

STUDY OF THE DAMAGING EARTHQUAKES IN THE MULA (MURCIA, SE SPAIN) REGION.

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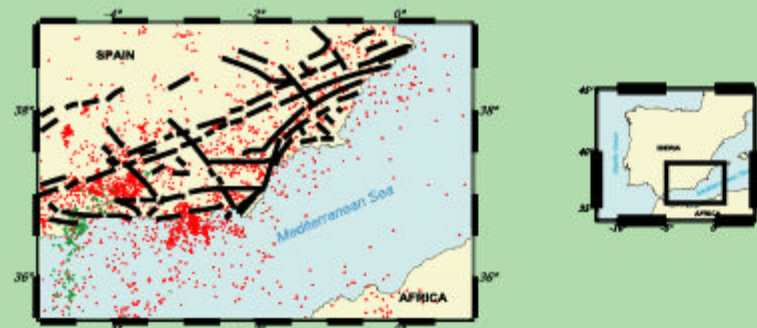
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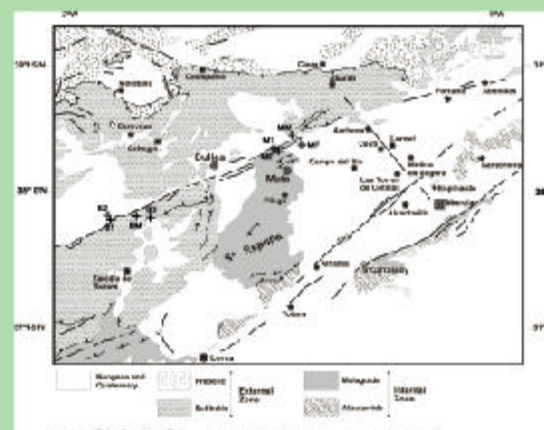


Distribution of epicentres ($M > 2.5$) for the period 1975-2000 taken from the IGN Data File and main geological faults in southern Spain. Red circles shown shallow foci ($h < 40$ km.), green intermediate depth ($40 < h < 150$ km.) and blue deep foci ($h > 600$ km.)



Main geological features for the Mula and Bullas area. MF, MM, M1 and M2 indicate the foreshock, main shock and two larger aftershocks for the Mula series (1999). BM, B1, B2 and B3 indicate the main shock and the three larger aftershocks for the Bullas series (2002).

From the geological point of view Mula is located in the Betic Internal Zone, in the Malaguide Complex whereas Bullas is in the Betic External Zone, in the Subbetic Domain.



At left, damage in Lorquí town for the April 3rd, 1911 earthquake ($I_0 = \text{VII-VIII EMS}$). At centre and right, damage in Puebla de Mula town for the February 2nd, 1999 Mula mainshock ($I_0 = \text{VII EMS}$).



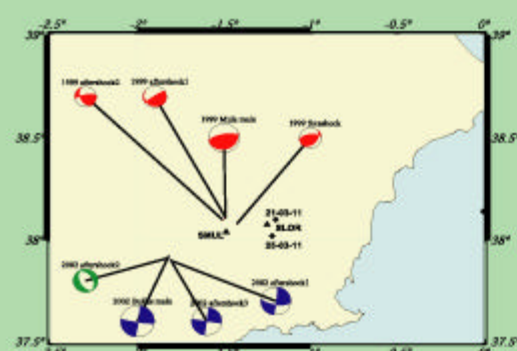
Intensity maps for the 21/03/1911 ($I_0 = \text{VII-VIII EMS}$) and 03/04/1911 ($I_0 = \text{VIII EMS}$) earthquakes. From seismograms in EBR, CRT and TOL stations magnitudes of 5.7 and 5.3 have been estimated.

Differences in I_0 may be explained because many buildings were already damaged by the March event when the April shock occurred.



Fault plane solutions for the 1999 Mula and 2002 Bullas series obtained from first motion of P and SH waves. Focal mechanisms shown reverse faulting for the Mula series and strike-slip motion for the Bullas series. Events are located near the contact between Betic Internal and External Zones, there coincident with several N60-70E faults that form part of the Crevillente "fault" (really there are several parallel faults) or Cadiz-Alicante accident.

From geological point of view these faults formerly move as dextral strike slip faults, but at present, with a horizontal maximum compression in the NNW-SSE to N-S direction, tend to move oppositely, with sinistral character (in many cases with reverse component and even as pure reverse faults).



Strong motion recorded at SLOR (blue) and SMUL (red) IGN stations for the 1999 Mula and the 2002 Bullas earthquakes, respectively. At right, the response spectra (critical damping 5%) for the three component at SLOR and SMUL stations. Maximum values of 0.013g and 0.015g have been recorded at the EW (Mula) and the NS (Bullas) components.

Spectra response predicted at near field for the 1999 Mula and the 2002 Bullas earthquakes (bottom right). An empirical estimation has been carried out due to the lack of accelerograms in the epicentral area using similar ground conditions: $M_w = 4.8$, epicentral distance 8km, and soil as depth alluvium. Strong motions models derived from European data (critical damping 5%) have been used.



Seismic hazard map obtained in this study for the Murcia region (bottom left). The seismogenetic zones defined by the Spanish building code NCSE-2002 have been used as input of the programEQ-Risk. The isolines represent the peak values of ground acceleration (PGA) for a return period of 500 years.

