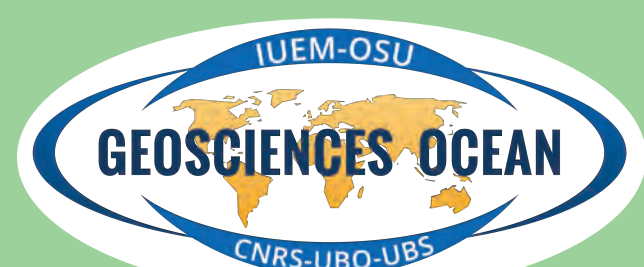# The FOCUS project offshore Catania, Sicily
(FOCUS = Fiber Optic Cable Use for Seafloor studies of earthquake hazard and deformation)

Gutscher, M.-A., Royer, J.-Y., Graindorge, D., Murphy, S., Klingelhoefer, F., Aiken, C., Cattaneo, A., Barreca, G., Quetel, L., Riccobene, G., Petersen, F., Urlaub, M., Krastel, S., Gross, F., Kopp, H.

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.
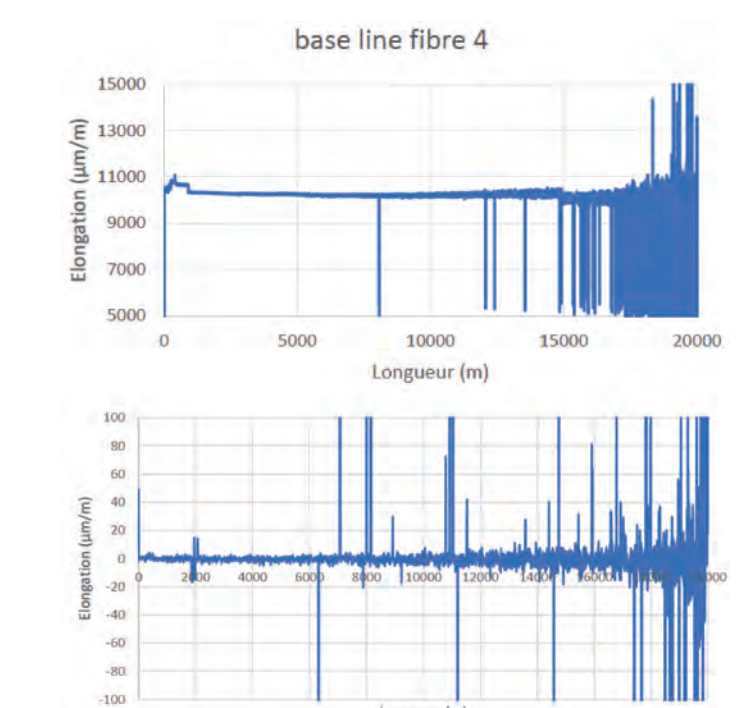
During the 5-year FOCUS project we aim to detect small (1 - 2 cm) displacements across the recently mapped North Alfeo Fault about 20 km offshore Catania, an urban area of 1 million people. Here, the Catania EMSO (European Multidisciplinary water-column and Seafloor Observatory) station is located in 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 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. This would provide a breakthrough in seismology, tectonics and natural hazard early warning technology.
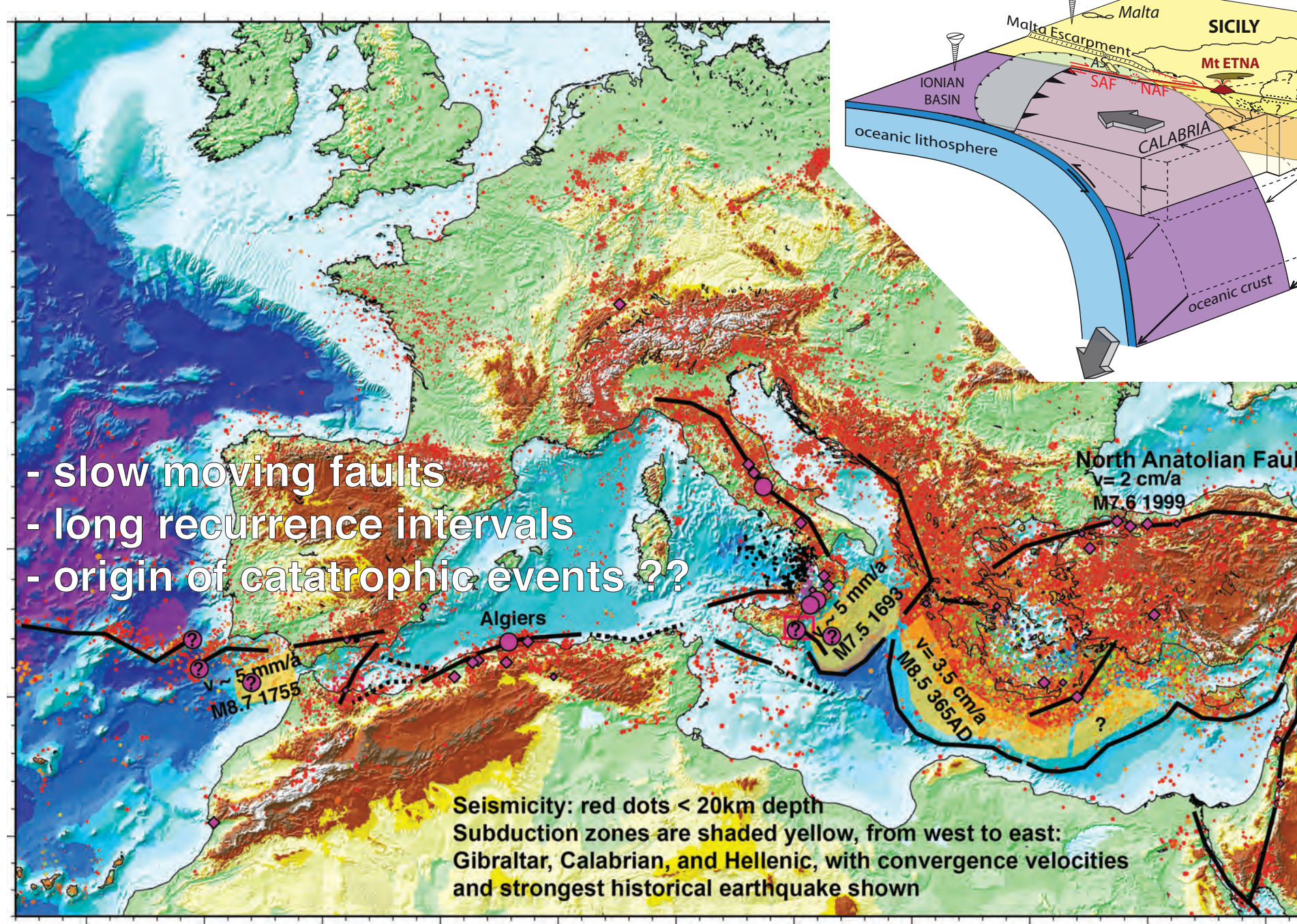
BOTDR (Brillouin Optical Time Domain Reflectometry)

Structural Health Monitoring (SHM)
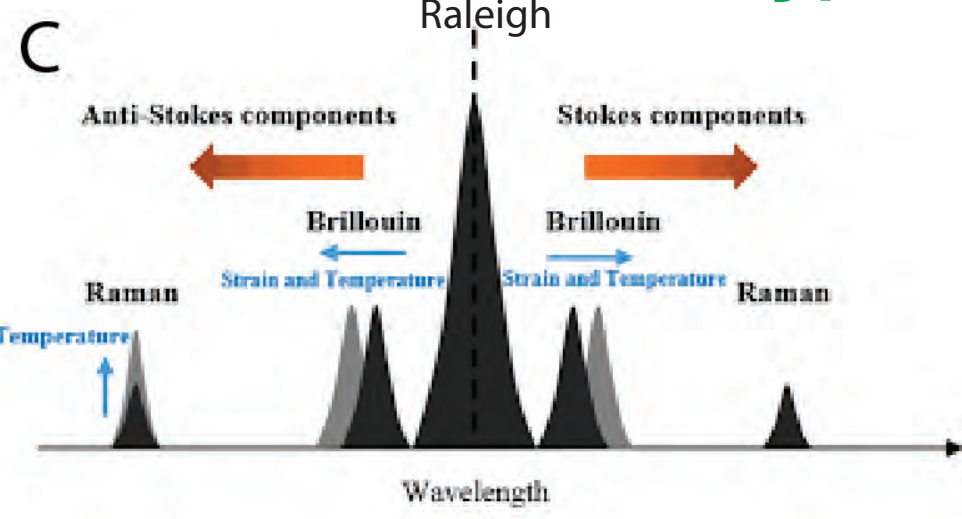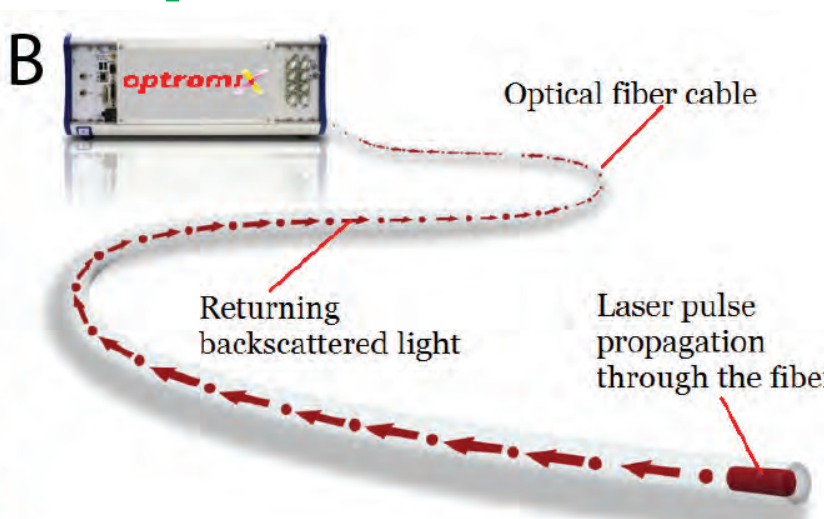
preliminary BOTDR tests on EMSO cable (July 2017)

Telecom cables (cross Euro - African plate boundary)

LES CÂBLES

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

baseline GDS4 to GDS5

Seafloor geodetic network

Apr. 2016 - July 2017
4 cm slow-slip event over 8 days in May

active fault 20 km offshore Catania !
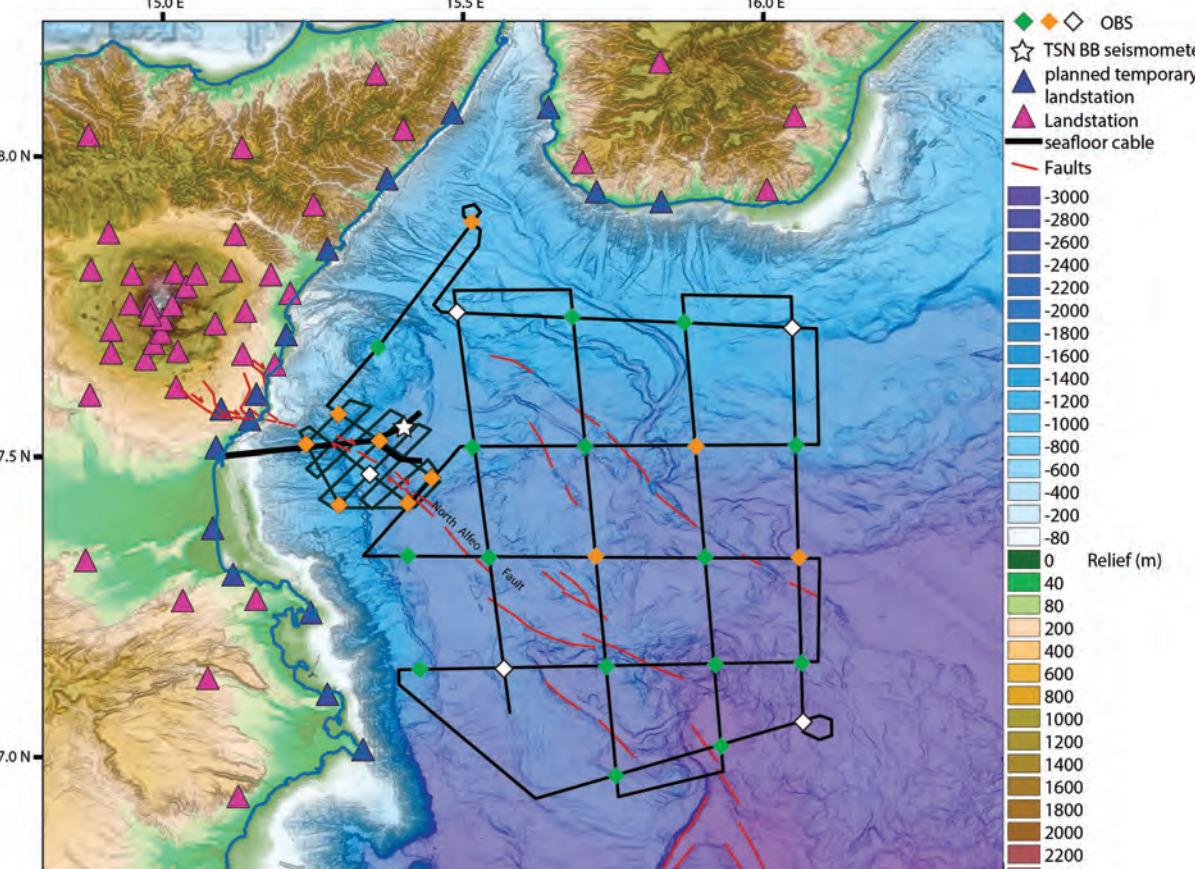(urban popul. 1 million)

Mediterranean Region: seismicity, faults and catastrophic earthquakes

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

- slow moving faults
- long recurrence intervals
- origin of catastrophic events?

North Anatolian Fault v=2 cm/s M7.4 1999

Seismicity: red dots < 20km depth
Subduction zones are shaded yellow, from west to east:
Gibraltar, Calabrian, and Hellenic, with convergence velocities
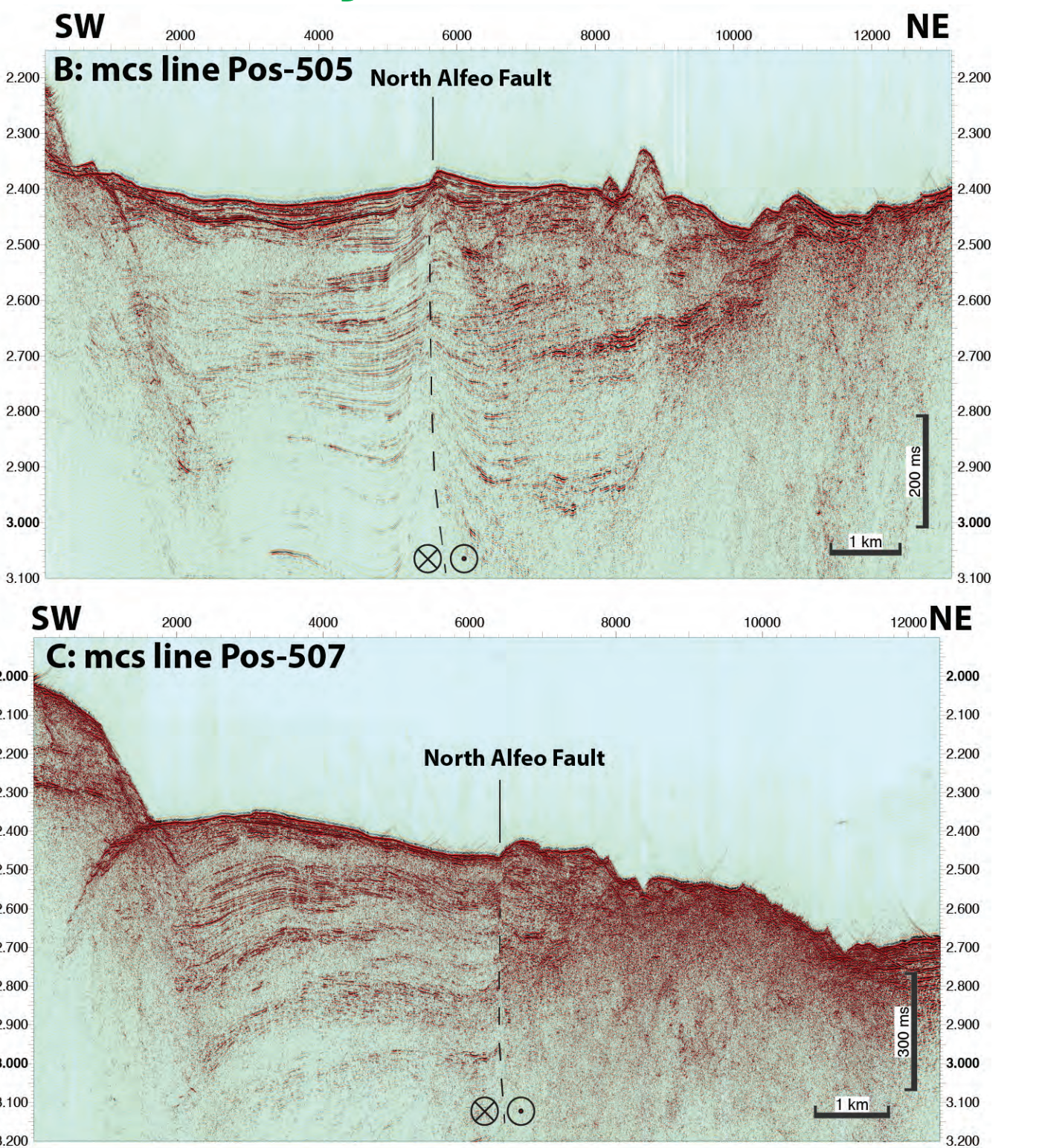and strongest historical earthquake shown

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

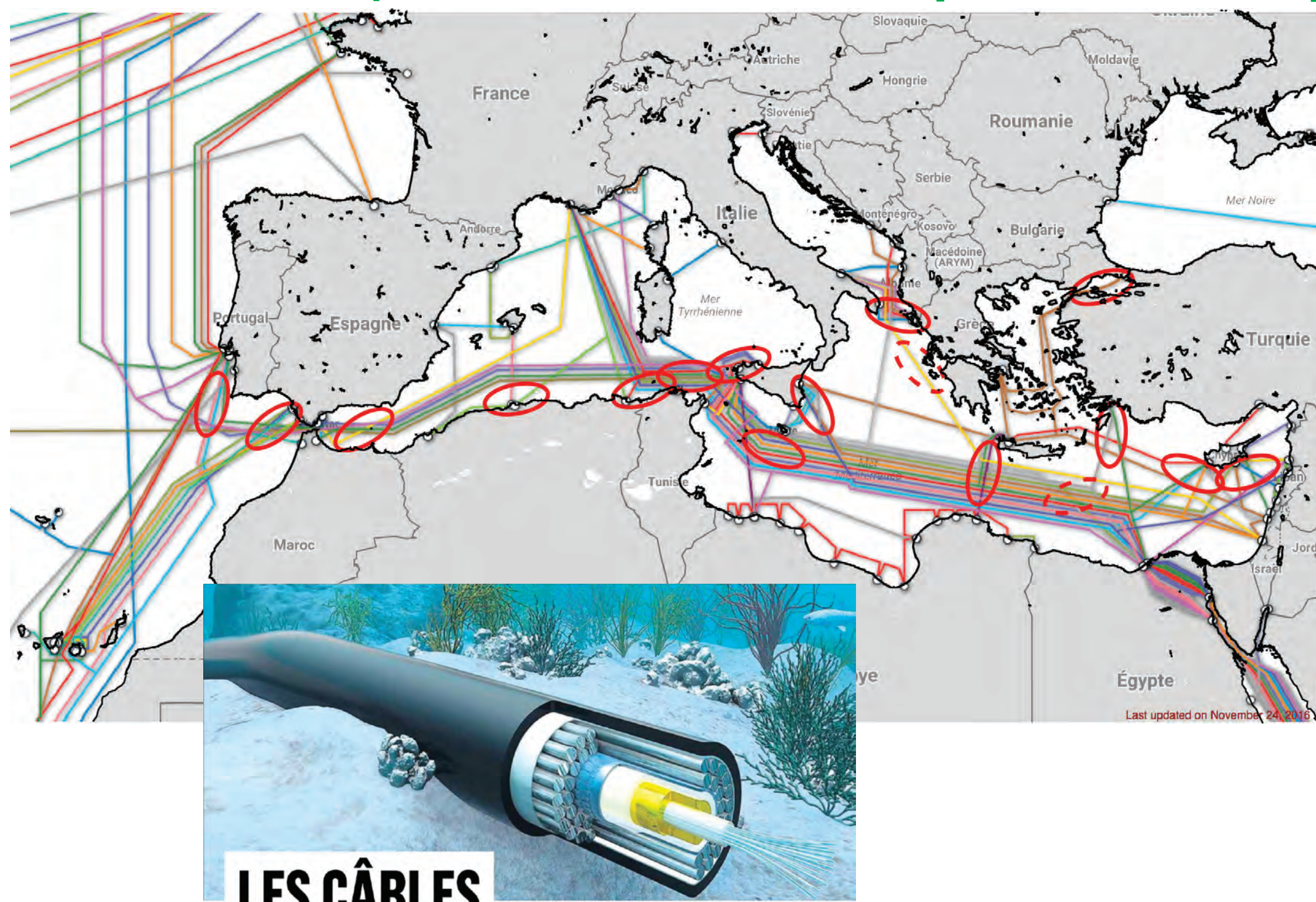## Etna - Catania region: cable, seafloor observatory and N Alfeo Fault

Mt. Etna

SE flank faults 3-5 mm/yr

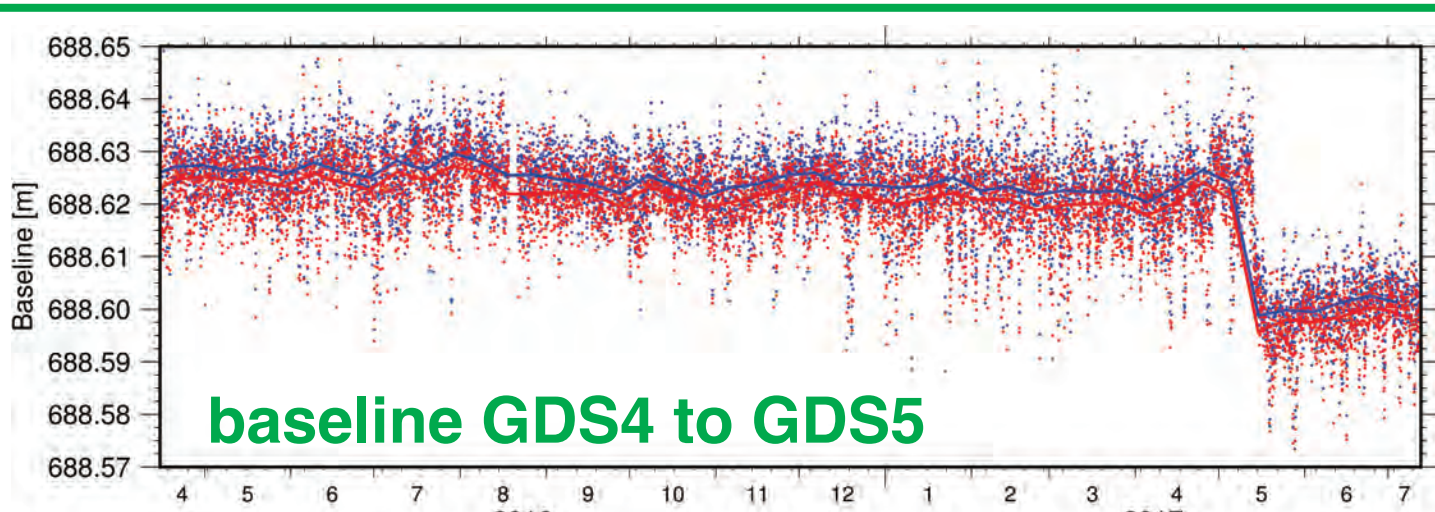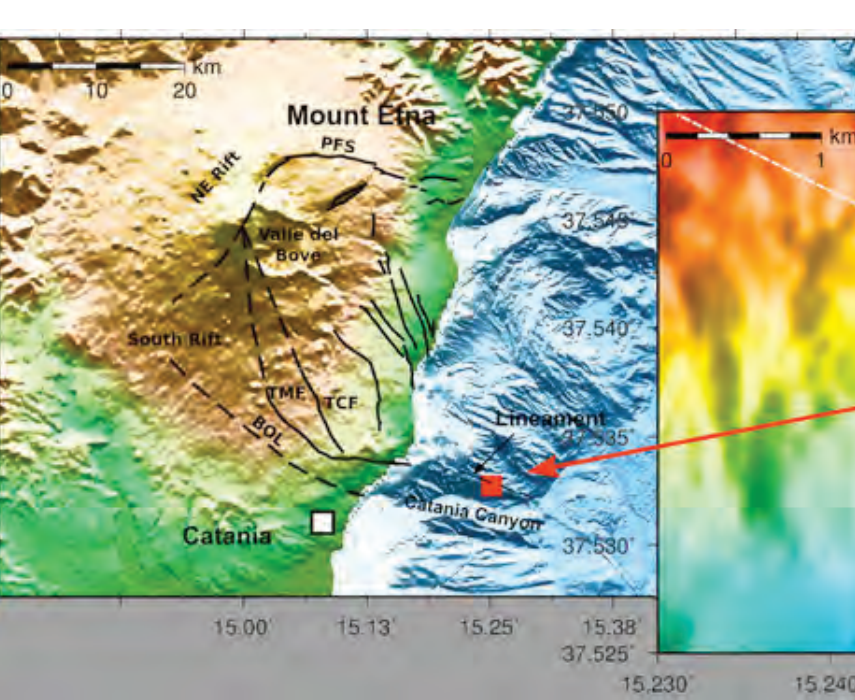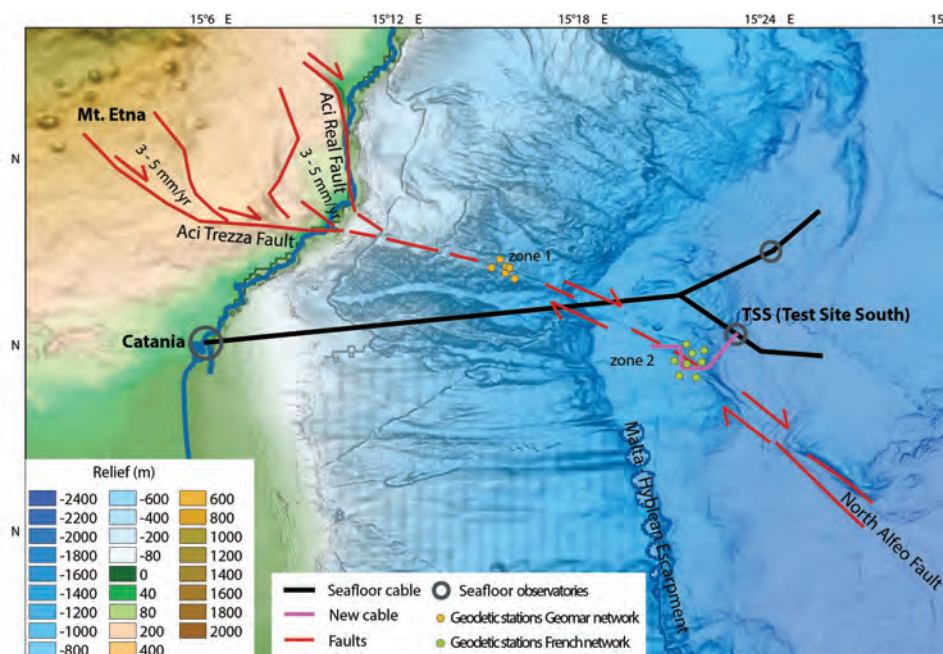Etna - N Alfeo fault link (4cm slip (May 2017))

25 km

Catania

6 km new cable

North Alfeo Fault

TSN

TSS Nemo
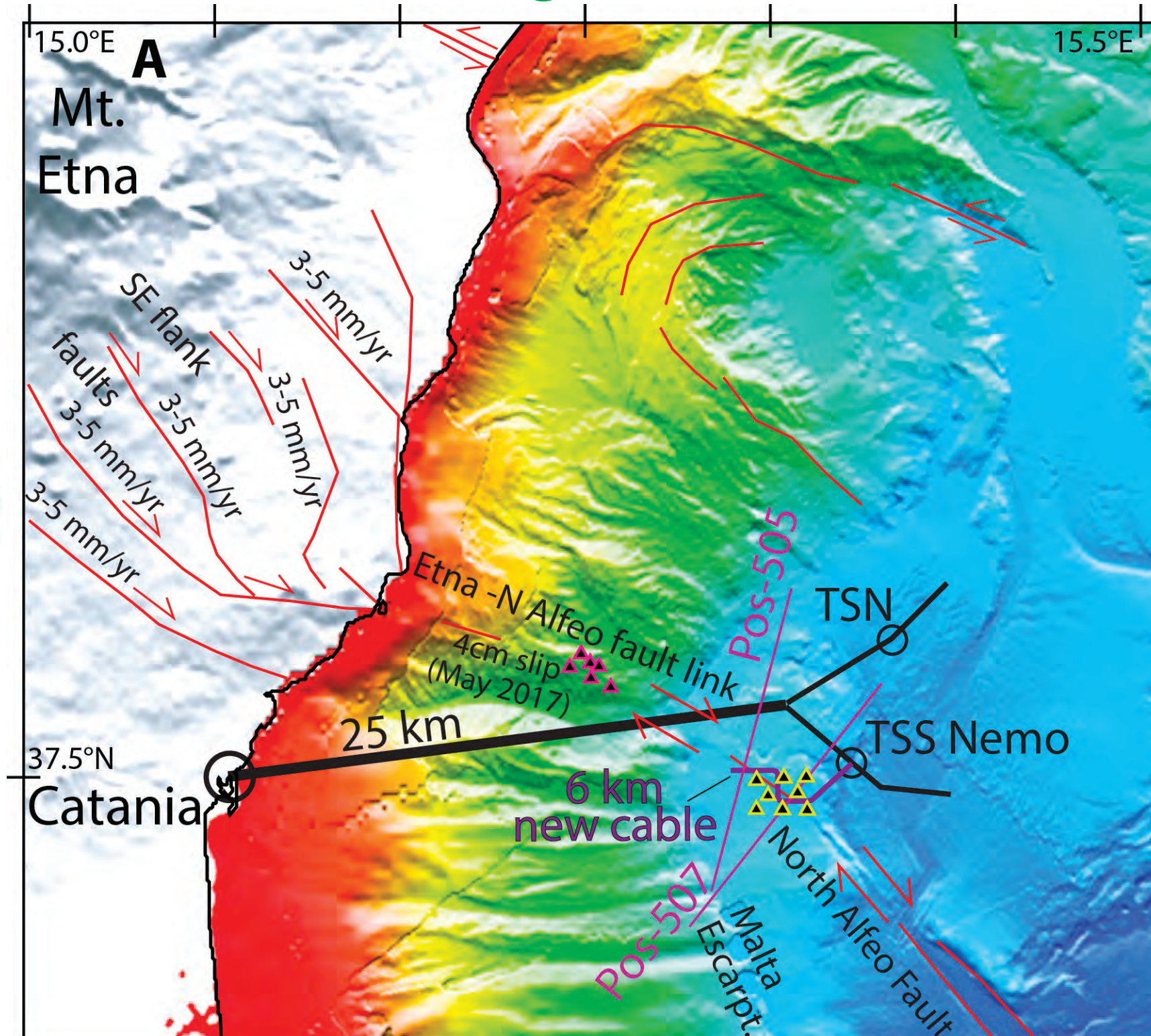
Bathymetry and planned seafloor experiment

B: mcs line Pos-505   North Alfeo Fault

C: mcs line Pos-507   North Alfeo Fault

seismic profiles (F. Gross, S. Krastel, Univ. Kiel - unpubl. data)

10-day FocusX1 expedition
scheduled 12-21 April - cancelled
possibly rescheduled in summer 2020

planned seafloor geodesy
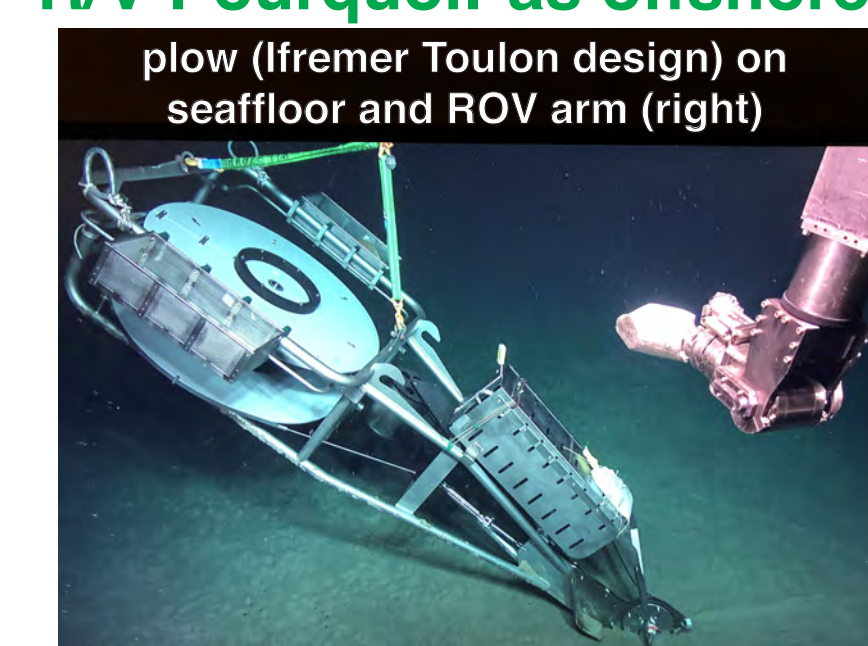6 German, 8 French stations

proposed path, 6-km long cable

TSN (Test Site N)

TSS (Test Site South) 2060m depth
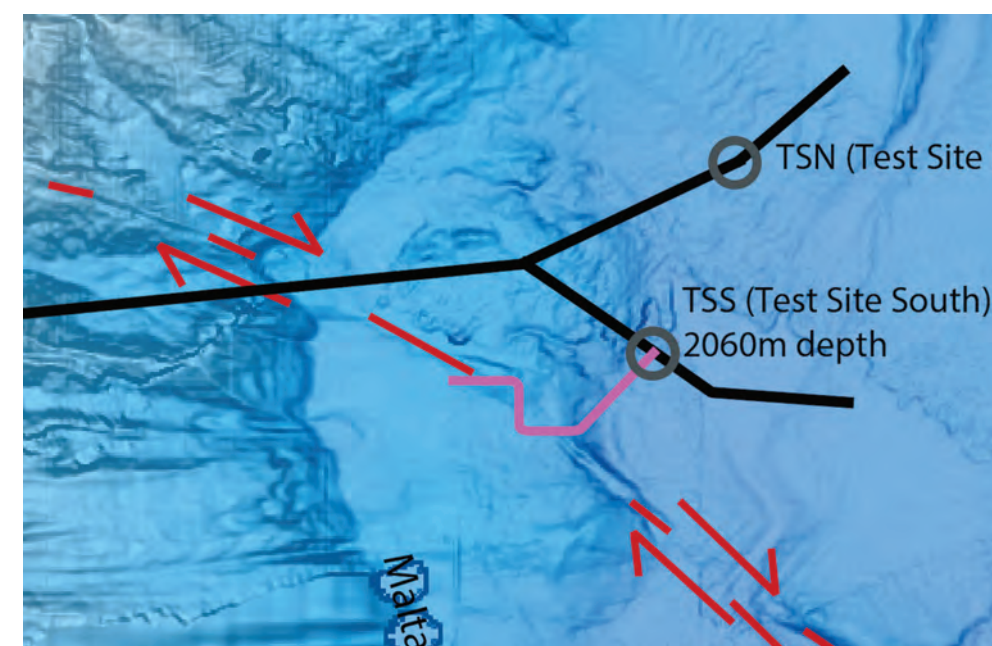
6-km long, 9mm diam. fiber optic cable

Technical Description
FO Sensor Cable

CROSS-SECTIONAL DRAWING

Drawing No:
D-11150 Issue 5

Cable deployment procedure (ROV + plow for burial)
Cable deployment tests performed 2-4 March 2020
R/V PourquoiPas offshore Toulon in 660m depth

plow (Ifremer Toulon design) on seafloor and ROV arm (right)

Y-junction box to be deployed at Test Site South

ROV Victor6000 - planned operations (cable laying)

EMSO TSS (Test Site South) deep-water junction panel 2100m water depth

ODI Teledyne wetmate connector

blade of the plow (after March tests)

plow tests with R/V PourquoiPas

track and groove after cable burial