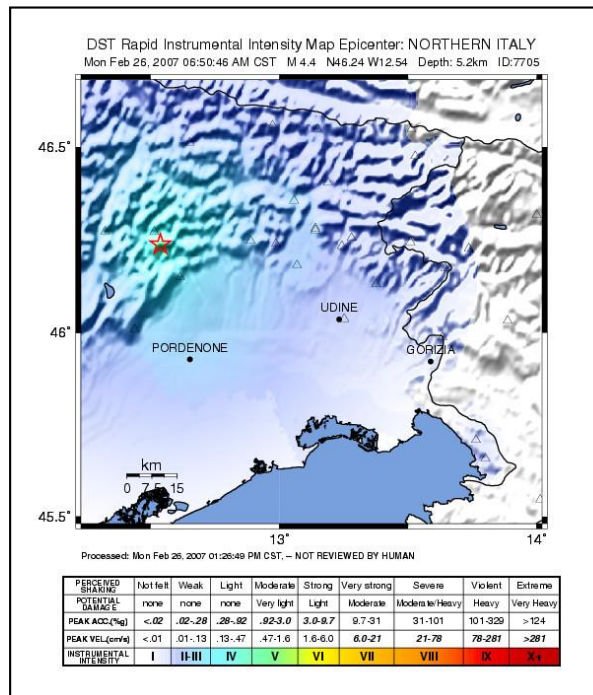
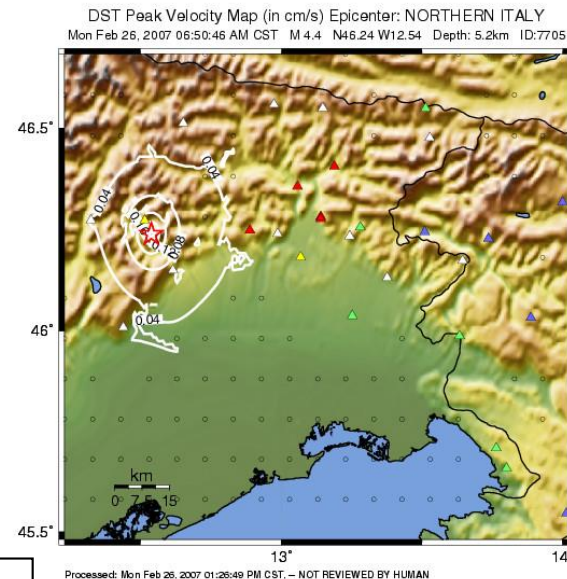
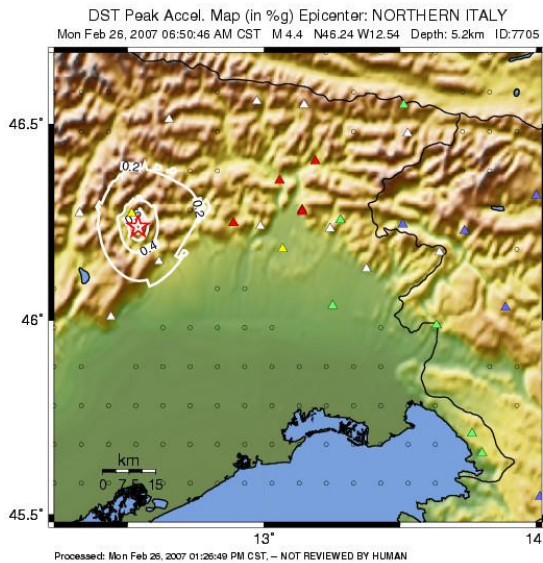


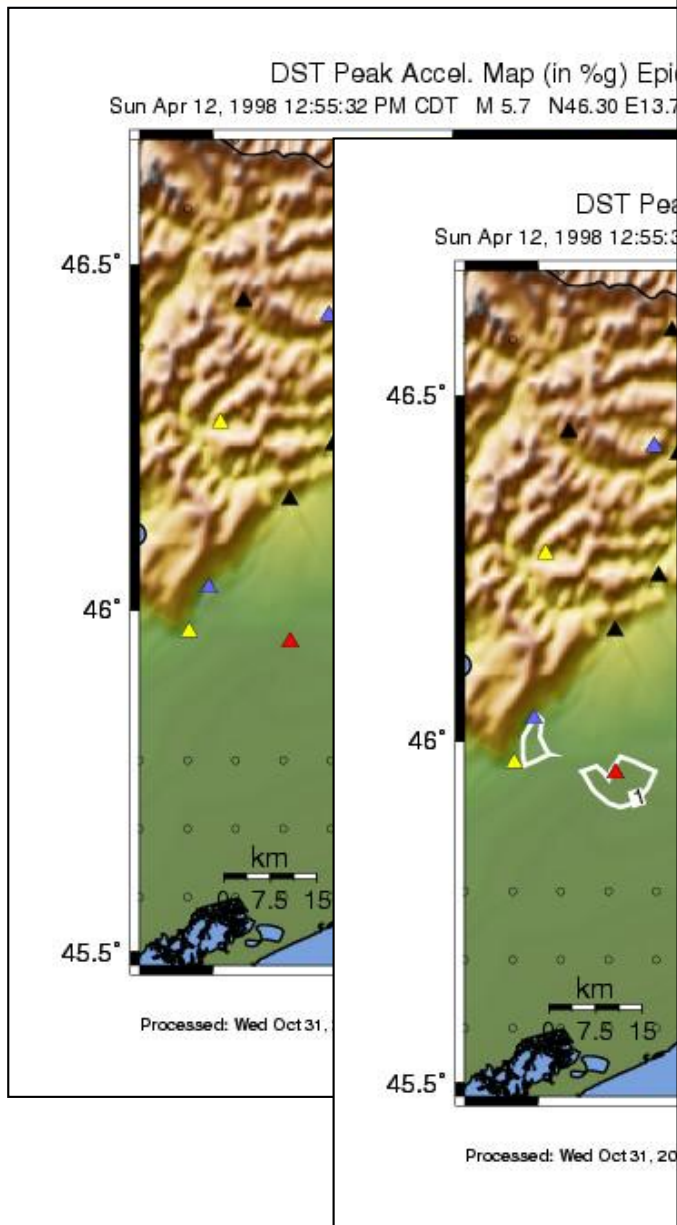
Relazioni PGA/PGV – Intensità



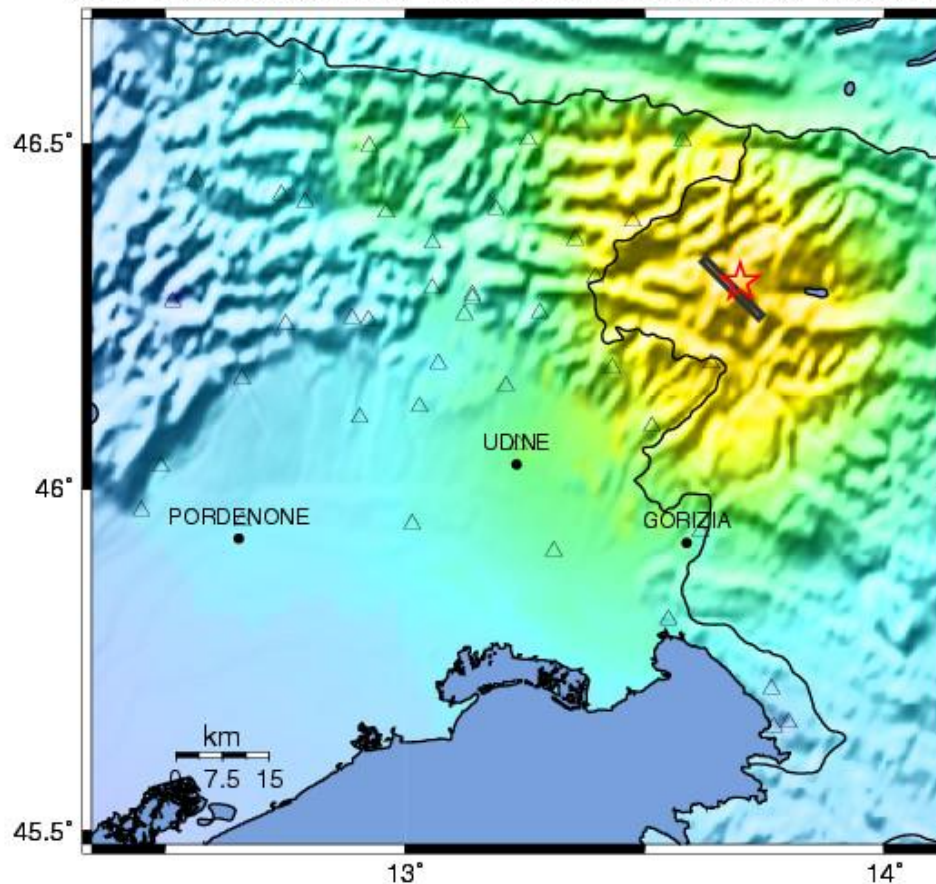
Integrated networks in Southern Alps area







DST Rapid Instrumental Intensity Map Epicenter: BOVEC
Sun Apr 12, 1998 12:55:32 PM CDT M 5.7 N46.30 E13.70 Depth: 15.2km ID:9804121055



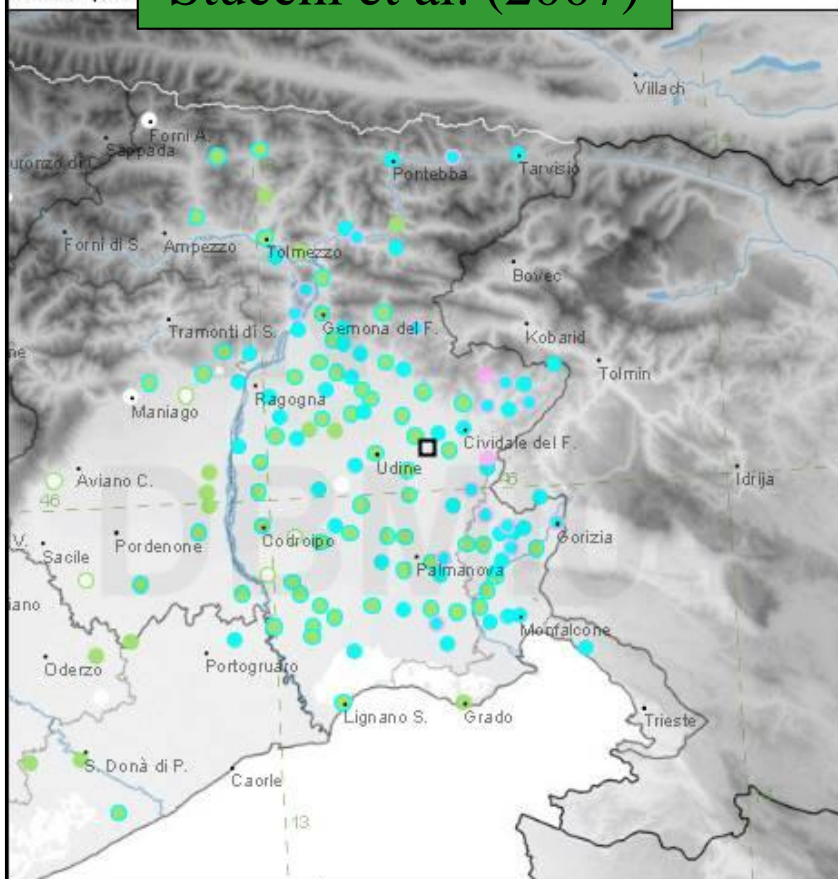
Processed: Wed Oct 31, 2007 12:07:06 PM CST, - NOT REVIEWED BY HUMAN

PERCEIVED SHAKING	Not felt	Weak	Light	Moderate	Strong	Very strong	Severe	Violent	Extreme
POTENTIAL DAMAGE	none	none	none	Very light	Light	Moderate	Moderate/Heavy	Heavy	Very Heavy
PEAK ACC.(%g)	<.07	.07-0.4	0.4-0.9	0.9-2.0	2.0-4.5	4.5-10	10-23	23-53	>53
PEAK VEL.(cm/s)	<.03	.03-0.2	0.2-0.6	0.6-1.7	1.7-4.7	4.7-13	13-36	36-100	>100
INSTRUMENTAL INTENSITY	I	II-III	IV	V	VI	VII	VIII	IX	X+

Terremoto di Udine 1998 Mw 5.70

Area epicentrale

Stucchi et al. (2007)



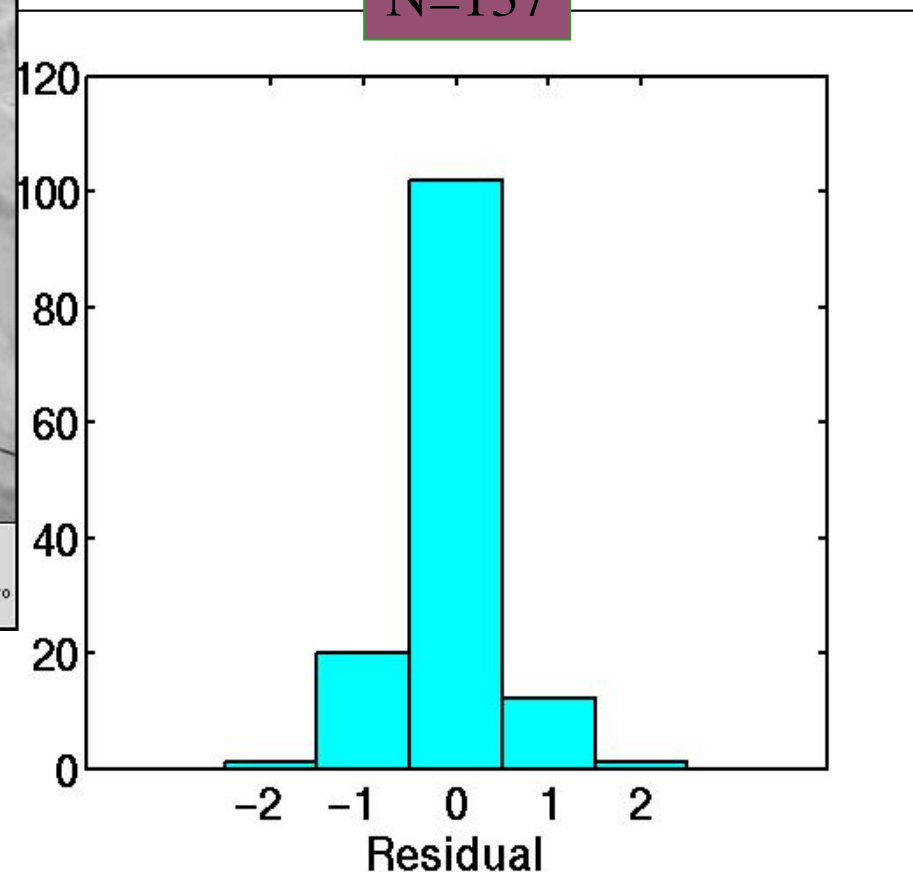
INGV-DBMI04

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

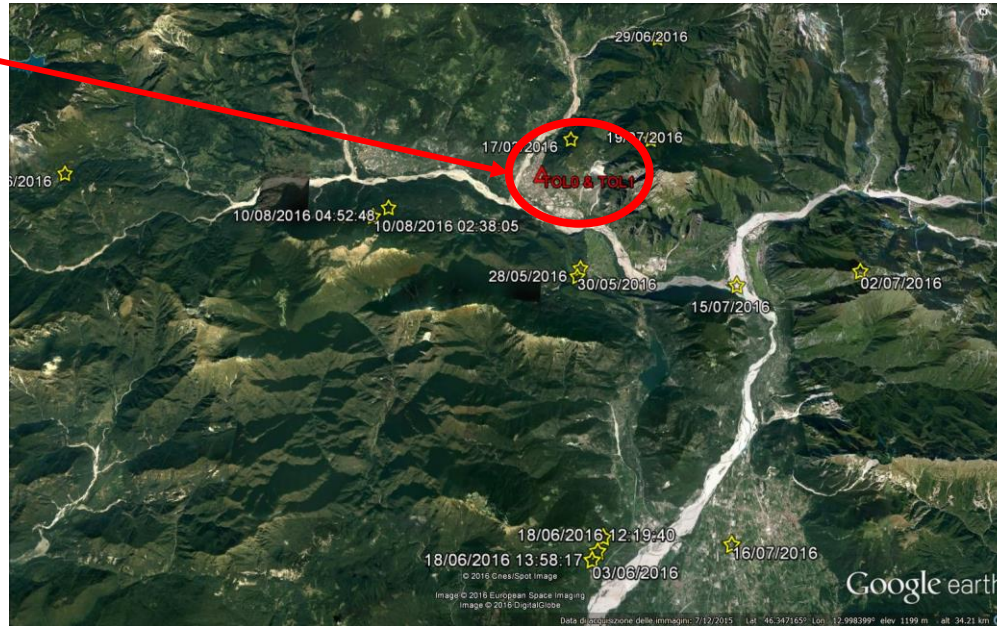
$$Misfit = \frac{\sum_{i=1}^N |I_{COM} - I_{OBS}|}{N} = 0.264$$



N=137

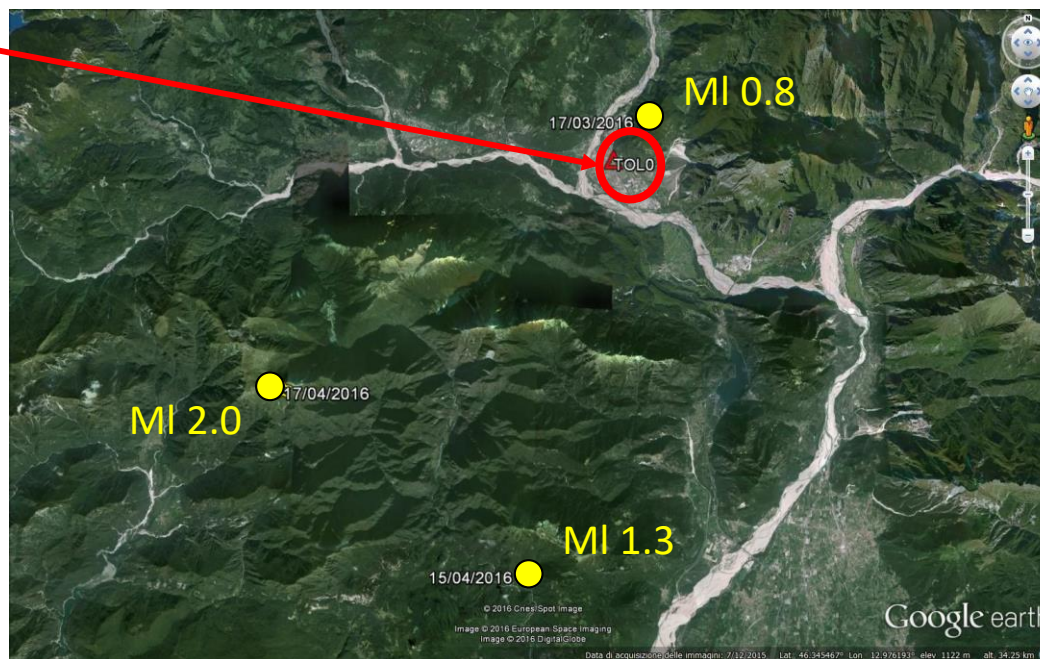


Tolmezzo

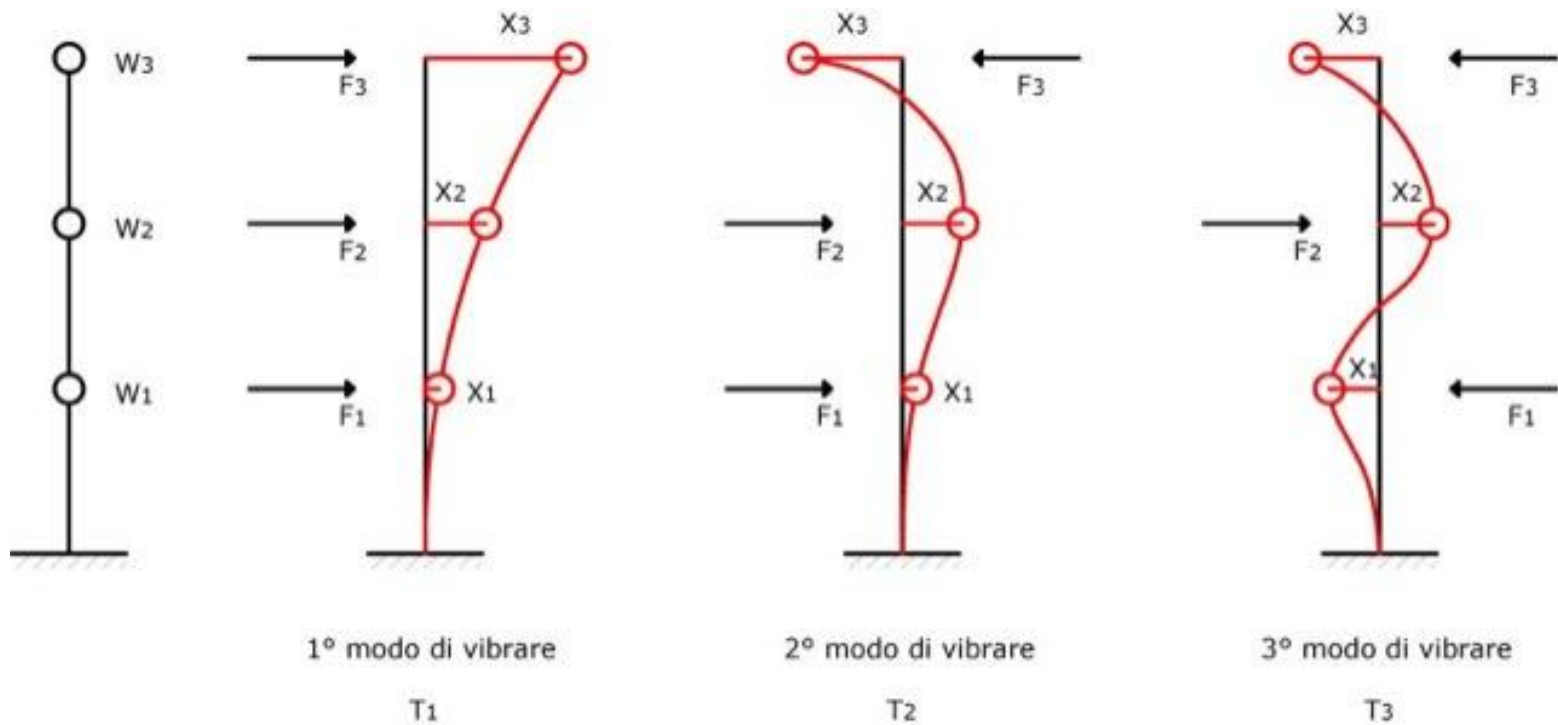


1976 – 2016 Simposio "Monitoraggio sismico e accelerometrico per la Protezione Civile: stato dell'arte e nuove strategie a 40 anni dal terremoto del Friuli / CRS Udine 19 aprile 2016

Tolmezzo

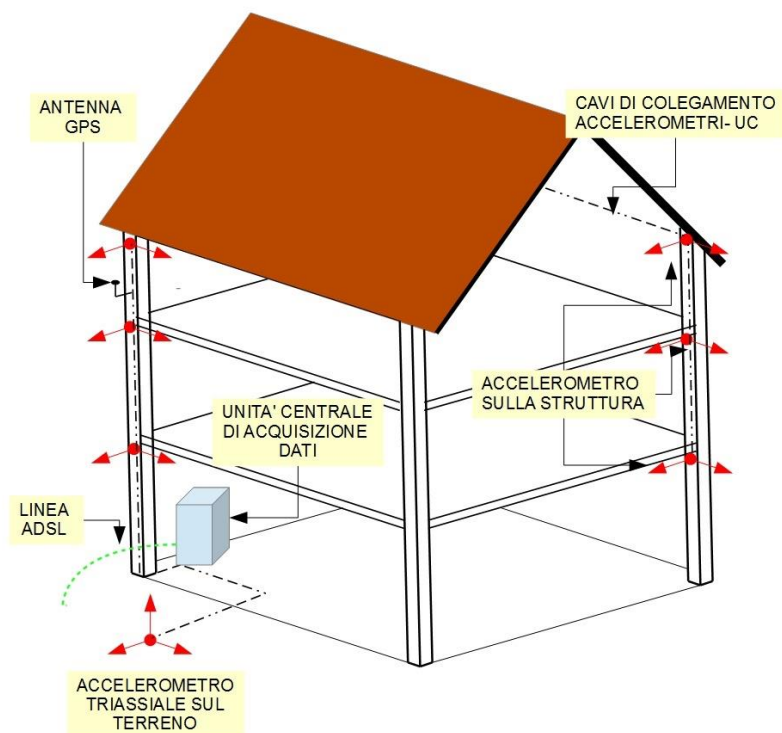


Modi elementari o modi naturali di vibrare



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

