The FOCUS project offshore Catania, Sicily
(FOCUS = Fiber Optic Cable Use for Seafloor studies of earthquake hazard and deformation)


Abstract / Summary

Two-thirds of the earth’s surface is covered by water and thus largely inaccessible to modern networks of seismological instruments. The global network of submarine telecommunication cables, if properly adapted, offers tremendous possibilities as a large-scale seismological monitoring tool for the future. Application of laser reflectometry in fiber optic cables can potentially be used to detect movement across active submarine faults in real time. This is the objective of the ERC (European Research Council) funded project - FOCUS. BOTDR (Brillouin Optical Time Domain Reflectometry) is commonly used for structural health monitoring of large-scale engineering structures (e.g. - bridges, dams, pipelines, etc.) and can measure very small strains (<< 1 mm/m) at very large distances (10 - 200 km). However, this technique has never been used to study faults and deformation on the seafloor.

During the 5-year FOCUS project we aim to detect small (1 - 2 cm) displacements across the recently mapped North Alfeo Fault about 20 km offshore Catania, an urban area of 1 million people. Here, the Catania EMSO (European Multidisciplinary water-column and Seafloor Observatory) station is located in 2100 m depth and connected to land by a 25 km long electro-optical cable. BOTDR observations will have to be calibrated by other independent measurements. Therefore, targeted marine geophysical surveys of the seafloor along the trace of the cable and faults are planned, with the use of seafloor geodetic instruments to quantify relative displacement across the fault. The first step will be to connect a 6-km long fiber optic cable to the seafloor observatory TSS (Test Site South) and then deploy the cable using a deep-water cable-laying system with an integrated plow to bury the cable 20 cm in the soft sediments in order to increase coupling between the cable and the seafloor. The targeted track for the cable will cross the North Alfeo Fault at three locations.

A further goal of the FOCUS project is to develop dual-use cables with standard telecom fibers in the protected core, and additional strain-sensor fibers towards the exterior, which could eventually replace (pure) telecom cables and become the new standard. This would provide a breakthrough in seismology, tectonics and natural hazard early warning technology.

Mediterranean Region: seismicity, faults and catastrophic earthquakes

Sicily - Calabria: subduction, roll-back and lateral slab tear fault (location uncertain/debated)

FocusX2 marine expedition (requested for 2021)
- Planned seismological experiment
- 30 ocean-bottom seismometers
- landstations (permanent & temporary)
- HR seismic profiles (580 Nm)

Etna - Catania region: cable, seafloor observatory and N Alfeo Fault

Bathymetry and planned seafloor experiment

Telecom cables (cross Euro - African plate boundary)

10-day FocusX1 expedition
scheduled 12-21 April - cancelled
possibly rescheduled in summer 2020
planned seafloor geodesy
6 German, 8 French stations

Cable deployment procedure (ROV + plow for burial)
Wireless telecommunication fibers in the protected core, and additional strain-sensor fibers towards the exterior, which could eventually replace (pure) telecom cables and become the new standard.

Seafloor geodesy:
network offshore Mt. Etna
(Urlaub et al., 2018, Sci. Adv.)

ROV Victor6000 - planned operations
(cable laying)
proposed path, 6-km long cable

Baseline GD84 to GD55

6-km long, 9mm diam.
fiber optic cable

Apr. 2016 - July 2017
4 cm slow-slip event over 8 days in May
active fault 20 km offshore Catania !
(urban popul. 1 million)