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Seismotectonic analysis of the 2013 seismic sequence at the western Corinth Rift

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ABSTRACT

This study focuses on a series of small intraplate earthquakes that took place during May–August 2013 on the southwestern coast of the Corinth Rift (Central Greece), a few km southeast of Aigion city. The Corinth Rift is one of the most seismically active parts of the Mediterranean. We analyzed more than 1500 events with $0.4 \le M_L \le 3.7$, the major part of which was recorded by a dense local network. The seismicity is densely clustered in a volume of dimensions $\sim 4 \times 2 \times 6\,\text{km}^3$, aligned in a N110° direction and at depths ranging between 6 and 12 km. Precisely relocated hypocenters and reliably constrained focal mechanisms indicate north dipping planar faults with an average dip of ~60°. Stress inversion of focal mechanisms implies that the dominant local stress field is extensional in a N5° direction, in good agreement with geodetic observations. The swarm evolved in two phases, with a spatiotemporal migration of epicenters from the eastern toward the western part of the rupture zone, while slip distribution appears homogeneous over the eastern part and strongly inhomogeneous in the western part. These two phases also produced different results in scaling relations such as the Gutenberg–Richter law, the Modified Omori Formula and the Epidemic Type of Aftershock Sequence model. Similar results from other studies have been reported and correlated with a fluid driven mechanism, however further research is required to strengthen this hypothesis for the purposes of this study.

1. Introduction

The present study concerns the seismotectonic analysis of a large sequence of small earthquakes that took place on the western Corinth Rift in Central Greece, over a three month period in 2013. The Corinth Rift is a prevailing extensional tectonic structure with a length of 110 km in a N120° direction and is classified as one of the most seismically active areas in Europe (Fig. 1).

Crustal extension in the Corinth Rift has been attributed to a combination of three major scale processes involving: the back arc extension due to the Hellenic Trench subduction zone (Doutsos et al., 1988), the propagation of the North Anatolian fault within the Aegean (Armijo et al., 1996) and the gravitational collapse of the overloaded crust after the Hellenides orogeny phase (Jolivet, 2001).

The Corinth Rift is a young tectonic rift (1–2 My) (Bell et al., 2009) comprised of E–W striking normal faults that are located onshore to the north and south and offshore in-between. The faulting is mainly composed of 10–20 km long *en echelon* segments, with dip angles 50–70° with a southward dip on the northern shore and a northward dip on the southern shore (Fig. 2) (Micarelli et al., 2003; Moretti et al., 2003; McNeill et al., 2005a; Bell et al., 2008).

The deformation demonstrated by GPS surveys shows a very high horizontal strain rate in a N–S direction, equal to about $10\,\text{mm}\,\text{y}^{-1}$ in the eastern part of the Rift, $14\,\text{mm}\,\text{y}^{-1}$ in the central part and $15\,\text{mm}\,\text{y}^{-1}$ in the western part (Clarke et al., 1998; Briole et al., 2000; Avallone et al., 2004). In addition, an uplift rate of more than $1\,\text{mm}\,\text{y}^{-1}$ has been reported on the southern shore and Holocene subsidence ($1.3\text{–}2.5\,\text{mm}\,\text{y}^{-1}$) offshore (De Martini et al., 2004; McNeill et al., 2005b, 2007; Palyvos et al., 2008). The E–W increase in strain rates has not been constant during the Corinth Rift's history and the step-like increase in the amplitude of the extension rate is related to shifts in the loci of maximum extension (Bell et al., 2011), to reach the present day kinematic rates (Ford et al., 2013). The rapid growth and offshore fault development in the western part of the rift, has been suggested to be the result of strain transfer between segments of the major sub-parallel faults of western Heliki and Aigion (McNeill et al., 2007).

The syn-rift deformation within the western Corinth Rift has been investigated by many researchers (McNeill et al., 2005a, 2007;

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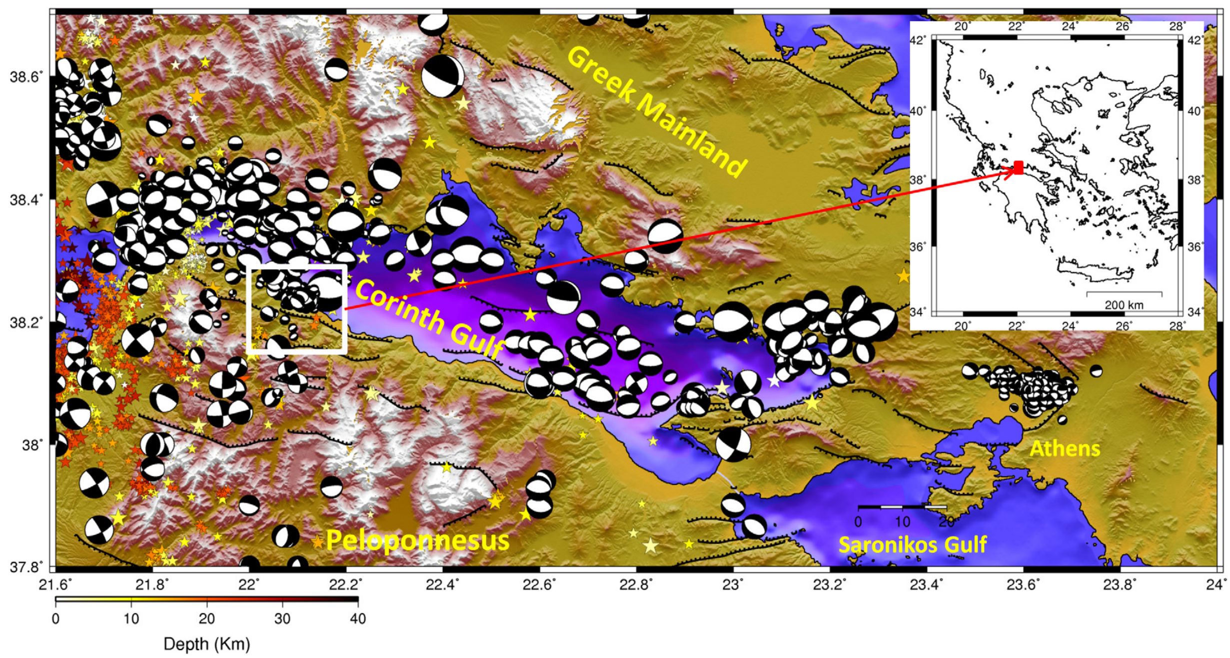

Fig. 1. Map showing the main tectonic features of the Corinth Rift that includes epicenters of instrumentally recorded earthquakes with Ms ≥ 4.0 (1900–2013, Makropoulos et al., 2012, NOAGI – http://bbnet.gein.noa.gr) and available focal mechanisms (1861–2013) from Papazachos and Papazachou (2003) NOAGI (http://bbnet.gein.noa.gr/HL/database), Harvard (http://www.globalcmt.org), Vannucci and Gasperini (2004), Papadimitriou et al. (1994, 2002), Hatzfeld et al. (2000). Barbed lines are active faults (Armijo et al., 1996). The white rectangle shows the position of the study area. The embedded map in the upper right corner of the panel shows the position of the study area within the Greek territory.

Bell et al., 2008, 2009; Taylor et al., 2011; Beckers et al., 2015). An interesting discussion concerns the role of low-angle faults and detachments in the western Corinth Rift and their association with the steeply dipping faults that are observed on and off shore. A low-angle detachment zone with a dip 15–20° has been suggested to be located offshore at depths between 6 and 9 km, in order to accommodate the measured strain rates (Rigo et al., 1996; Bernard et al., 1997; Briole et al., 2000). On the other hand, the absence of

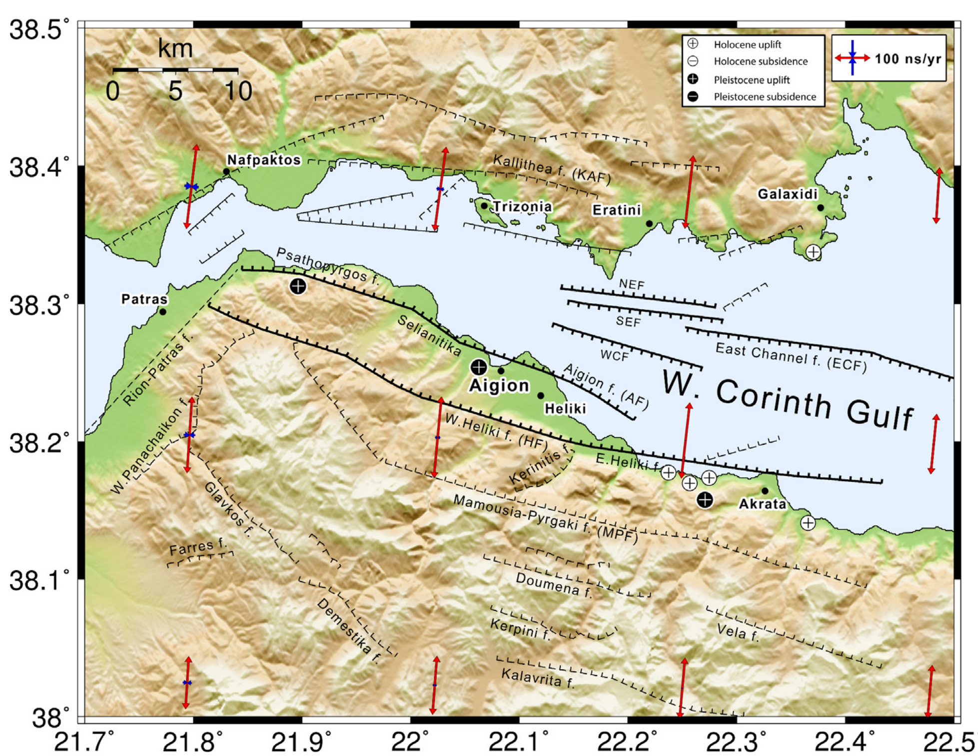

Fig. 2. Tectonic framework of the Aigion area. The onshore faults were provided by the KRIPIS research project and the faults offshore are after Bell et al. (2009). Double arrows denote the principal components of the strain tensor e_1 (in blue) and e_3 (in red), after Chousianitis et al. (2015). (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)