New macroseismic studies of the 2014-2015 earthquake series near Ober-Ramstadt as well as macroseismic reevaluations of the 1869-1871 earthquake swarm in the northern Upper Rhine Graben

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Eight of the stronger earthquakes of the recently occurred earthquake series near Ober-Ramstadt southeast of Darmstadt in Hesse during the period of March 2014 and November 2015 have been analyzed macroseismically. The Hessian Earthquake Agency (Hessischer Erdbebendienst, HED) has received several hundred earthquake questionnaires by the public. After analyzation of these online questionnaires, macroseismic maps have been produced. Furthermore, the intensities were used to determine a macroseismic epicenter, as well as hypocenter depth and magnitude. The comparison with the instrumentally determined hypocenter and magnitude shows a good estimate considering all error estimates. For example the M_L = 4.2 earthquake on May 17th 2014 had an instrumentally determined depth of 4.3 km ± 1.5 km, while the macroseismic determined depth was 4 km ± 1 km and a magnitude of M_L = 4.3. Since the procedure used to work with these recent events, we adapted the analyzation procedure to 11 of the strongest earthquakes of the 1869-1871 earthquake swarm near Groß-Gerau in the northern Upper Rhine Graben. For this analysis, original reports from that time were used and macroseismic maps were produced. We show a comparison between the newly derived hypocenter parameters for these events and those given in the earthquake catalog of Germany (Leydecker catalogue). Most events show deeper depths than in previous interpretations. Interestingly these deeper hypocenters match those of recent earthquakes in the area near Groß-Gerau.

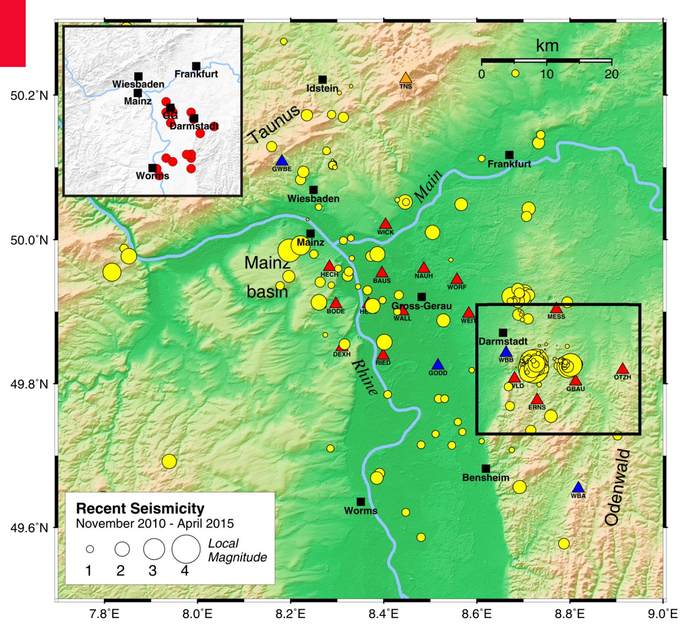

Fig. 1: Earthquake activity in the northern Upper Rhine Graben between November 2010 and April 2015. The inset shows the locations of swarm earthquakes in the 19th century.

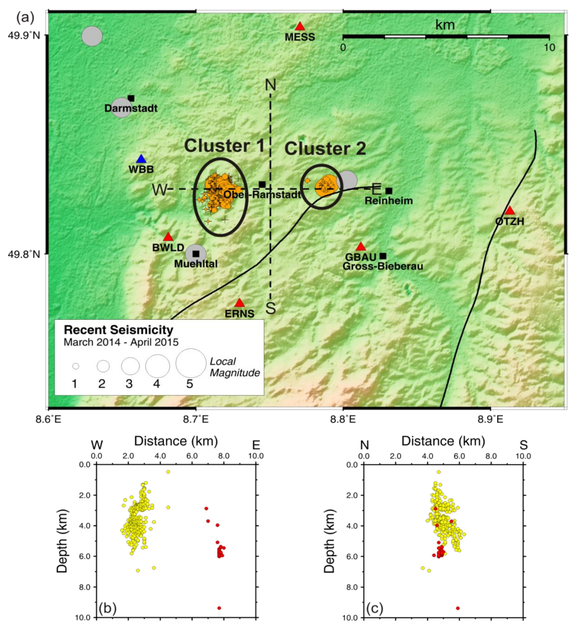

Fig. 2: (a) Relative localisations (orange circles) between March 2014 and April 2015. Grey circles mark the locations of swarm earthquakes in the 19th century. (b) und (c) Hypocentres along W-E and N-S profiles. Yellow and red circles represent earthquakes belonging to cluster 1 or 2.

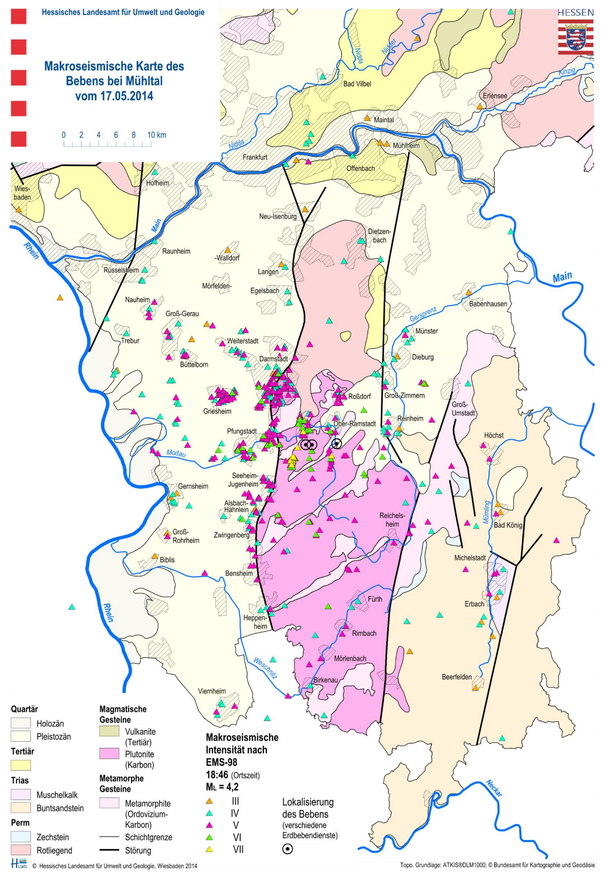

Fig. 3: Macroseismic map of the May 17th 2014 earthquake (UTC 16:46)

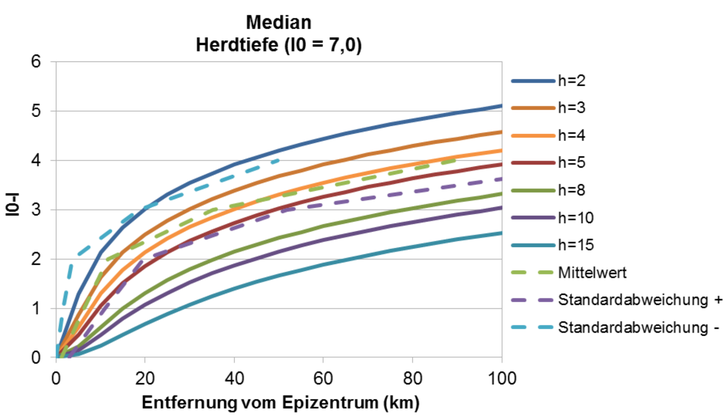

Fig. 4: Hypocentre depth in km dependent on epicentral distance and intensity for the May 17th 2014 earthquake. The green dashed line corresponds to the makroseismic observations. The other two dashed lines show the uncertainties (standard deviation).

Datum	Zeit	h_neu	h_alt	M_neu	M_alt	I_neu	I_alt	Lat_neu	Lon_neu	Lat_alt	Lon_alt
30.10.1869	20:00	10	3	4.4	3.9	6	6	49.88	8.48	49.9	8.5
31.10.1869	12:10	4	2	-	3.7	6	6	49.92	8.48	49.9	8.5
31.10.1869	15:25	3	2	4	4.2	7	6.5	49.92	8.48	49.917	8.483
31.10.1869	17:26	7	5	4.4	4.6	7	6.5	49.995	8.48	49.917	8.483
01.11.1869	04:07	10	6	4.2	4.2	7	6.5	49.92	8.48	49.91	8.53
01.11.1869	23:48	20	10	4.7	4.4	6	6	49.92	8.48	49.9	8.5
02.11.1869	21:26	7	6	4.4	4.7	7	6.5	49.92	8.48	49.92	8.48
03.11.1869	03:48	5	5	3.7	4.3	6.5	6.5	49.92	8.48	49.9	8.5
22.11.1869	07:08	7	6	4.4	4.2	6.5	6	49.92	8.48	49.9	8.5
10.02.1871	05:32	13	7	4.4	4.7	7	7	49.65	8.57	49.65	8.6
12.02.1871	10:24	7	3	3.8	-	6	6	49.87	8.66	49.84	8.8

Tab. 1: Comparison of the newly determined hypocenter parameters with the informations given in the earthquake catalogue of Germany (Leydecker, 2011). h = Hypocenter depth, M = Magnitude, I = Intensity, Lat = Latitude, Lon = Longitude.

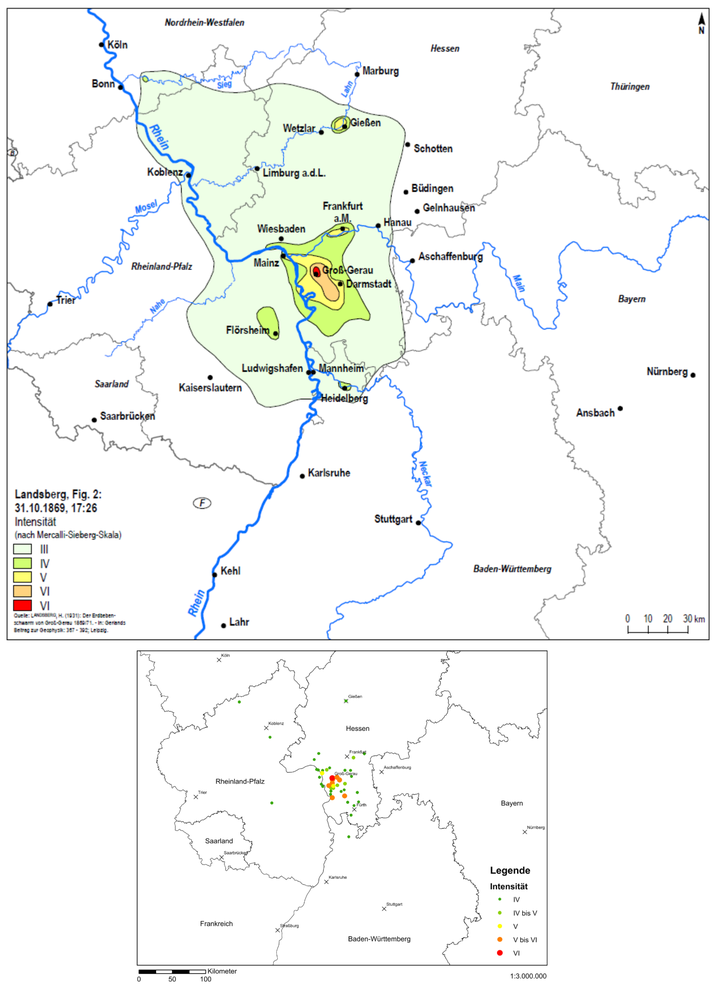

Fig. 5: Newly created macroseismic maps of the October 31st 1869 earthquakes. Intensities were assigned to the historical reports according to the EMS-98 scale.

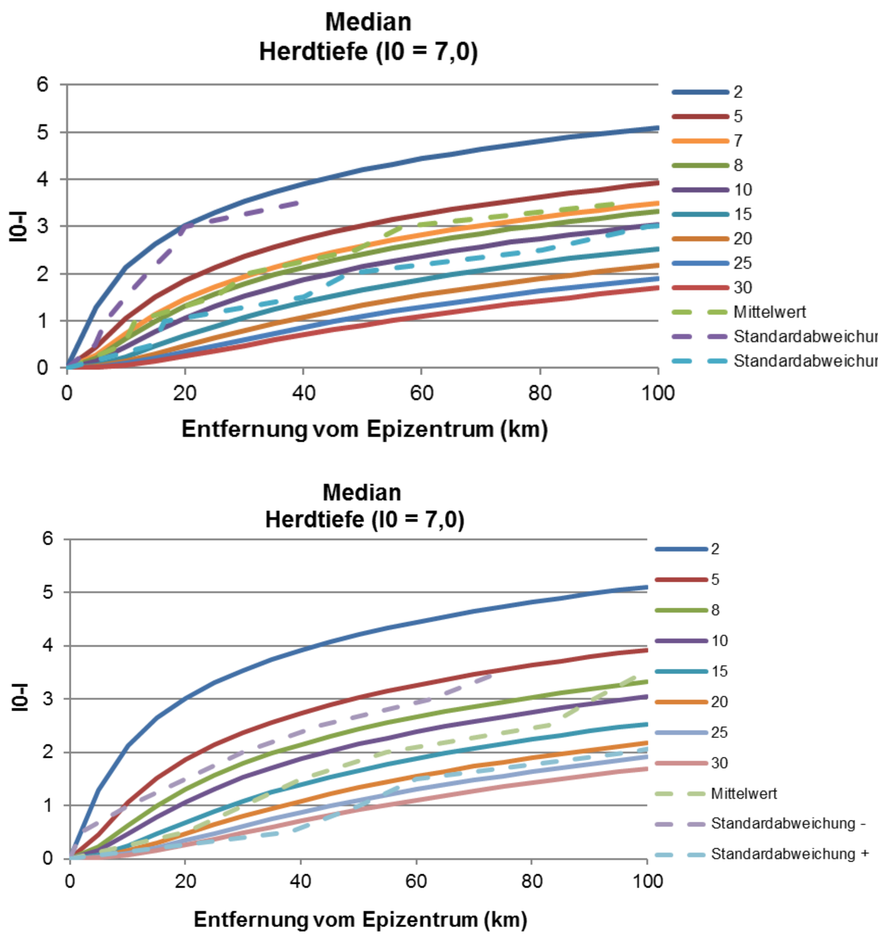

Fig. 6: Hypocentre depth in km dependent on epicentral distance and intensity for the February 10th 1871 (UTC 05:32) and the Oktober 31st 1869 (UTC 17:26) earthquake. The green dashed line corresponds to the makroseismic observations. The other two dashed lines show the uncertainties (standard deviation).

Conclusions: We show that macroseismic and microseismic data can be used to determine good estimates of hypocentral parameters. The newly determined hypocenter parameters do match those of recently observed earthquakes.

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Für eine lebenswerte Zukunft

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