Supplementary Material for:

Interplay of tectonic and dynamic processes shaping multilayer extensional system in southern-central Apennines

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enhanced_catalog.csv

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Table S3. Average focal mechanisms and kinematics axes for each cluster.

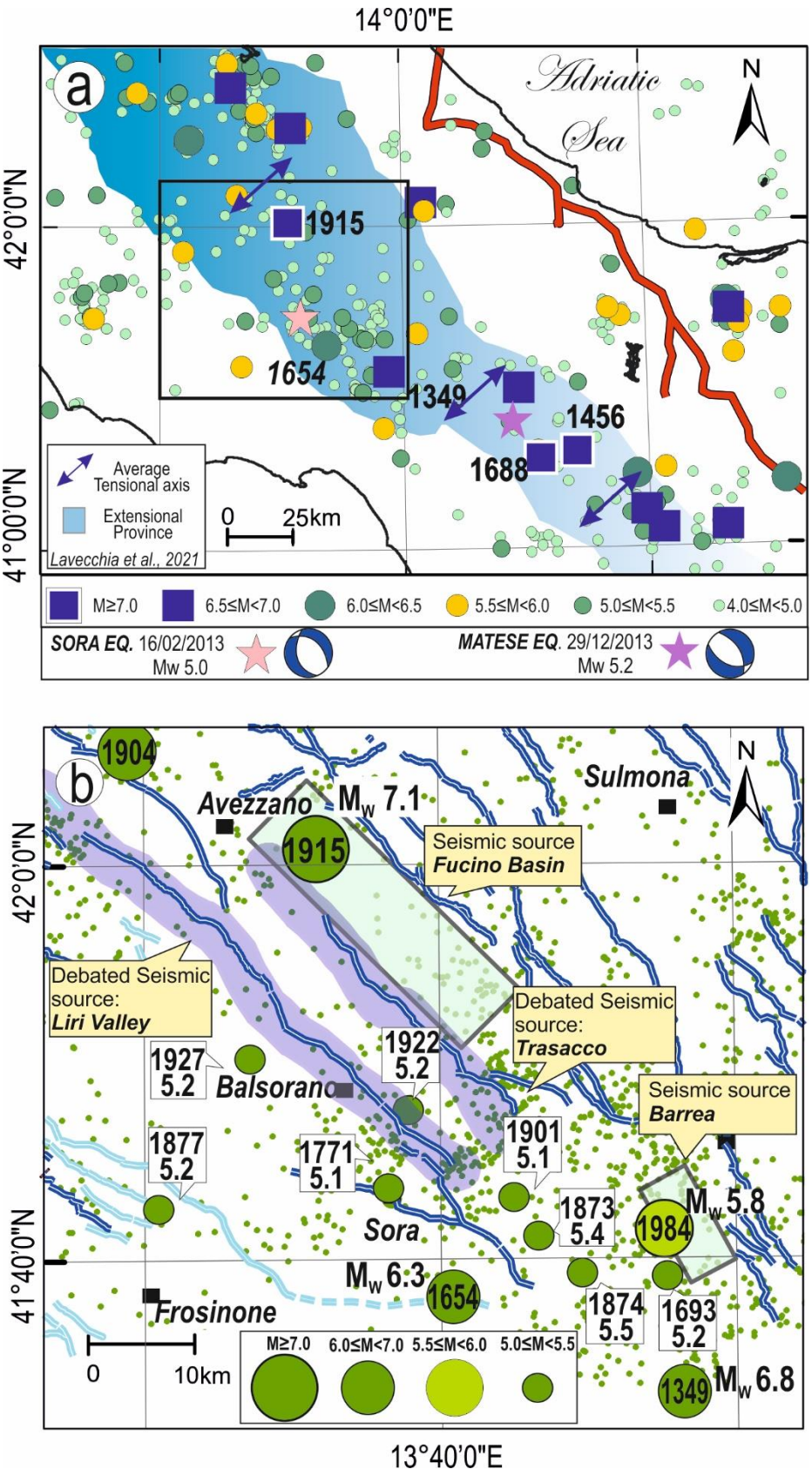


Figure S1. The seismotectonic framework of the study area. (a) Extensional Province from [5], and major historical and instrumental earthquakes from CPTI15v4 [6,7]. The red line represents the Outer Thrust Front (OTS). (b) Historical and instrumental seismicity map, active faults from QUIN database [8–10], and individual (light green rectangles) and debated (purple areas) seismogenic sources as reported by DISS [1]. The date and magnitude of the seismic events with $5.0 \leq M_W \leq 5.5$ are detailed, while minor seismicity $M_W < 5.0$ is reported without labels.

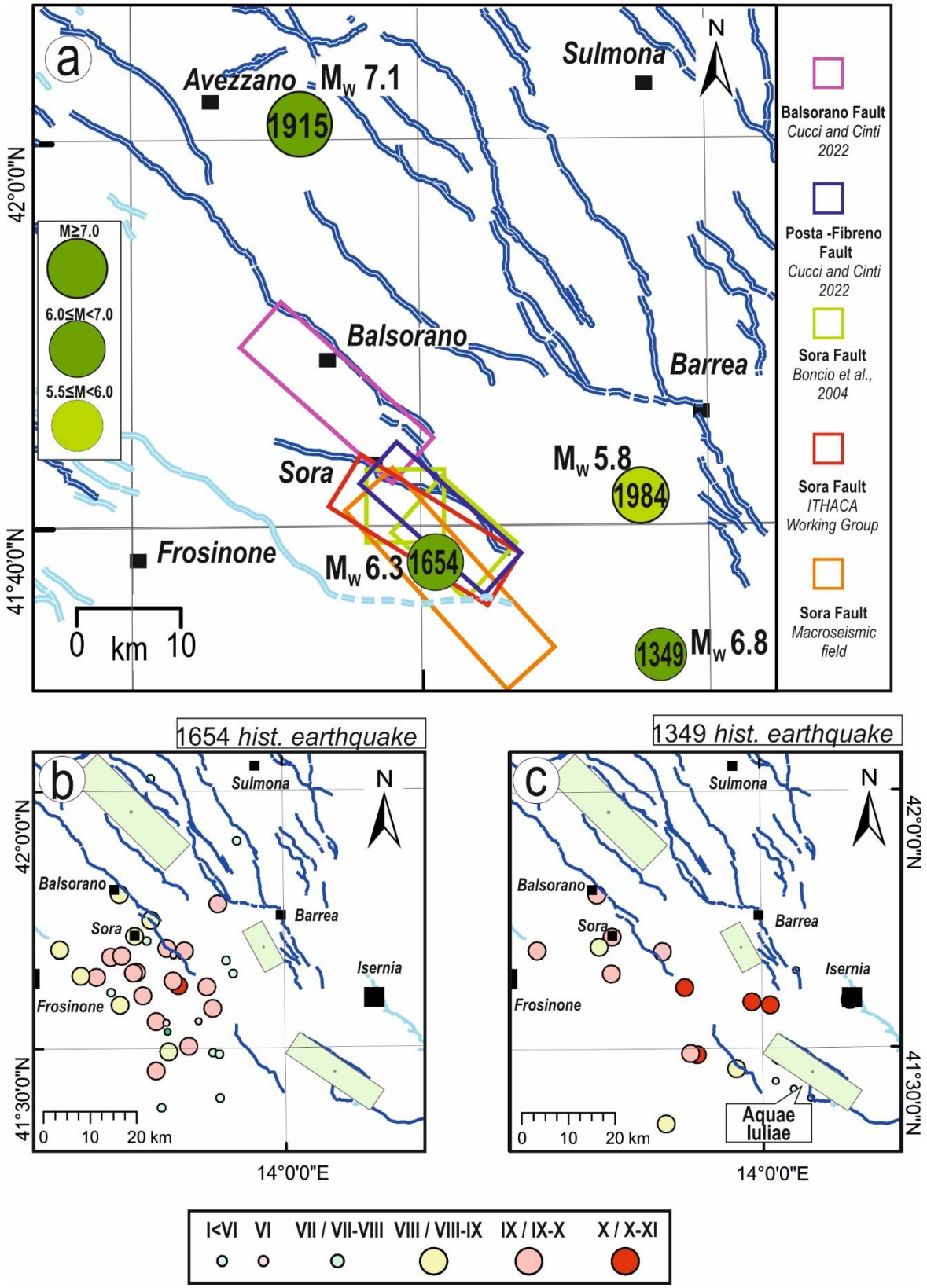


Figure S2. Active faults (as in Fig. S1) and some details on historical earthquakes. (a) Seismogenic sources of the 1654 were reported by [2] and referenced therein. (b-c) Macroseismic fields of the 1654 and 1349 earthquakes from DBMI15v4.0 [3] combined with the individual seismogenic source proposed by DISS [1].

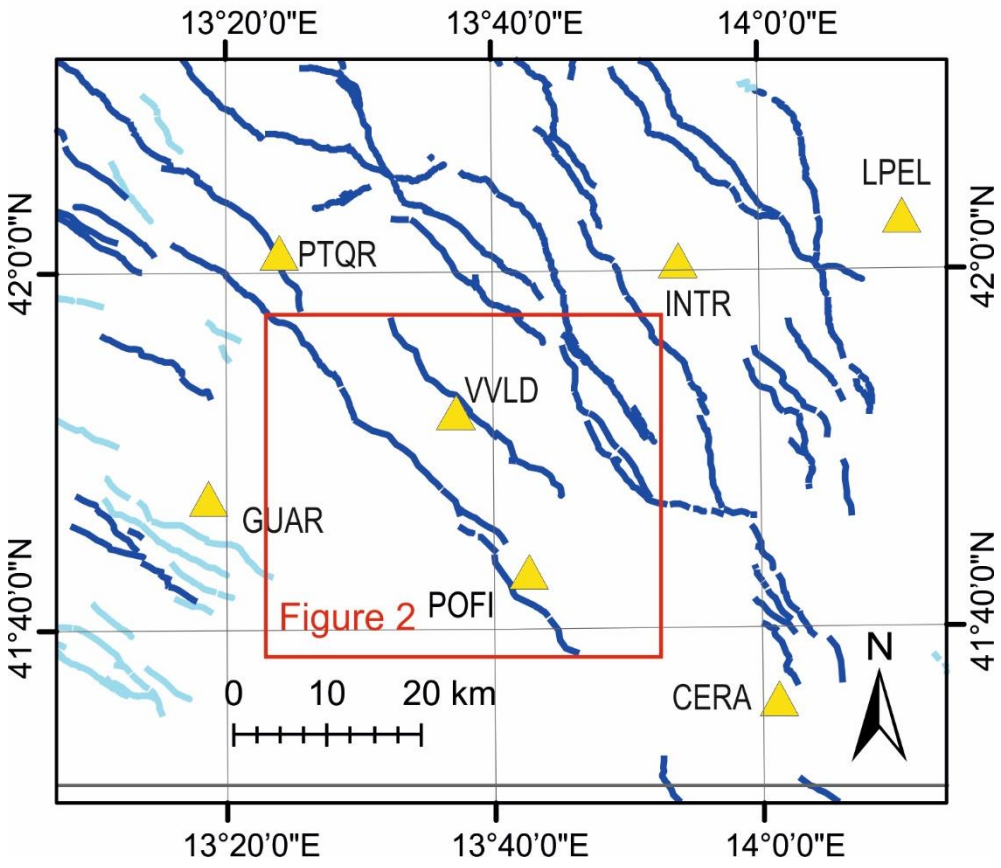


Figure S3. Map of the seven permanent seismic stations (yellow triangles) belonging to the Italian seismic network used for constructing the enhanced catalog. The red rectangle represents the study area shown in Figure 2.

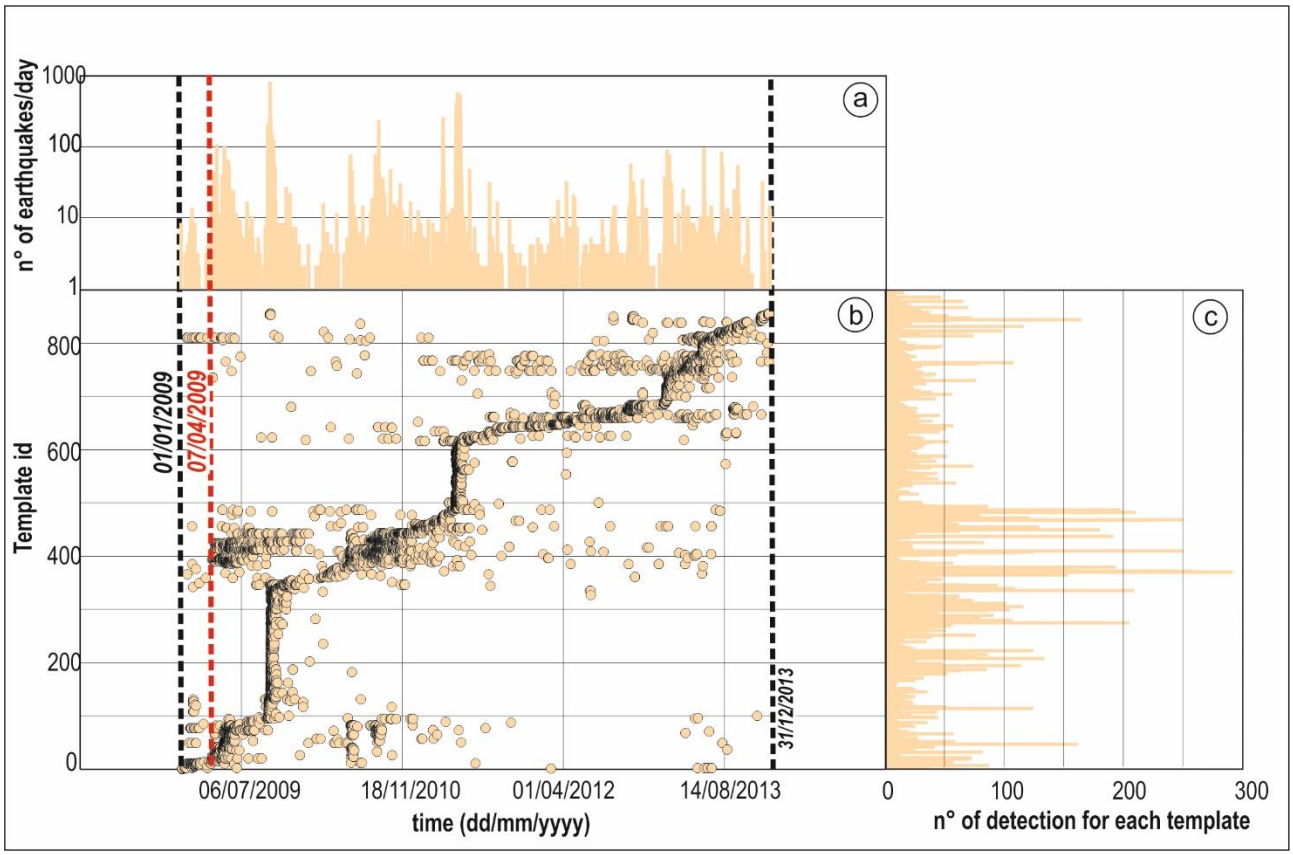
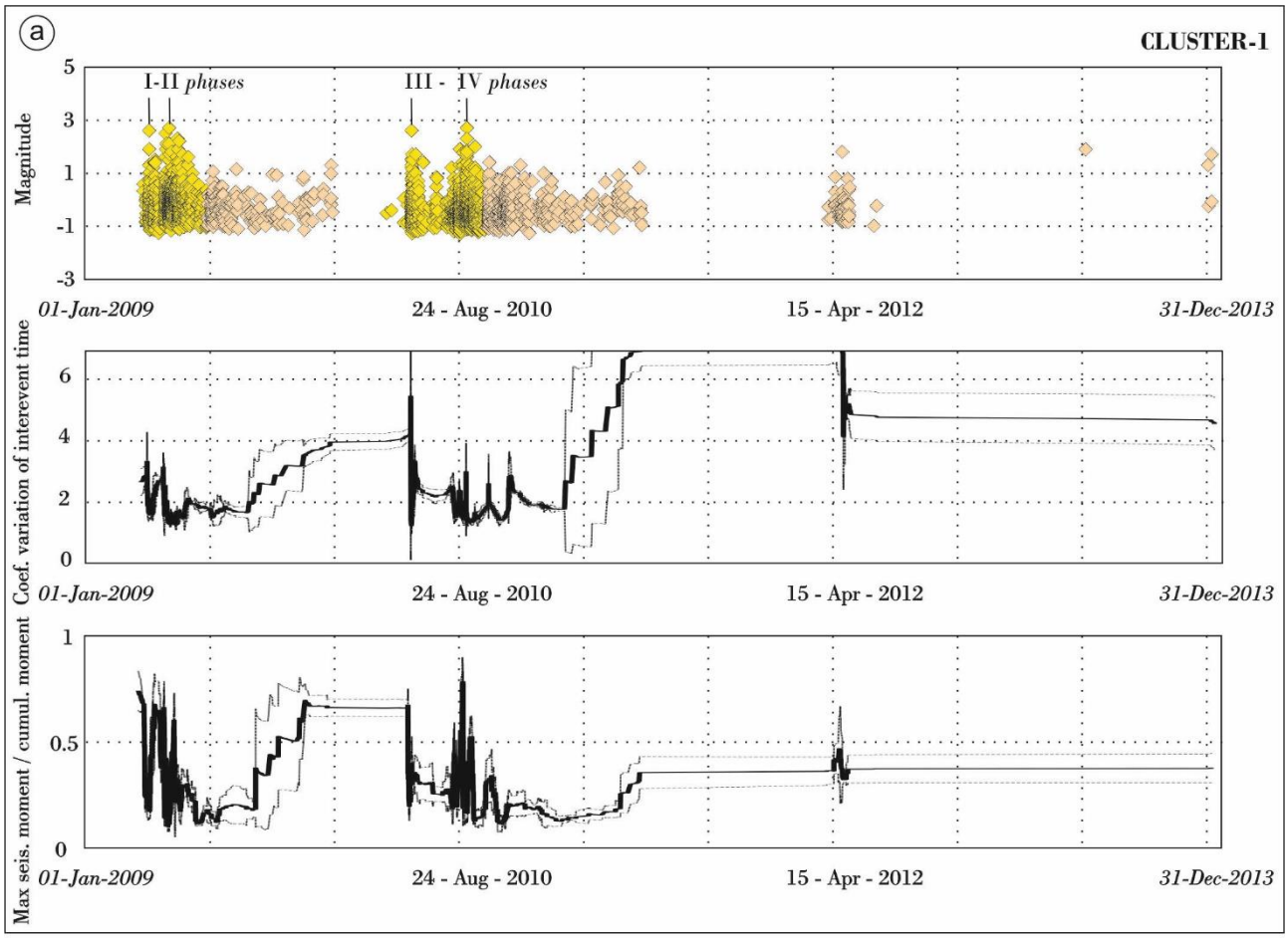
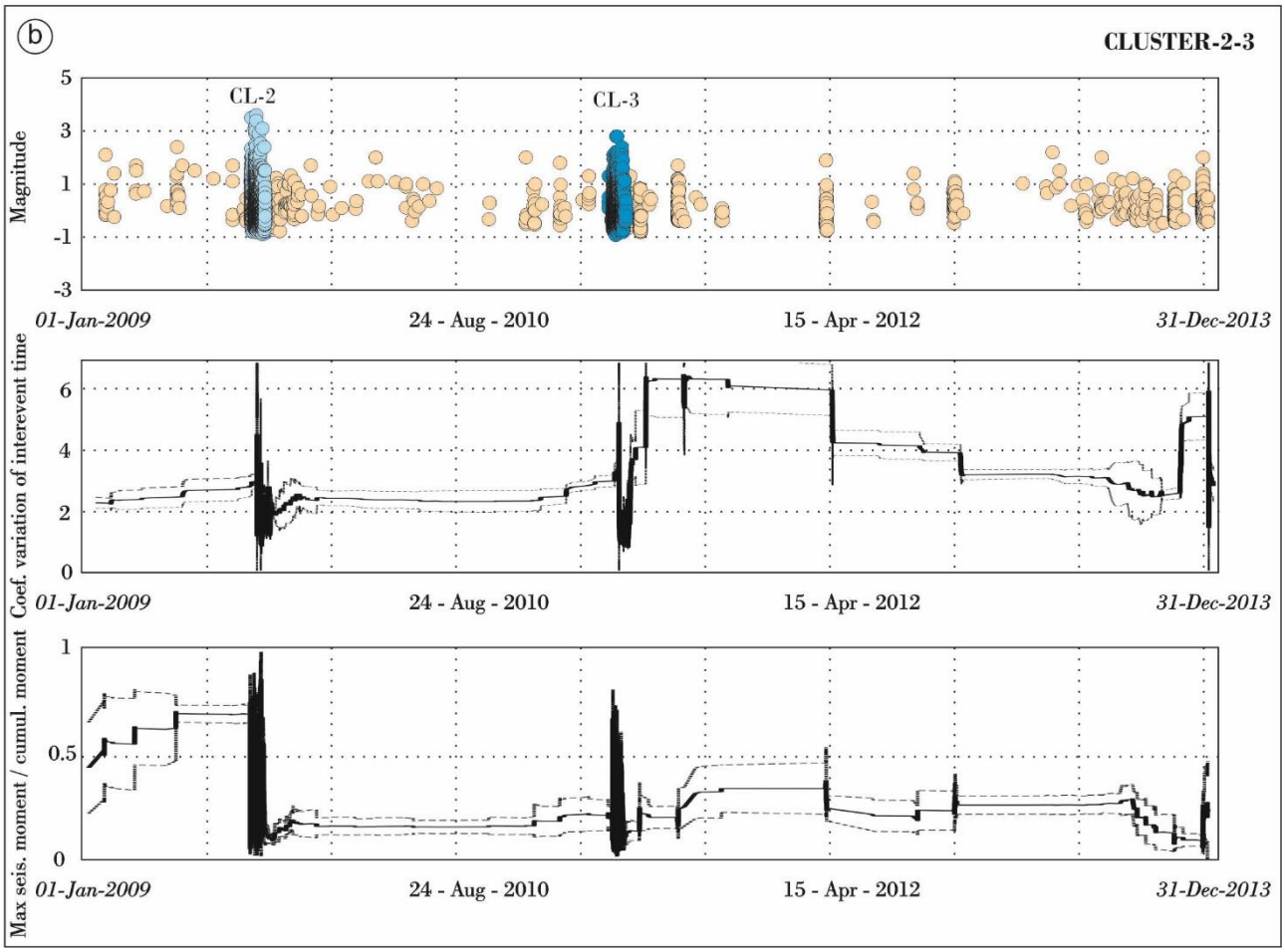


Figure S4. Templates and detections versus time: the new catalog. (a) Daily frequency of earthquakes of the new catalog. (b) Relation between the templates (id 1-856) and new detections versus time. (c) Number of detections for each template.


a
CLUSTER-1
I-II phases
III - IV phases
Magnitude
5
3
1
-1
-3
01-Jan-2009
24 - Aug - 2010
15 - Apr - 2012
31-Dec-2013
Coef. variation of interevent time
6
4
2
0
Max seis. moment / cumul. moment
1
0.5
0


b
CLUSTER-2-3
CL-2
CL-3
Magnitude
5
3
1
-1
-3
01-Jan-2009
24 - Aug - 2010
15 - Apr - 2012
31-Dec-2013
Coef. variation of interevent time
6
4
2
0
Max seis. moment / cumul. moment
1
0.5
0

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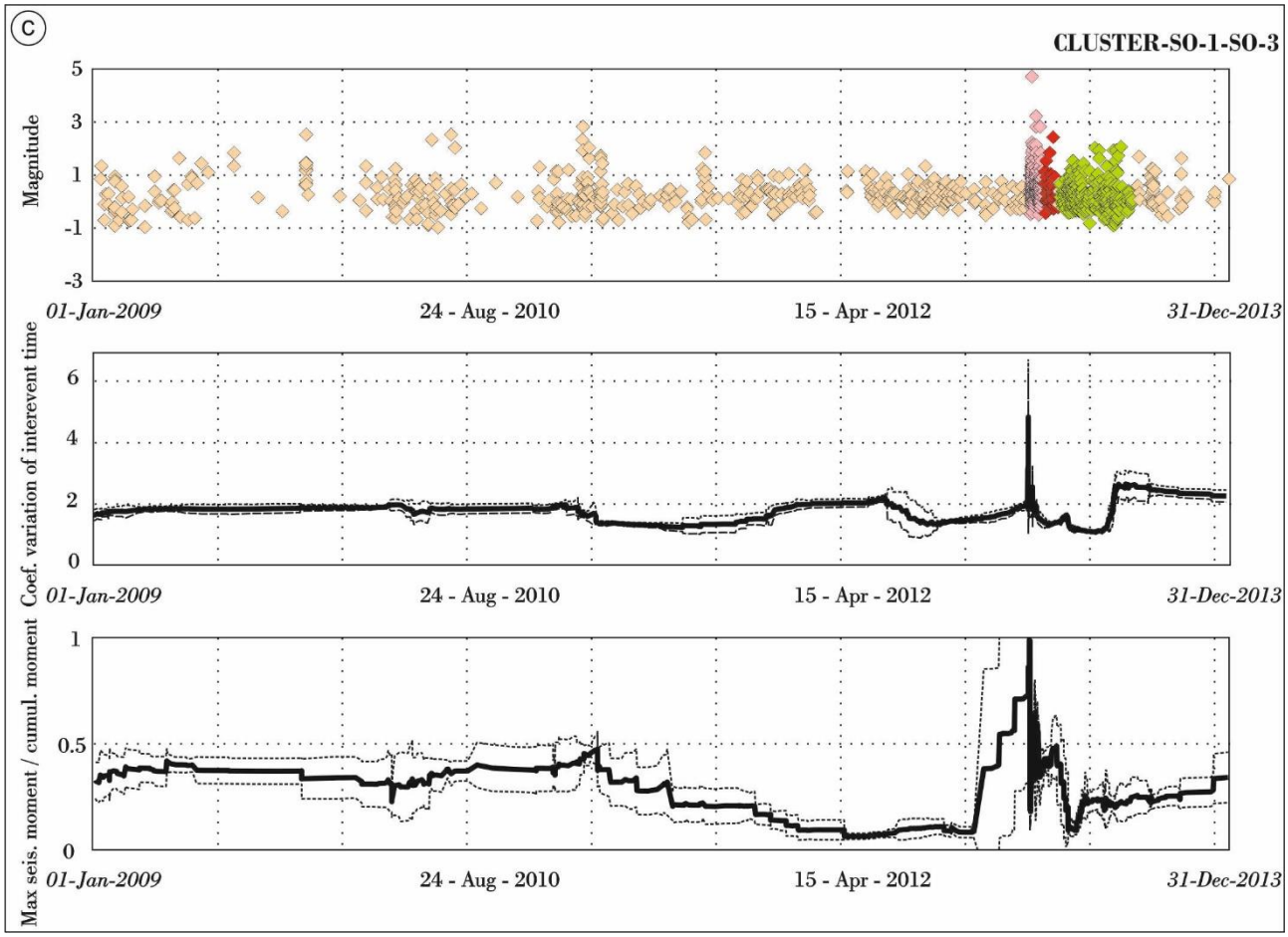
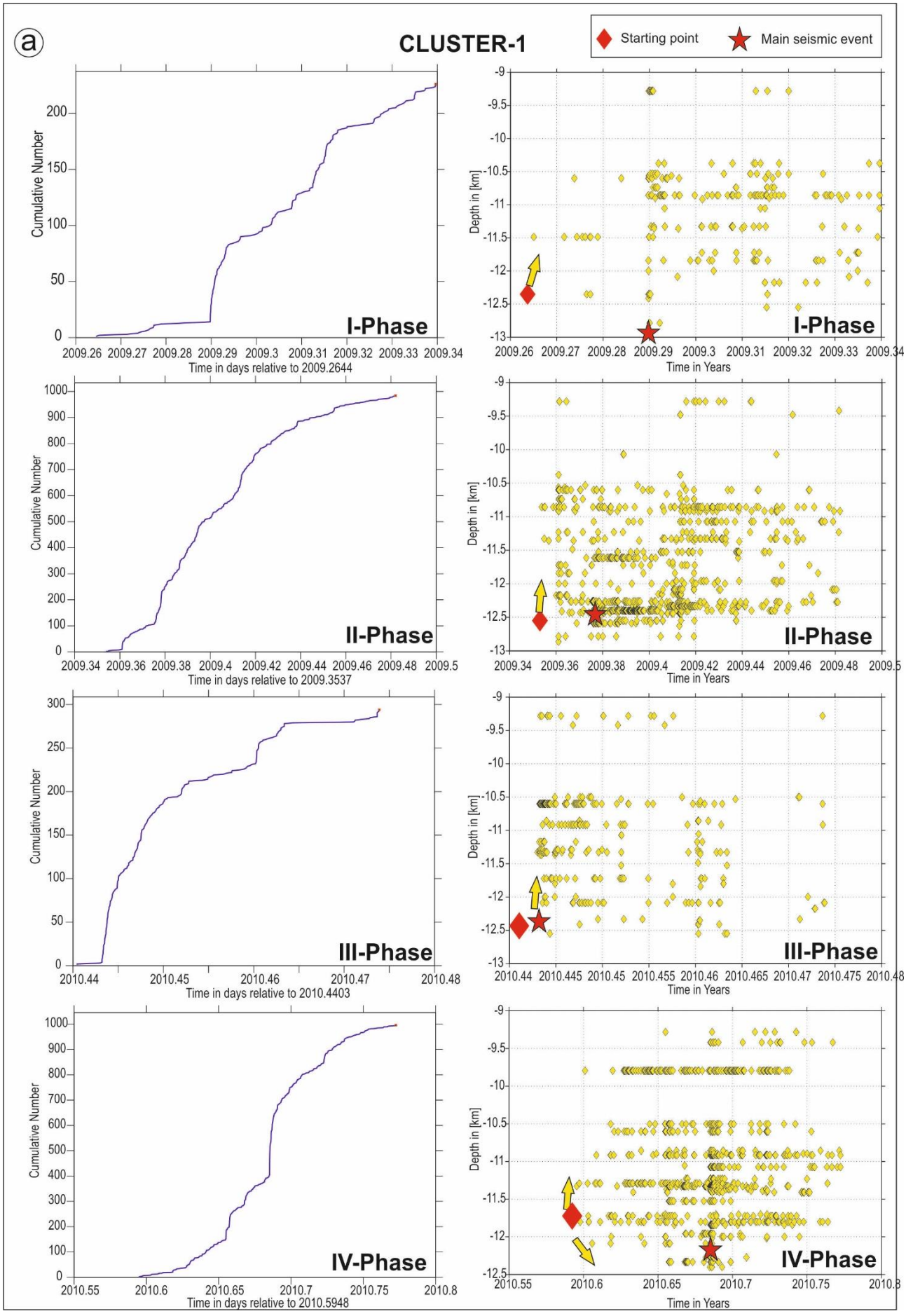


Figure S5. Magnitude versus time, coefficient variation of interevent times, and seismic moment ratio evaluated for CL-1 (a), CL-2,3 (b), and SO-1-SO-3 (c) and the new catalog.


ⓐ
CLUSTER-1
Starting point
Main seismic event
Cumulative Number
Depth in [km]
Time in days relative to 2009.2644
Time in Years
I-Phase
Time in days relative to 2009.3537
II-Phase
Time in days relative to 2010.4403
III-Phase
Time in days relative to 2010.5948
IV-Phase

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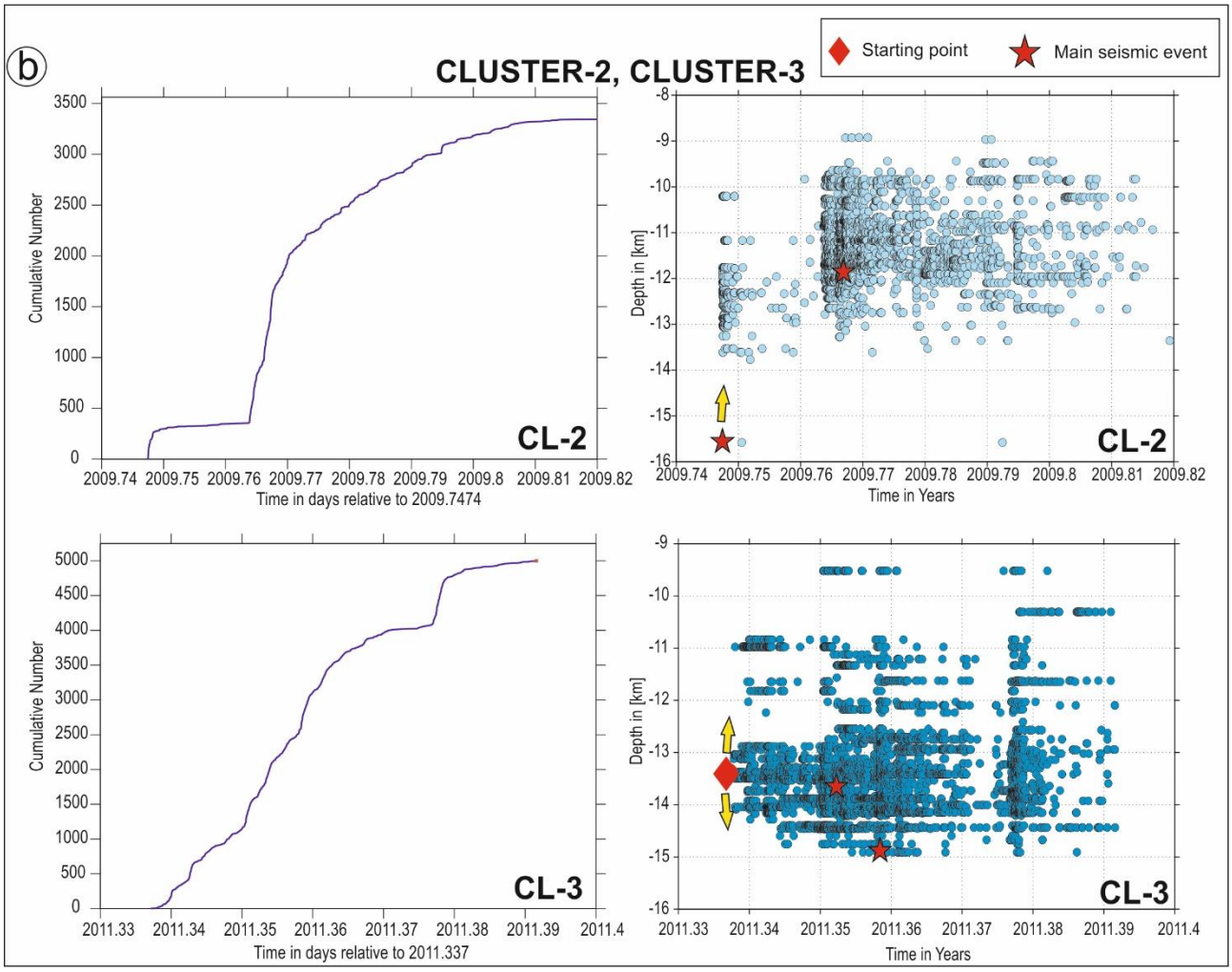
b
CLUSTER-2, CLUSTER-3
Starting point
Main seismic event
Cumulative Number
Time in days relative to 2009.7474
CL-2
Depth in [km]
Time in Years
CL-2
Cumulative Number
Time in days relative to 2011.337
CL-3
Depth in [km]
Time in Years
CL-3

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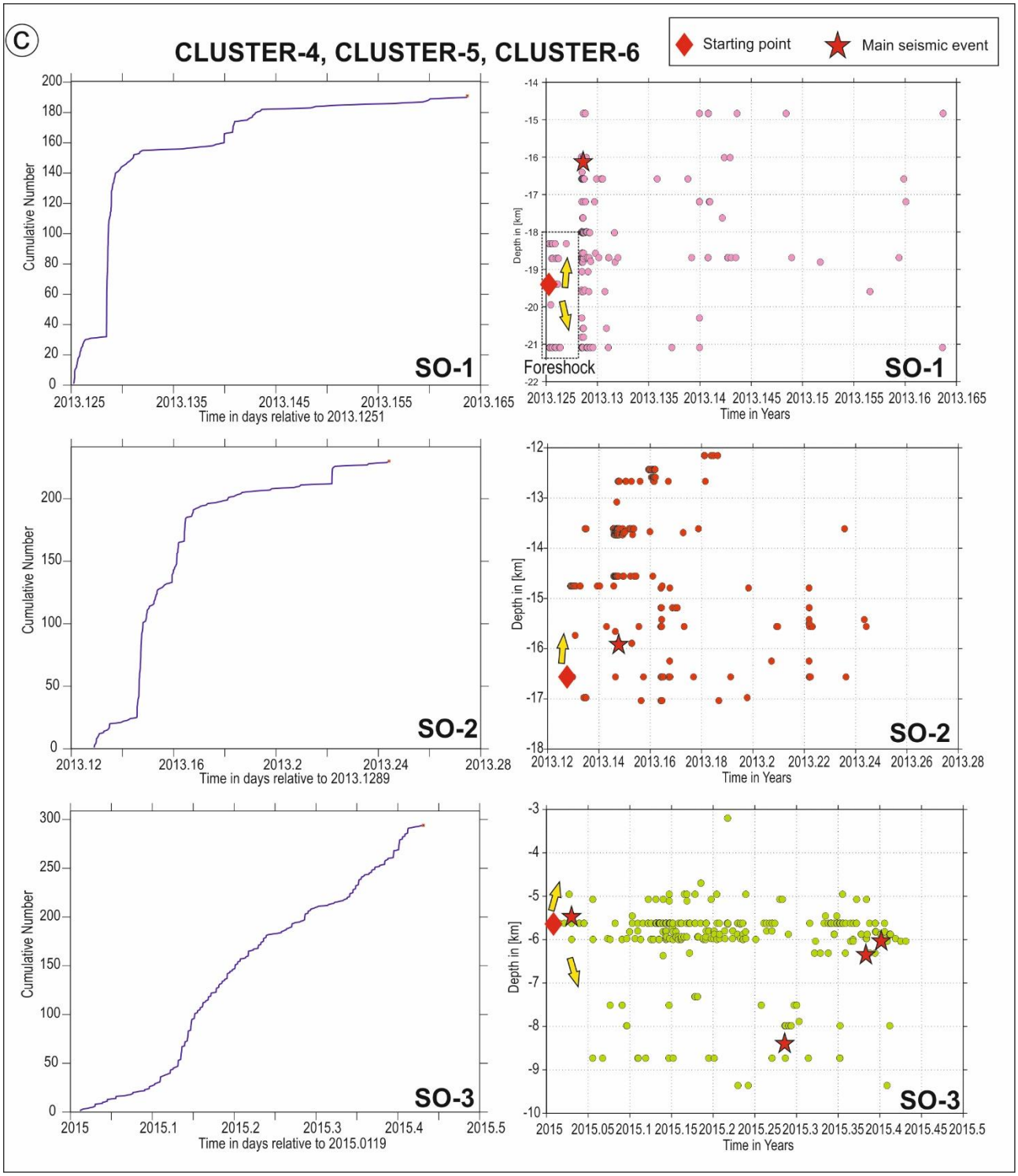

Figure S6. Cumulative number of events and depth distribution vs time for CL-1 (a), CL-2,3 (b), and SO-1-SO-3 (c) evaluated starting from the new catalog.

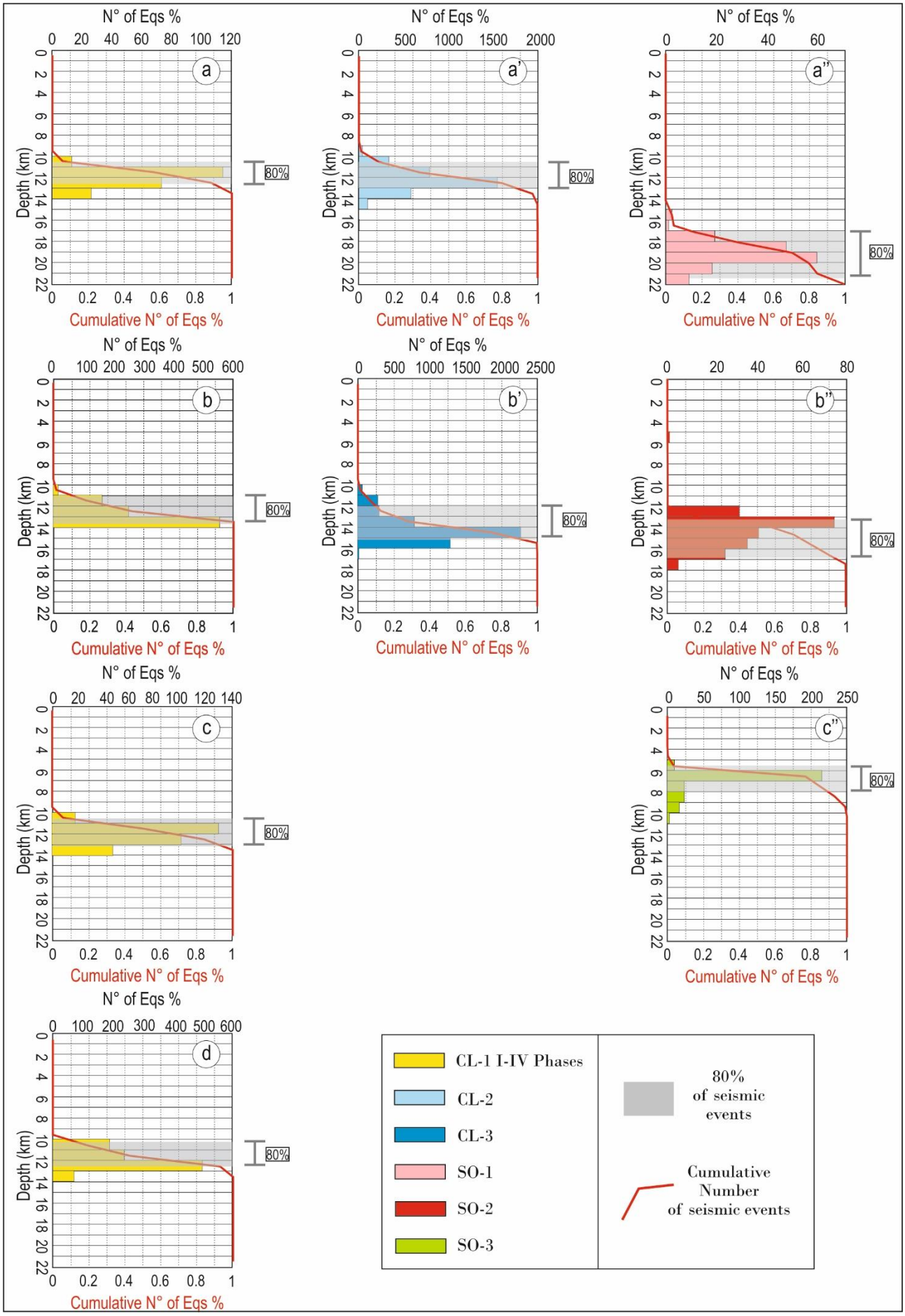

Figure S7. Depth distribution of each cluster CL-1, CL-2,3, and SO-1-SO-3.

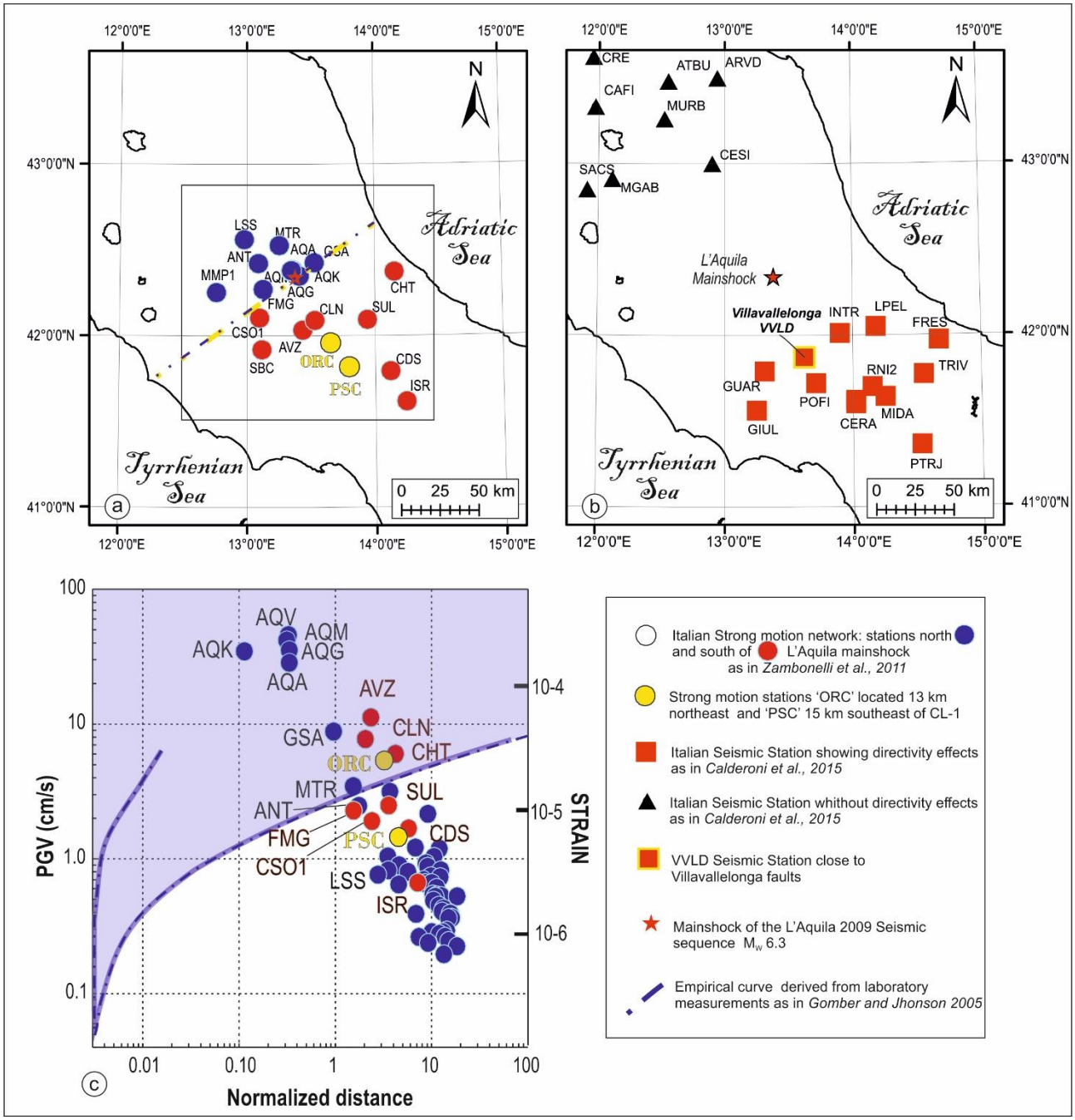

Figure S8. Main characteristics of ground motions recorded at the Italian national strong motion and seismic networks after the L'Aquila earthquake M_W 6.3. (a) Distribution of the strong motion network [12,13] in the study area. (b) Seismic stations of the Italian seismic network showing the directivity effects after the main seismic event of the L'Aquila seismic sequence. (c) Peak Ground Velocity (PGV) versus normalized distance sensu [14]. The normalization was performed considering the square root of the rupture area that can approximate the rupture dimension.

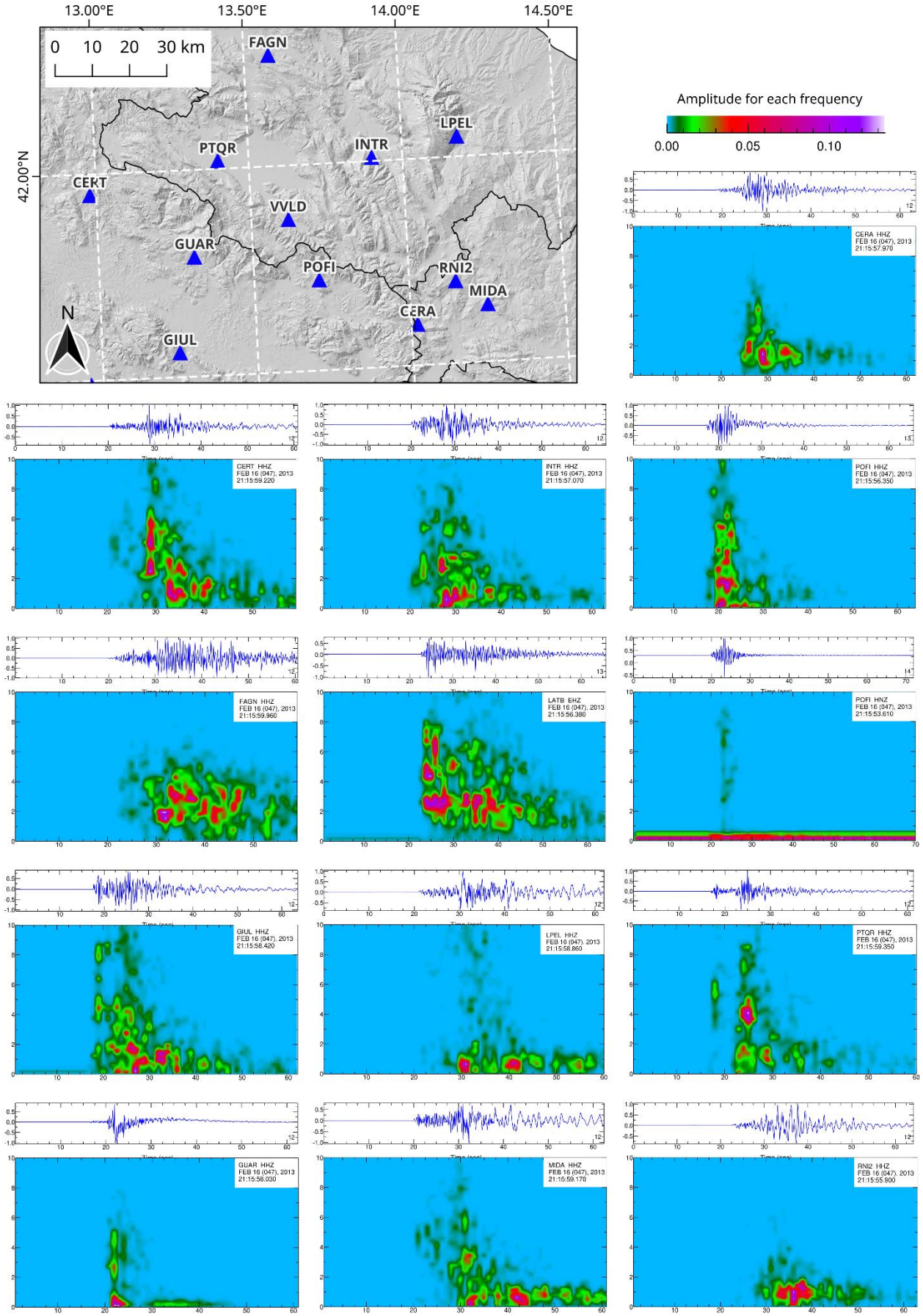

Figure S9. Spectrograms of the main event of the Sora earthquake, M_W 4.8, as recorded at the Italian seismic stations shown on the map.

	Phases	*N° eqs*	*Start (dd/mm/yyyy)*	*End (dd/mm/yyyy)*	*Duration (days)*	*n° eqs/day*	*Max Magnitude* M_L
CLUSTER-1	*Phase_1*	226	07/04/2009	04/05/2009	27	8	2.6
	Phase_2	984	10/05/2009	25/06/2009	46	21	2.7
	Phase_3	294	10/06/2010	22/06/2010	12	25	2.6
	Phase_4	978	06/08/2010	09/10/2010	64	15	2.7
CLUSTER-2	--	3336	30/09/2009	27/10/2009	27	124	3.6
CLUSTER-3	--	5003	04/05/2011	23/05/2011	19	263	2.8
CLUSTER-SORA_1	--	190	15/02/2013	01/03/2013	14	14	4.8, 5*
CLUSTER-SORA_2	--	230	17/02/2013	31/03/2013	42	5	3.2
CLUSTER-SORA_3	--	251	11/03/2013	11/07/2013	122	2	1.9

Table S1. Main characteristics of the analyzed clusters. (*) Value referred to the M_W from QRCMT [15].

Cluster	**V_P/V_S**	**± V_P/V_S**	**Diffusivity (D) m^2/s**	**±D m^2/s**
CL-1 *Phase_1*	1.877	0.003	0.87	0.21
CL-1 *Phase_2*	1.884	0.003	1.63	0.64
CL-1 *Phase_3*	1.894	0.002	0.78	0.27
CL-1 *Phase_4*	1.922	0.004	0.43	0.02
CL-2	1.892	0.002	1.54	0.09
CL-3	1.884	0.002	--	--
SO-1	2.067	0.007	--	--
SO-2	1.849	0.009	1.52	0.26
SO-3	1.795	0.003	0.42	0.03

Table S2. The values of V_P/V_S and diffusivity (D), along with their uncertainties, estimated in this study and related to each cluster.

	Average FM (°)				Kinematic axes (°)					
Cluster name	Strike1	dip1	Strike2	dip2	P-trend	P-plunge	T-trend	T-Plunge	B-trend	B-plunge
CL-1	340	75	70	89	296	10	205	10	72	76
CL-2	305	38	127	52	44	83	217	7	306	1
CL-3	304	37	124	53	34	82	214	8	304	0
SO-1*	291	38	165	65	118	59	234	15	331	27
SO-2	318	41	145	49	90	85	231	4	321	3
SO-3	320	42	146	48	93	86	233	3	323	3

Table S3. Average focal mechanisms and kinematics axes were computed for each cluster by using the focal mechanisms in [16]. All the average focal mechanisms are calculated by applying the Bingham statistical procedure [17] used to describe axial data on a sphere when there are no significant differences in magnitude. (*) The SO-1 average focal mechanism and the respective kinematics axes are evaluated following the moment tensor summation procedure that, conversely, weights the data for the seismic moment.

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