# Modeling the Mw 6.3 Andravida earthquake, 8 June 2008, Greece

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## Abstract

The source model is based on centroid position and moment tensor from near-regional waveforms, and hypocenter position from first-arrival location. It consists of a single 12 x 6 km asperity on a 24 x 12 km fault with random $k^{-2}$ slip distribution. Mutual position of the hypocenter and centroid indicates the NE rupture propagation direction. The asperity area is almost free of on-fault aftershocks. Most aftershocks fit with the loaded sectors of the Coulomb stress perturbation resolved with optimally oriented rake. The stress resolved on planes parallel with mainshock explains the concentrated (and a few hours delayed) activity SW of hypocenter. More diffused NE aftershocks are better explained when resolving the stress on planes striking 170°, suggested by some regional faults. Remarkable off-fault surface ruptures on the reactivated Nisi fault (Koukouvelas et al., 2009) seem to relate with the stress perturbation as well, although not accompanied by aftershocks, thus of aseismic origin.

## Location

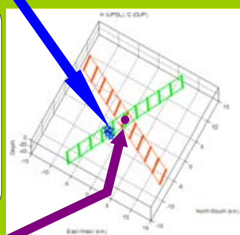
We located the earthquake and its 192 aftershocks by the HYPOINVERSE method (Klein, 2002), based on high-quality P and S readings at 16 stations, in epicentral distances < 200 km; minimum 5 stations per event. To understand the uncertainty, hypocenter of mainshock was calculated in three crustal models, using different Vp/Vs ratios, 1.75 to 1.78, and varying starting depths between 5 and 25 km. The solution was very stable; when rounding to 0.01° and 1 km depth, it resulted in four most likely alternative epicenter positions.

high-quality

*Hypocenter (alternative positions)*
37.94° N, 21.51° E or 37.94° N, 21.52° E, depth 18 or 19 km
**37.95°** N**, 21.50**° E or 37.95° N, 21.51° E, depth 20 or **23 km**

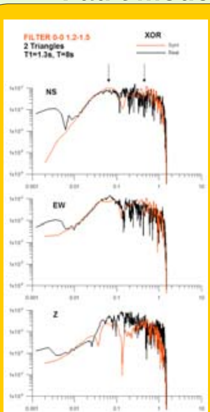
## H-C consistency

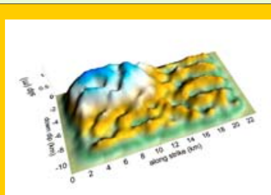
The fault plane was identified by the H-C method (Zahradnik et al., 2008). According to this method, from two planes of the conjugated fault-plane solutions passing through centroid position, C, the likely fault plane is the one that encompasses hypocenter, H; the uncertainties of both H and C must be taken into account. These data suggest the right-lateral fault. The H-to-C distance is 7.4 km, with C situated NE of H, thus indicating rupture propagation from SW to NE. This result is similar to the fault-plane identification we reported to EMSC seven hours after the earthquake occurrence.




*Centroid (optimum position)*
37.98° N, 21.53° E, depth 17 km
strike/dip/rake = 27°/ 89°/ 177°, Mo=3.2 x 1018 Nm, Mw=6.3

## Fault model




Regional waveforms at a few stations (e.g. XOR) were used to estimate the source size, taking directivity into account. Two maxima in the amplitude spectra of the ground-motion velocity indicated a fault with an asperity on it. We propose the main slip patch 12 x 6 km, centered at C, releasing one half of the total moment. The whole fault of 24 x 12 km continues beyond the asperity towards NE with random $k^{-2}$ slip distribution (Gallovic and Brokesova, 2004). The main slip patch coincides with area almost free of on-fault aftershocks.

## Acknowledgement

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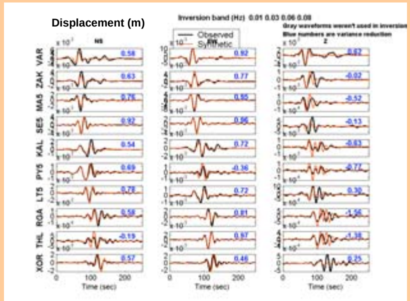
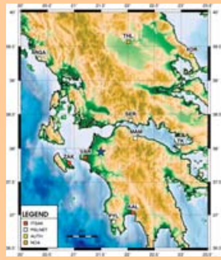
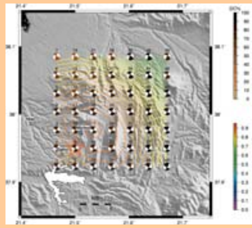
## Centroid moment tensor

Focal mechanism of the mainshock was calculated by the ISOLA method (Sokos and Zahradnik, 2008). Waveforms in the frequency range 0.01-0.03-0.06-0.08 Hz were inverted for the deviatoric moment tensor while the optimum source position (centroid, C) and time were grid-searched. Ten near-regional stations were used. The observed waveforms were matched fairly well, with the overall variance reduction of 0.76. Using iterative deconvolution we found no need of additional subevents.



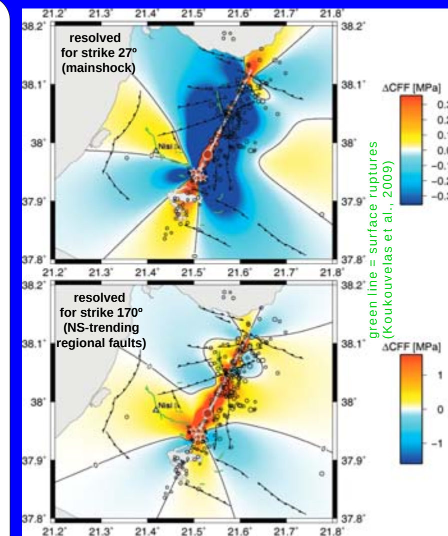



star = hypocenter
maximum of correlation = centroid

## Aftershocks and Coulomb stress

The perturbation of the Coulomb Failure Function due to the mainshock model, ΔCFF, was calculated using FARFALLE code (Nostro et al., 2002). The stress was resolved at 17 km depth on vertically dipping planes of two orientations: striking as the mainshock (27°), or as some regional faults (170°). The rake angles maximizing the total-stress CFF (regional plus perturbed stress) were considered. The aftershock cluster SW from hypocenter fits well with localized stress resolved on the 27° planes. More diffused aftershocks NE of the hypocenter are better explained by the stress resolved on the 170° planes, suggested by some regional faults. It may relate with temporal evolution: most of the SW aftershocks occurred with a few hours delay. The NE aftershocks might have been enhanced by dynamic stress in the forward rupture direction. Remarkable off-fault surface ruptures (Koukouvelas et al., 2009) at Nisi fault seem to relate with the stress perturbation as well, although not accompanied by aftershocks at all, thus suggesting aseismic origin.




stars = alternative positions of mainshock hypocenter
full circle = centroid, open circles = aftershocks

## References

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