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The Significance of Local Networks in Shear-wave Splitting: The Case of the Gulf of Corinth

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Abstract

The Gulf of Corinth (GoC) is an active tectonic rift located in central Greece. Its unique seismotectonic properties have rendered it a prime candidate for tectonic (e.g. Bell *et al*., 2008), seismic (e.g. Stefatos *et al*., 2002) and seismological (e.g. Rigo *et al*., 1996) studies. Its long history of both moderate-to-strong events (Makropoulos *et al*., 2012) and seismic swarms (Kapetanidis *et al*., 2015; Mesimeri *et al*., 2016) has been the main instigator for installing and operating dense local networks. The intense observation period of the GoC started in 1995, with the installation of the permanent Cornet seismological network (Papadimitriou et al., 2010) by the Seismological Laboratory of the National and Kapodistrian University of Athens (SL-NKUA). This network was located at the eastern tip of the rift, monitoring an area that featured the destructive Alkyonides sequence of 1981 (Jackson *et al*., 1982). The four digital stations that comprised Cornet recorded over 6,300 events until 2008. Near the western part of the GoC, the Corinth Rift Laboratory Network (CRLN) was installed in 2000 (Lyon-Caen *et al*., 2004) to monitor the area surrounding the focus of the 1995 Aigion earthquake (Bernard *et al*., 1997). The CRLN has since facilitated numerous studies of seismicity in the area, providing local recordings of thousands of events every year. Today, the network is comprised of six borehole and eight surficial stations. The above networks have been complemented by broadband stations operated by the SL-NKUA, the Geodynamic Institute of the National Observatory of Athens (GI-NOA) and the Seismological Laboratory of the University of Patras (SL-UP). In 2008, the Hellenic Unified Seismological Network (HUSN) launched, providing prompt and uninterrupted access to the continuous data recorded by stations of the three institutes.

The extensive record of monitoring in the GoC has permitted the detailed study of seismic properties. Shear-wave Splitting (SwS) is the phenomenon of velocity dependence from the propagation direction of shear-waves. The latter undergo splitting and are distinguished into two components; the S_{fast} travelling with a higher velocity and the S_{slow}. It is a prominent characteristic of media with strong anisotropic features, such as finely-layered rocks (Valcke *et al*., 2006). However, it has long been debated that the cause of SwS in the upper crust can be attributed to the existence of vertical microcracks, saturated with fluids. These microcracks are sensitive to both pore-fluid and local stress variations, as described by the Anisotropic Poro-Elasticity (APE) model (Crampin and Zatsepin, 1997; Zatsepin and Crampin, 1997). Thus, the polarization direction of the S_{fast} (φ) can be used as an indicator of the regional maximum horizontal stress component (σ_{Hmax}) and the time-delay between the arrivals of the split waves (t_d) can be viewed as a representation of the pore stress state.

SwS has been studied in the GoC since the 1990s (Bouin *et al*., 1996). In the current study, we combine results obtained from recordings of Cornet, CLRN and HUSN, to delineate the anisotropic features of the whole GoC. The database constructed in the presented work is composed of 281 events measurements between 1996-1997 from the eastern GoC (Kaviris, 2003; Papadimitriou *et al*., 1999), 201 measurements from the Villia sequence of 2013 (Kaviris *et al*., 2014), 663 pairs from events of 2013 (Kaviris *et al.*, 2017) and 1,642 measurements from events of 2014 (Kaviris *et al*., 2018) in the western GoC. The dataset was further improved by including new measurements from recent events.

The mean φ (in most stations) seems to agree with the general WNW-ESE direction of σ_{Hmax}, as determined by seismotectonic data in the area (Armijo *et al*., 1996; Rigo *et al*., 1996; Bernard *et al*., 1997; Elias and Briole, 2018). However, there are significant deviations from this direction. A group of stations in the NW edge of the GoC exhibits directions perpendicular to the above, i.e. NE-SW. Time-delays do not exhibit a specific trend, which is an expected feature, given that they are affected by factors with a periodicity far smaller than the length of the database. Clarifying the characteristics of seismic anisotropy in the GoC is pivotal for monitoring stress variations through SwS (Crampin *et al*., 1999) and constraining focal mechanisms with shear-wave polarizations, after the effect of anisotropy is corrected. The presented detailed report of SwS properties in the whole of the GoC would be impossible without the operation of dense local networks. Splitting studies involve a rigid and strict event selection procedure and an even stricter analysis regime, leading to a significant percentage of rejected candidates. Without the provision of thousands of events, the number of results would be poor, leading to an inconclusive interpretation of the phenomenon. The need of constantly improving and densifying the networks is paramount for such studies. Initiatives, such as the HELlenic Plate Observing System (HELPOS), have enhanced the ability of conducting SwS surveys by expanding data availability and contributing to the operation of the participating networks.

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