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# From shallow to very shallow image of the highly active Kefalonia – Zakynthos fault system

M.F. Loreto[1], P. Nomikou[2], V. Ferrante[1], A. Argnani[1], M. G. Ferrante[3], D. Accettella[3], R. Ametller[4], A. Bubbi[3], A. Cova[3], M. Dal Cin[3], L. Facchin[3], M. Ferrante[3], A. Fiorentino[5], M. Iurcev[3], D. Lampidou[2], I. Merino[6], E. Nikoli[2], M. Ligi[1], F. Muccini[7,8], C. Palmiotto[1], L. Petracchini[8], S. Romano[1], R. Romeo[3], S. Poulos[2], M. Santulin[3], M. Sanchez[4], P. Visnovic[3], F. Zgur[3], A. Ganas[9], C. R. Ranero[6,10]

(1) National Research Council, Institute of Marine Sciences, Bologna, Italy filomena.loreto@bo.ismar.cnr.it (2) Department of Geology and Geoenvironment, National and Kapodistrian University of Athens, Zografou campus, Athens, Greece (3) National Institute of Ocenaography and Applied Geophysics, Sgonico-Trieste, Italy (4) Marine Technology Unit, CSIC, Barcellona, Spain (5) Italian Institute for Environmental Protection and Research, Marine Geology Section, Rome, Italy (6) Barcelona Center for Subsurface Imaging, ICM, Spanish National Research Council, Barcelona, Spain (7) National Institute of Geophysics and Volcanology, Rome, Italy (8) National Research Council, Institute of Enviromental Geology and Geoengineering, Rome, Italy (9) Institute of Geodynamics, National Observatory of Athens, Athens, Greece (10) Institució Catalana de Recerca i Estudis Avançats, ICREA, Barcelona, Spain

In May 2022 and June 2023 two oceanographic cruises were carried out around the Ionian Islands with the aim of defining the real geometry of the strike-slip fault system of Kefalonia and of the reverse faults present south of Zakynthos. The acquired multidisciplinary and multiresolution data will also allow to understand the dynamics of the area offshore the Peoloponnese peninsula, the deformation of the surface sediments at the transition of the two systems, i.e. from reverse fault system to strike-slip fault system, and the relationship between the recorded seismicity and mapped fault activity. To date, the analysis of the processed data has allowed us to define the tectonic and morphological complexity of the fault system affecting the investigated area.

## Background

The area offshore the Peloponnese and the Ionian Islands (Cephalonia, Lefkada, Zakynthos and Ithaki), NW Greece, is characterized by a comparatively more intense instrumentally-recorded seismicity than any other region in the Mediterranean, often with tsunamigenic potential. During the last four decades, there have been several large earthquakes with Mw>6 in Kefalonia 1983, Strofades 1997, Lefkada 2015, Zakynthos 2018 (see references in Ganas et al., 2020). Based on focal mechanisms (Ganas et al., 2020; Papadimitriou et. al. 2021), Kefalonia system shows strike-slip movements, while Zakynthos is mainly affected by compression with a small transcurrent component. Although the several seismological studies (Cirella et al., 2020; Ganas et al. 2016) and modelling (Basili et al., 2013; Svigkas et al. 2019) that allowed to define the several fault plane solutions related with the main events, a clear image of fault planes related to the several events still not known.

Furthermore, a new discussion has recently emerged about the role played by the Kefalonian fault system. Although it has long been recognized as a Transform Fault (Scordilis et al., 1985), some authors have proposed it as a pro-STEP (Subduction-Transform-Edge-Propagator) fault (Ozbakir et al. 2020) formed simultaneously with Pliocene fragmentation of the Epirus fragment.

## Objectives

Accordingly, two marine geophysical surveys have been carried out in 2022 and 2023 to acquire seismic and swath data in the study area. The scope of the surveys was to understand the deformation of shallow sediments, which are controlled by the geodynamic structure of the two complicated tectonic systems and to find some clues of STEP fault activity.

## Methods

We acquired 437 km of high-resolution multichannel seismic (mcs) profiles and magnetic data (Ionians project 2022; Figure 1), 954 km of deep-penetration multichannel seismic profiles and more than 1700 km of sub-bottom profiler and swath data. Moreover, 2 gravity cores were acquired in the deepest parts of the area in turbiditic depocenters at 3.7 to 4.2 km water depth (Poseidon project 2023).

The high-resolution mcs were shoot every 6.25 m with one water-gun (total volume of 12 $inc^3$), recorded with a 75-long streamer, 24 active channels achieving a coverage of 600% and record length of 3072 ms (for more detail see Loreto et al., 2022). We performed standard processing from SEGD reading to post-stack time migration. Magnetic data were collected using a SeaSpy marine magnetometer towed 133 m respect to the stern.

The high-penetration mcs were shoot every 37.5 m with 4 synchronized Airgun (total volume of 1000 $inc^3$), recorded with a 1500-long streamer, 120 active channels, reaching a coverage of 2000% and record length of 12000 ms. Swath bathymetry was acquired with a Konsberg EM304, while the sub-bottom chirp profiles were acquired using Topas PS18. The two systems were synchronized by a k-sync to avoid any frequency interferences. The two gravity cores sampled 2.2 m and 2.7 m of sediments.

**Results and Conclusions**

In this contribution, we will present and discuss results from the geophysical survey mapping the shallow structure. The Kefalonia fault system is characterized by several faults bounding blocks with different kinematic movements changing along the fault strike. From the western part of the Kefalonia – Lefkada region towards southwest the fault changes from a narrow and very steep single fault scarp to a complex setting of fault planes (Figure 2) that rotate north-westward at the ending part. Southwest to Zakynthos several NE-SW structures, associated with the tectonic elements appear associated to landslides and to the recent seismicity recorded in the area.

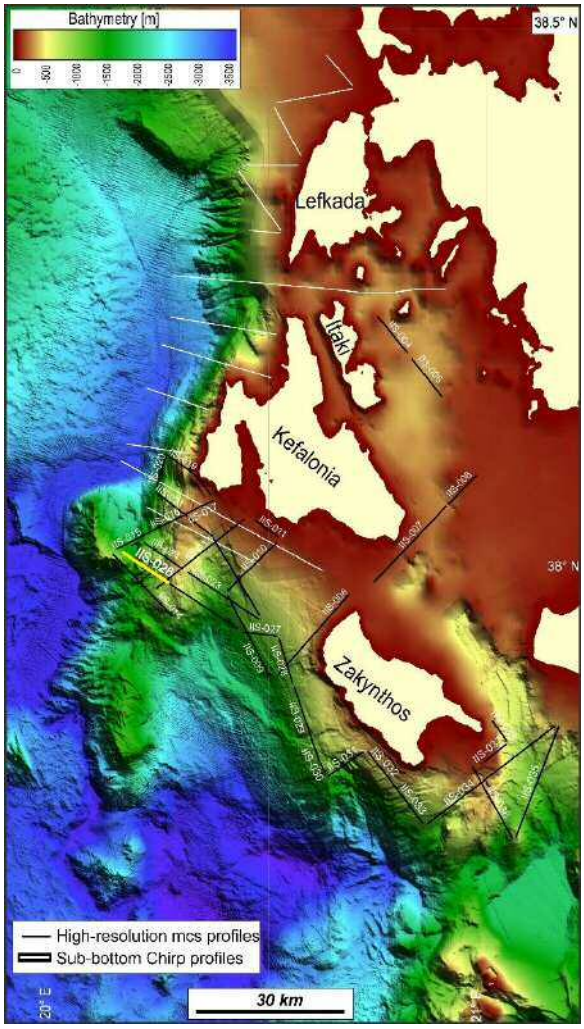


**Figure 1. Location map of high-resolution mcs and some sub-bottom chirp profiles acquired during the Ionians 2022 and Poseidon 2023 cruises. Middle resolution morpho-bathymetry downloaded from the official Emodnet portal (DTM Release 2020; https://emodnet.ec.europa.eu/en/bathymetry) and gridded using the open-source GMT (Wessel and Smith, 2018).**

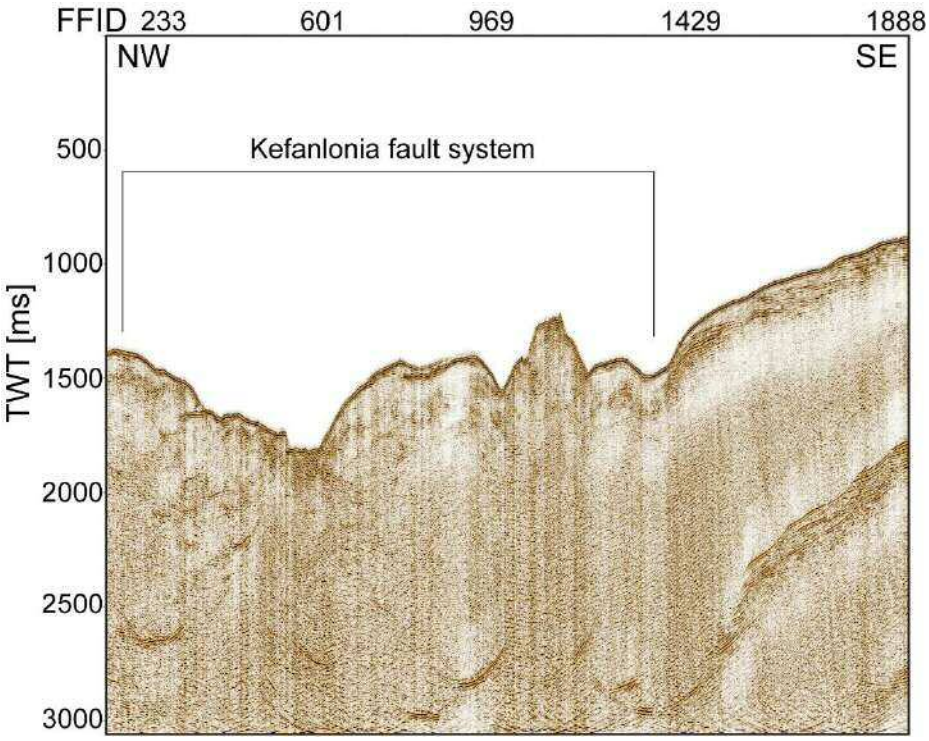


**Figure 2. Seismic image of the southern part of Kefalonia fault system, seismic line IIS_26 (yellow line in Figure 1).**


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