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Benefitting from cabled observatories to study active submarine faults: the FOCUS project (FOCUS = Fiber Optic Cable Use for Seafloor studies of earthquake hazard and deformation)

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EMSO (the European Multidisciplinary water-column and Seafloor Observatory) includes a 28 km long cable offshore eastern Sicily (Catania) crossing the tectonically active North Alfeo fault. This is the perfect place to test a novel use of fiber optic cables to detect deformation on the seafloor. Laser reflectometry using BOTDR (Brillouin Optical Time Domain Reflectometry), commonly used for structural health monitoring of large-scale engineering structures (e.g. - bridges, dams, pipelines, etc.) can measure very small strains (< 1 mm) at very large distances (10 - 200 km). This technique has never been used to monitor deformation caused by active faults on the seafloor. The objective of the FOCUS project (submitted for an advanced grant to the European Research Council - ERC) is first to demonstrate that this technique can measure small (1 - 2 cm) displacements across an active fault and to calibrate these observations with other methods (several arrays of acoustic seafloor geodetic stations). Two other EMSO test sites with fiber optic cables, the 100 km long Capo Passero (SE Sicily) and the 2 km long cable off Molene Island (W France) will also be studied. Initial reflectometry tests were performed on these three cables using a Febus BOTDR interrogator in June and July 2017. Unexpectedly high dynamic noise levels (corresponding to strains of 200 - 500 μm/m) were observed on the Molene cable, likely due to the high-energy, shallow water, open ocean environment. The tests on the EMSO infrastructure in Sicily indicated low experimental noise levels (20 - 30 μm/m) out to a distance of 15 km.
The plan is to deploy a 5 km long fiber optic cable, from the deep-sea junction panel, at the Catania EMSO Test Site South (in 2100 m water depth), and to cross the North Alfeo fault at two locations. Beforehand, a targeted marine geophysical survey of the seafloor along the trace of the cable must be performed, with deployment of seafloor geodetic instruments to quantify fault displacement and of ocean-bottom seismometers to monitor seismicity. Once the BOTDR fault-monitoring technique has been tested, demonstrated and calibrated offshore Eastern Sicily, the goal is to expand it to other fiber optic cable networks, either existing research networks in earthquake hazard zones (Japan, Cascadia) or to the Mediterranean region through access to retired (decommissioned) telecommunication cables or development of dual-use cables (two of the anticipated outcomes of the FOCUS project). This represents a potentially tremendous breakthrough in seismology, tectonics and natural hazard early warning capability.