InSAR observation of the shallow MW 5.1 Lorca earthquake (Spain). Comparison with elastic dislocated model

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INSAR OBSERVATION OF THE SHALLOW M_W 5.1 LORCA EARTHQUAKE (SPAIN). COMPARISON WITH ELASTIC DISLOCATION MODEL.

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1. ABSTRACT

Space geodetic techniques such as Interferometric Synthetic Aperture Radar (InSAR) and Global Positioning Systems (GPS) have demonstrated useful in mapping the displacement field of large earthquakes (M_w ~6 or higher) but the displacement fields of smaller earthquakes (< M_w 5.5), such as the ones that typically results from the European and African plates collision, are less often analyzed form space geodetic techniques and their characterization, in terms of slip on the fault plane at depth and focal depth location, often challenges seismologic techniques. In this study we present the results of InSAR analysis of the 11 of May 2011 M_w 5.1 Lorca earthquake. We use 4 SAR data acquired from the European C-band Advanced SAR (ASAR) sensor onboard Envisat satellite to map the ~3 cm of surface displacement field produced by the Lorca earthquake (Figure 1). Then, we use a simple elastic dislocation model (as described in [1]) to characterize the fault plane geometry and the fault slip at depth and adjust its parameters to fit the observed deformation. We found that the Lorca earthquake ruptured a ~3 km segment of the Alhama de Murcia Fault, centered at 4.2 km depth and produced ~21 cm reverse slip with ~6 cm left lateral component on a 45° plane striking N65E (Figure 2). We also observed a high level rate (~0.7 cm/month) subsidence in the Guadalentin basin due to water pumping for intensive agriculture. This value is in accordance with those reported by other authors (e.g. [2]), with no significant rate change associated with the earthquake.

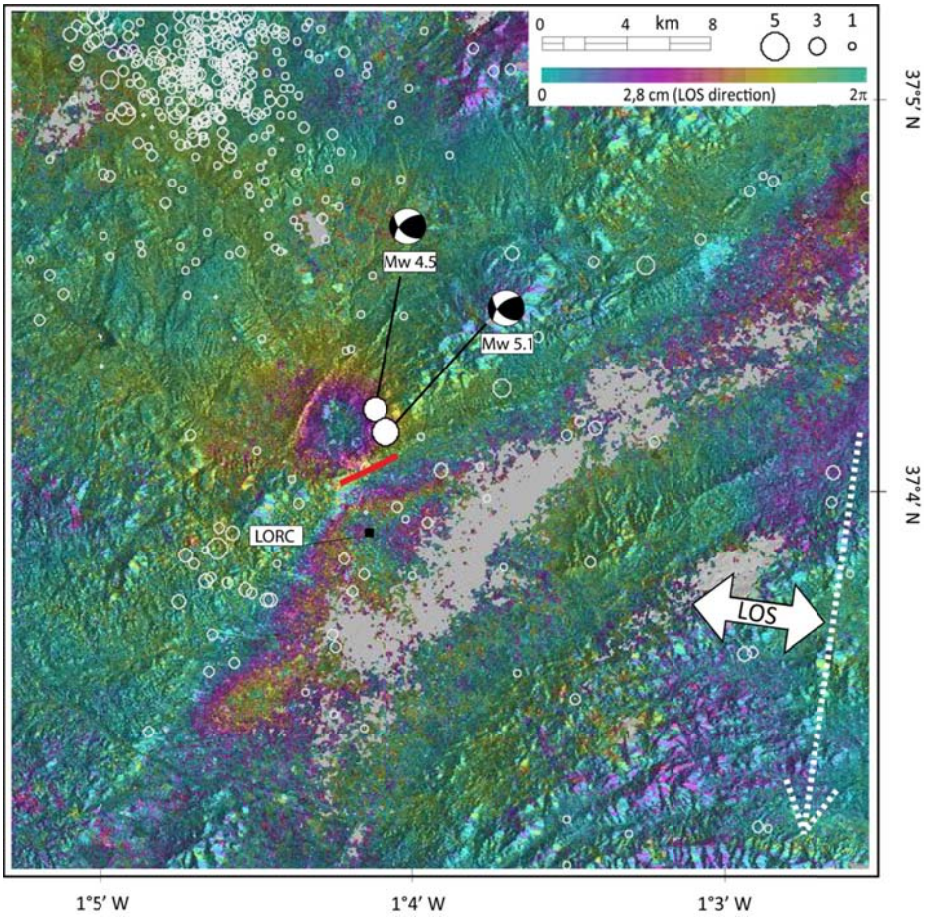

Figure 1: Surface displacement field due to both the Lorca earthquake and 5.2 month of water pumping in the Guadalentin basin. Empty white circles represent instrumental seismicity (IGN catalogue) and magnitude; full white circles represent the main shocks locations and magnitudes (IGN catalogue –please see López-Comino et al. (2012) for detailed aftershock relocation-). The main shocks, Mw 4.5 and Mw 5.1 on the 11 of May 2011 are plotted with their respective focal mechanism. One colour fringe corresponds to 2π phase cycle i.e. 2.8 cm in the Line of Sight (LOS) direction (23° off the vertical). The red segment represents the surface extension of the modeled seismogenic fault.

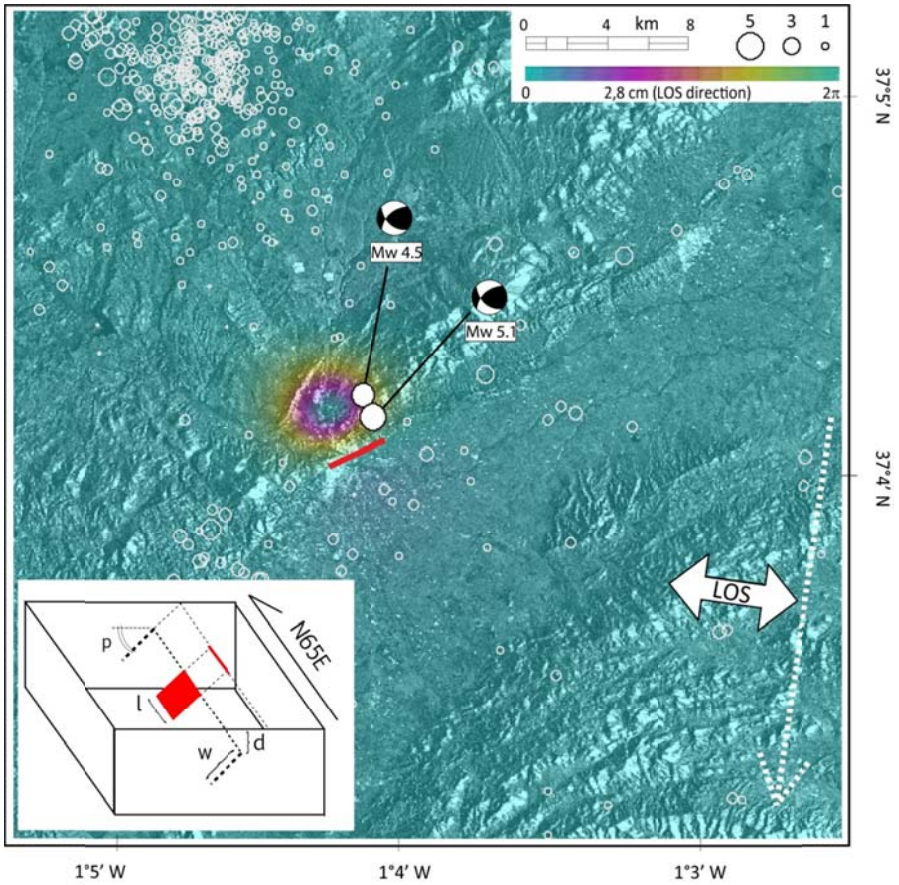

Figure 2: Surface displacement of the Lorca earthquake as inferred from our elastic dislocation model (model parameters are in table II). Seismicity: same as figure 2. The white rectangle inset represents a cartoon of the modelled fault plane; l = 2.9 km; w = 2.9 km; d = 3.2 km ; p = 45°. LOS: Line of Sight direction (23° off the vertical). The red segment represents the surface extension of the modeled seismogenic fault.

2. REFERENCES

[1] P. Briole, G. De Natale, R. Gaulon, F. Pingue, R. Scarpa, Inversion of geodetic data and seismicity associated with the Friuli earthquake sequence (1976-1977) Italy., Annales Geophysicae, 4 B, pp. 481-492., 1986

[2] P. González, J. Fernández (2011), Drought-driven transient aquifer compaction imaged using multitemporal satellite radar interferometry, Geology, 39(6), pp 551–554, 2011

[3] López-Comino, J.-Á., F. de L. Mancilla, J. Morales, and D. Stich (2012), Rupture directivity of the 2011, Mw 5.2 Lorca earthquake (Spain), *Geophys. Res. Lett.*, 39, L03301, doi:10.1029/2011GL050498.

3. AKNOWLEDGEMENTS

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