15th International Congress of the Geological Society of Greece
Athens, 22-24 May, 2019 | Harokopio University of Athens, Greece
Bulletin of the Geological Society of Greece, Sp. Pub. 7 Ext. Abs. GSG2019-215

Directivity effect on strike slip faults at North Aegean area, Greece

D. Kementzetzidou[1], A.A. Panou[1], P. Papadisopoulou[1]

(1) Aristotle University of Thessaloniki, Department of Geology, 54124, Thessaloniki, Greece, dkementz@geo.auth.gr, arpanou@geo.auth.gr, ppara@geo.auth.gr

This study examines the ground motion pulses during events which occurred in strike slip faults in order to show rupture directivity. Earthquake directivity is the focusing of wave energy along the fault in the direction of rupture. Observations from previous studies have displayed the effects of near-fault ground motions and suggested the forward and backward rupture directivity (Cocco, 1997; Somerville et al., 1997; Koketsu and Miyake, 2008; Poiata et al., 2012; Kane et al., 2013). Forward rupture directivity effects occur when the rupture front propagates toward the site, and the direction of slip on the fault is aligned with the site. Conversely backward directivity effects occur when the rupture propagates away from the site. Rupture directivity effects cause spatial variations in ground motion amplitudes and duration around faults. If a site is located in the forward direction of the rupture most of the seismic energy will arrive in a large brief pulse. Backward directivity effects are recorded as long duration motions with low amplitudes at long periods.

Considering the aforementioned works, an attempt is made here to explain the effects of rupture directivity using waveforms from earthquakes which occurred in the study area (North Aegean, Figure 1). Digital recordings were taken from the broadband seismological stations belonging to the Hellenic Unified Seismological Network (HUSN, network codes: HL, HT, HP, HA). Waveform data have been processed to form individual events corresponding to the initial earthquakes, and have been associated with the appropriate response information for the time period of the event. The deconvoluted data is shown in ground velocity units.

A demonstration of the effect of the ground motion directivity pulses is given in Figure 1 for the Lemnos earthquake (M 5.9). The earthquake occurred on January 8th 2013 in North Aegean Sea on a right lateral strike slip fault. The fault plane solution estimated by NOA (National Observatory of Athens) and it indicates a right lateral strike slip faulting mechanism in a NE-SW direction (strike: 60^0), moment magnitude of 5.7 and a shallow hypocenter (8 km), at only 42 km epicentral distance from the Lemnos island. The locations of the stations used for this study and the recorded ground motions (north south component) as well as the focal mechanism of the earthquake are presented in Figure 1. The main aspects of the rupture configuration contributing to the generation of fault ground motions pulses during a strike-slip faulting event are studied here.

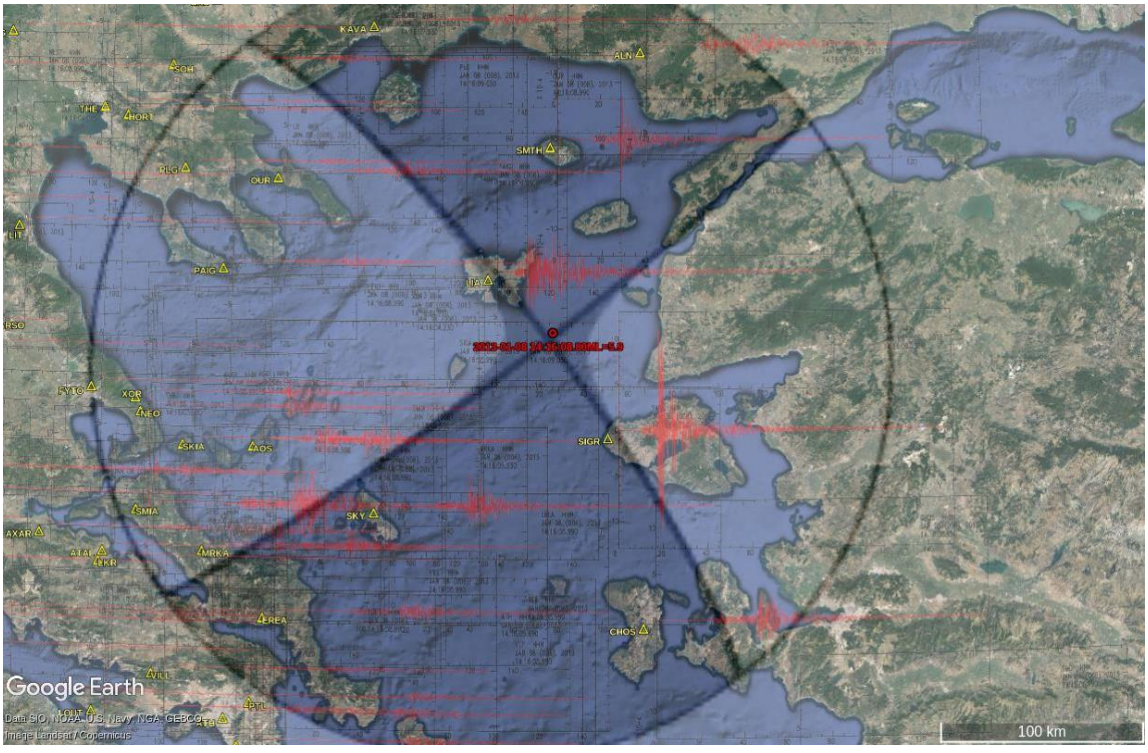
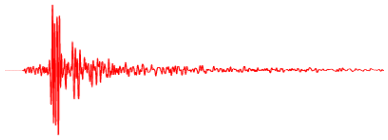


Figure 1. Map showing the epicenter and the focal mechanism of the 20130108_141608. Distribution of the stations (yellow triangles) and observed displacement time series (red lines) are also marked in the figure.

According to the focal mechanism we expect that forward rupture directivity effects propagate along strike. Therefore, stations recordings located in compression (grey) areas will present the forward rupture directivity effect whereas the recordings placed in dilatation (light) areas will show the backward directivity effect. Figure 1 points out the influence of rupture directivity effects at the recording sites. Despite similar epicentral distances, stations located at N and NNW as well as S and SE from the epicenter have amplitudes much larger than those located at E and W. Some representative stations along with the corresponding recordings and their rupture directivity classification are shown in Table 1. For example, the SIGR record is displayed where ground motions have a large amplitude and a short duration (forward directivity effect). On the other hand, the ground motion in station AOS is characterized by a longer duration and a lower amplitude ground motions (backward directivity effect).

Table 1. Ground velocity time histories of selective stations and their rupture directivity characterization.

a/a	Station	R (km)	Recordings	Directivity
1	LIA	44		Forward
2	SIGR	55		Forward
3	SMTH	89		Forward
4	AOS	159		Backward
5	OUR	157		Backward
6	PAIG	167		Backward

Acknowledgements

We acknowledge support of this work by the project “HELPOS – Hellenic System for Lithosphere Monitoring” (MIS 5002697) which is implemented under the Action “Reinforcement of the Research and Innovation Infrastructure”, funded by the Operational Programme "Competitiveness, Entrepreneurship and Innovation" (NSRF 2014-2020) and co-financed by Greece and the European Union (European Regional Development Fund).

References

Cocco, M., 1997. Seismic Hazard assessment: Rupture propagation modeling for ground motion prediction. Seismic Risk SERINA, 21-27 September, Thessaloniki, Greece.

Kane, D.L., Shearer, P.M., Goertz-Allmann, B.P., Vernon, F.L., 2013. Rupture directivity of small earthquakes at Parkfield. J. Geophysical Research. 118, 212-221.

Koketsu, K., Miyake H., 2008. A seismological overview of long-period ground motion. J. Seismol. 12, 133-143.

Somerville, P.G., Smith, N.F., Graves, R.W., Abrahamson, N.A., 1997. Modification of empirical strong ground motion attenuation relations to include the amplitude and duration effects of rupture directivity. Seismol. Res. Lett. 68, 199–222.

Poiata, N., Miyake, H., Koketsu, K., 2012. Generation Mechanism of Near-Fault Ground Motion for Dip-Slip Faulting. 15th World Conference on Earthquake Engineering, Lisbon, Portugal, p. 5071.