

THE PIANURA PADANA EMILIANA EARTHQUAKE

Introduction

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On May 22nd, 2012, at 04:03 local time, an earthquake of $M_L = 5.9$, according to the INGV (Italian National Institute of Geophysics and Vulcanology) estimation, struck the Pianura Padana Emiliana, Italy. The hypocenter was only 6 km deep, resulting in the consequent strong effects observed on the surface. The epicenter was located at Latitude 44.89° N and Longitude 11.12° E, in a sparsely inhabited area between the towns of Mirandola, Finale Emilia, Poggio Rusco and Bondeno (Fig. 1).

The main event was preceded by a shock at 01:13 ($M_L = 4.1$) and followed by a number of events of magnitude > 4.0. In particular, an earthquake of $M_L = 4.9$ occurred just one hour after the main event, at 05:02, and another of $M_L = 5.1$ occurred at 15:18. The most significant events until 15:21 (Italian time) on 20/05 are listed in Table 1.

The epicenters of the various shocks stretched over an area of about 40 km in W-E direction. The strongest earthquake of the sequence was due to a phenomenon of active compression in North-South direction, related to the thrust of the northern Apennines to the

North, above the Adriatic / African plate. It is a complex system of faults (Fig. 2).

In the following days, many events occurred, some of magnitude greater than 4.0 (Table 2), while an important new sequence was recorded on May 29th, when at 09:00 (Italian time) an event of $M_L = 5.8$ was recorded with epicenter between the towns of Medolla, Mirandola and Cavezzo. It was followed by numerous other events with a magnitude > 4.0, two of which > 5.0 (Table 3). Further events were recorded in the followings days (Table 4). It is worth reminding that another event was recorded on June 9th with epicenter on the Venetian Prealps (Table 5). After the main event of May 20th, the number of dis-

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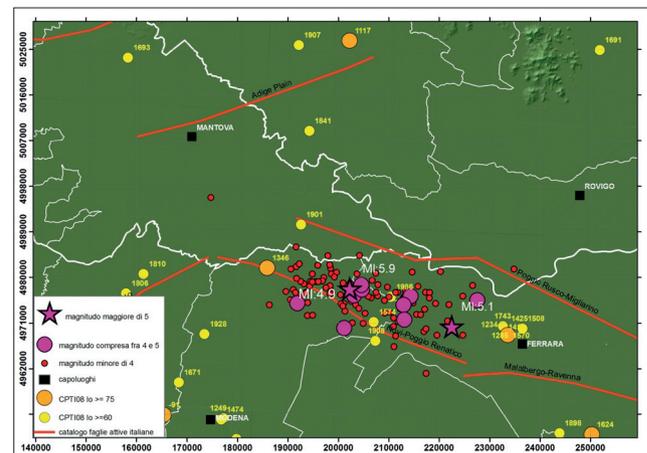


FIGURE 1 Map of the events of May 2012 and some historical seismic occurrence
Source: ENEA from INGV data

placed persons – initially 3000 – rose gradually. The victims were 7, 4 of which were workers: one in the collapse of a factory at Bondeno, two in the collapse of three industrial buildings at Sant’Agostino, and one in the collapse of an aluminum foundry. The final estimation of damage, after the shock of May

29th, was much heavier. In total there were 26 victims, most of them workers, and 20,000 homeless. Immediately after the first shock, ENEA gave the national Civil Protection Service its support to perform macroseismic observations and to assess the damage to houses and industrial buildings. Moreover, ENEA

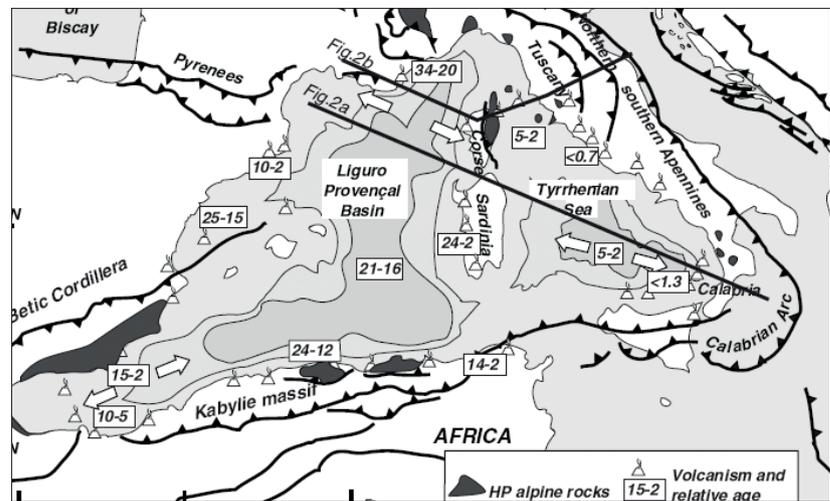


FIGURE 2
Complex system of faults
Source: courtesy by Faccenna et al.

Date	Time (UTC)	Lat	Lon	Depth (km)	M _L
2012/05/19	23:13:27	44.898	11.258	6.2	4.1
2012/05/20	02:03:52	44.89	11.23	6.3	5.9
2012/05/20	02:11:46	44.84	11.37	7.8	4.3
2012/05/20	02:12:42	44.82	11.22	20.4	4.3
2012/05/20	02:35:37	44.88	11.55	10	4.0
2012/05/20	02:39:10	44.89	11.26	5.2	4.0
2012/05/20	03:02:50	44.86	11.1	10	4.9
2012/05/20	09:13:21	44.879	11.241	3.1	4.2
2012/05/20	13:18:02	44.831	11.49	4.7	5.1
2012/05/20	13:21:06	44.882	11.383	2.4	4.1
2012/05/20	17:37:14	44.88	11.38	3.2	4.5

TABLE 1 Main events of May 20th, 2012
Source: INGV

Date	Time (UTC)	Lat	Lon	Depth (km)	M_L
2012/05/21	17:37:14	44.851	11.348	10.4	4.1
2012/05/23	21:41:18	44.868	11.251	4.8	4.3
2012/05/25	13:14:05	44.883	11.108	10	4.0
2012/05/27	18:18:45	44.882	11.158	4.7	4.0

TABLE 2 Main events between May 21st and 27th, 2012
Source: INGV

Date	Time (UTC)	Lat	Lon	Depth (km)	M_L
2012/05/29	07:00:03	44.851	11.086	10.2	5.8
2012/05/29	07:07:21	44.854	10.992	10	4.0
2012/05/29	07:09:54	44.926	11.036	10.4	4.1
2012/05/29	08:25:51	44.901	10.943	3.2	4.5
2012/05/29	08:27:23	44.854	11.106	10	4.7
2012/05/29	08:40:58	44.892	10.962	5.3	4.2
2012/05/29	09:30:21	44.892	11.053	1.2	4.2
2012/05/29	10:55:57	44.888	11.008	6.8	5.3
2012/05/29	11:00:02	44.873	10.95	11	5.1
2012/05/29	11:07:05	44.876	11.076	15	4.0

TABLE 3 Main events of May 29th, 2012
Source: INGV

Date	Time (UTC)	Lat	Lon	Depth (km)	M_L
2012/05/31	14:58:21	44.88	10.867	5.8	4.0
2012/06/03	19:20:43	44.9	10.940	9.2	5.1
2012/06/06	04:08:31	44.434	12.354	25.6	4.5
2012/06/12	01:48:36	44.88	10.888	10.8	4.3

TABLE 4 Main events after May 29th, 2012
Source: INGV

Date	Time (UTC)	Lat	Lon	Depth (km)	M_L
2012/06/09	02:04:56	46.209	12.444	7.1	4.5

TABLE 5 Characteristics of the event of June 9th, 2012
Source: INGV

also provided the Emilia-Romagna's General Directorate for the Promotion of Cultural Heritage with the assessment of the damage to churches and other historical buildings. The Civil Protection responded positively and assigned ENEA the task of performing safety controls on civil buildings, which was, of course, most urgent. Three teams of ENEA technicians began the on-site surveys in Cento, Bondeno, Finale Emilia on May 25th and, after the second shock of May 29th, in Novi di Modena, Carpi, Rovereto and Molinella. The activities, carried out on over 100 structures, were concluded at the beginning of July. In most cases, the activities were not limited to safety controls only: as a matter of fact, ENEA technicians participated actively in the design of the most urgent interventions to secure crumbling buildings. They also performed geological campaigns in the area affected by soil liquefaction. Fi-

nally, interventions on the cultural heritage started at the beginning of September and are still in progress; they include important structures like the very famous Ghirlandina Tower and the Cathedral in Modena.

The Pianura Padana Emiliana earthquake was characterized by the phenomenon of soil liquefaction and the heavy damage to cultural heritage structures (churches, castles, historical buildings) and to industrial buildings, pointing out the importance of seismic preservation of such structures. All these issues are discussed in the papers of this Focus, in which the main results of the activities carried out immediately after the quakes are reported. The analysis of the data are still in progress and will be presented in the next future. We thank all the authors, ENEA's researchers and others, that contributed to realize this volume in a short time.

