

Assessing the Seismic Sensitivity on a Submarine Optical Fiber Link between Malta and Sicily, Italy



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1 Introduction

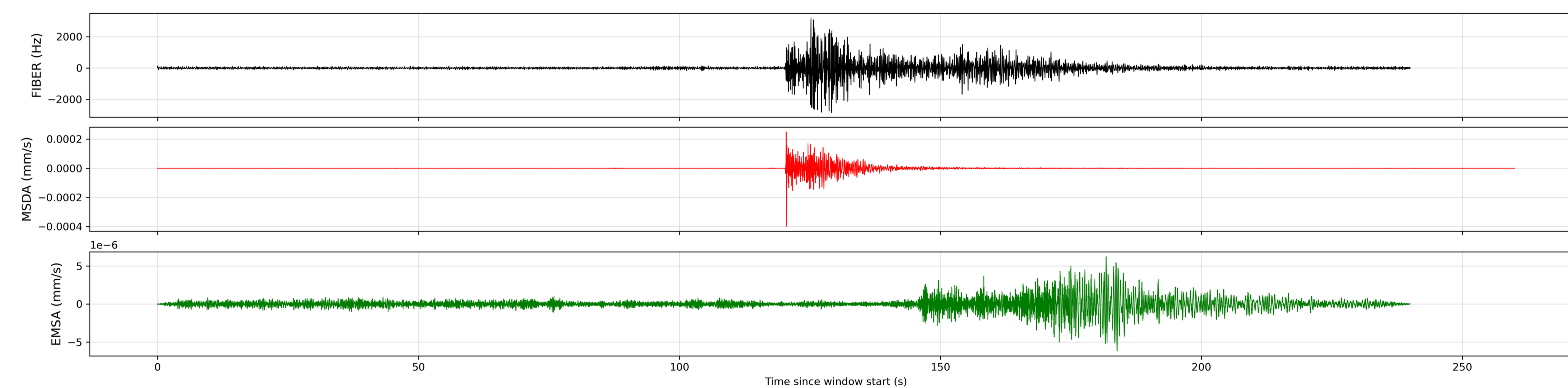
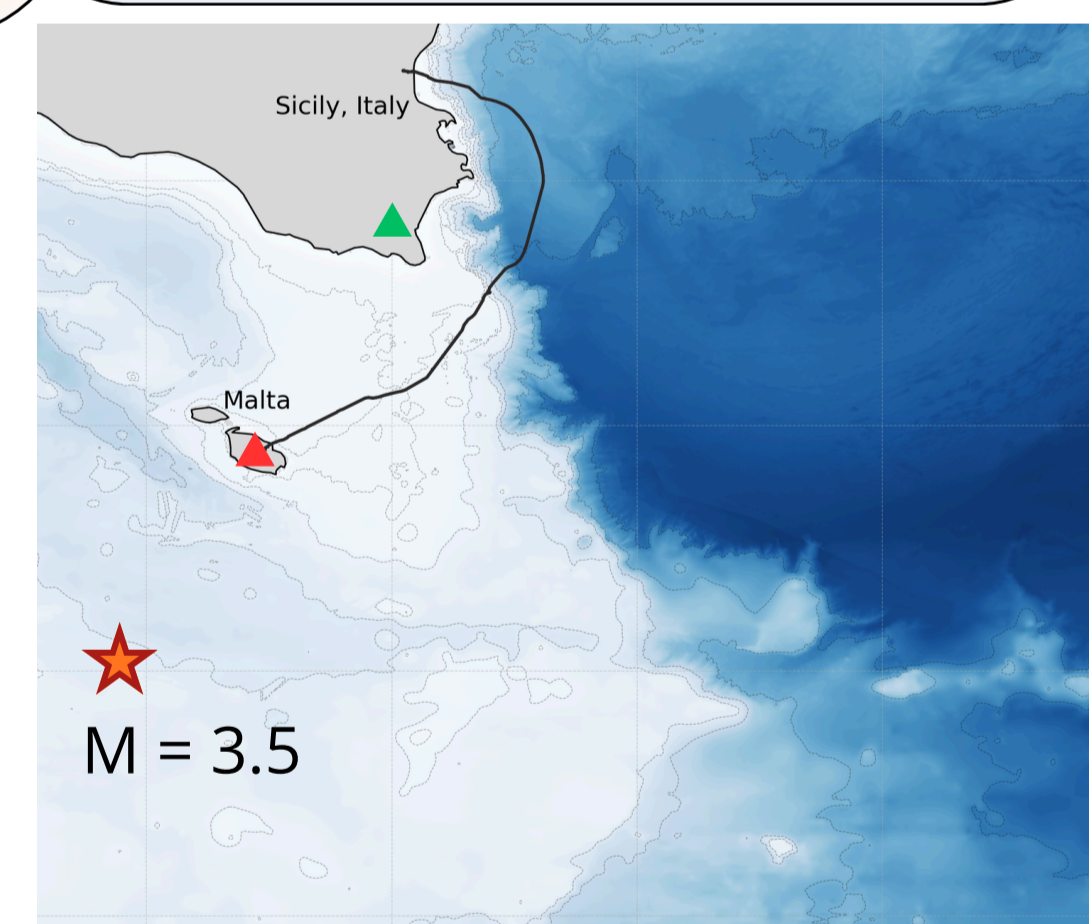
Submarine regions remain sparsely instrumented, limiting seismic monitoring in offshore environments. Optical fibers used for telecommunications can detect ground motion via laser interferometry.

We evaluate the seismic sensitivity of a 260 km optical fiber link between Malta and Catania, continuously carrying internet traffic. The fiber recordings are validated by comparing to nearby seismic stations.

We analyse a dataset comprising approximately 1,500 seismic events extracted from the Istituto Nazionale di Geofisica e Vulcanologia (INGV) catalogue, spanning the period from January 2023 to March 2025. The selected events cover magnitudes between 1.4 and 7.9, and hypocentral distances between 3 km and 6,000 km.

In addition to the event-based analysis, we report observations of noise affecting the recorded signals. These contributions were found to arise from a range of sources, included environmental influences (e.g. weather-induced effects), anthropogenic activity, and other external factors, and are observed to impact the measured spectra.

4 Arrival Example



5 Discussion

- Sensitivity depends on magnitude-distance relationship as expected.
- Noise correlates with weather, daytime anthropogenic activity, and marine environmental noise, lowering SNR.
- Cable records fewer high-confidence than terrestrial instruments, but adds valuable submarine coverage.
- Ongoing acquisition will refine sensitivity and performance characterisations.

6 Conclusions

- ✓ The Malta—Catania submarine optical fiber can detect earthquakes across a wide range of magnitudes and distances.
- ✓ At least 35% of analysed events are identifiable (categories A—C).
- ✓ The fiber complements land-based seismic networks and extends monitoring into submarine regions.
- ✓ Environmental and human activity noise limits detection, particularly for $M < 2.5$ events.

7 References

Donadello, S., Clivati, C., Govoni, A. et al. Seismic monitoring using the telecom fiber network. *Commun Earth Environ* 5, 178 (2024). <https://doi.org/10.1038/s43247-024-01338-2>

This study is funded by the European Union under Project SENSEI, which aims to transform fibre-optic communication networks into distributed sensors for detecting environmental and geophysical signals, improving monitoring and early warning across Europe (Project ID 101189545).

2 Methodology

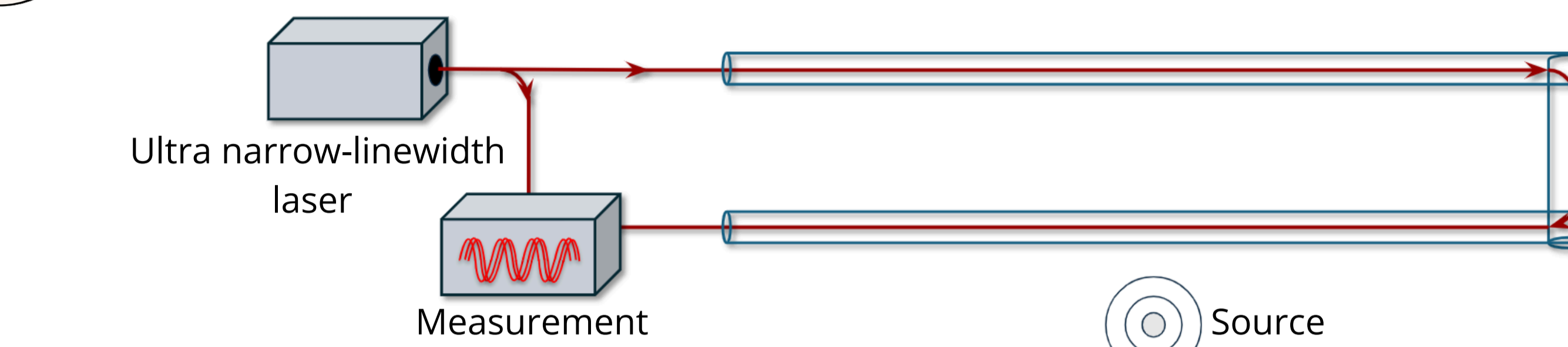


Fig 1. High-level diagram of the laser interferometry setup

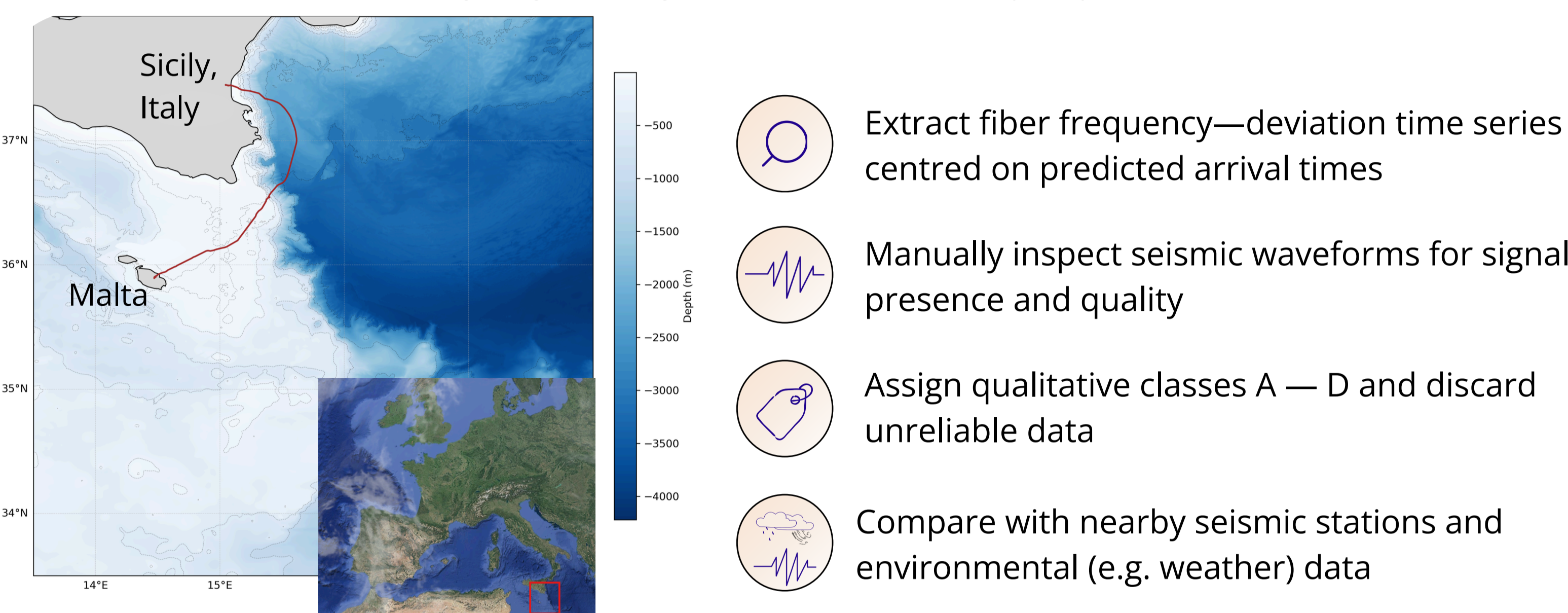


Fig 2. Bathymetry and location of testbed

3 Results

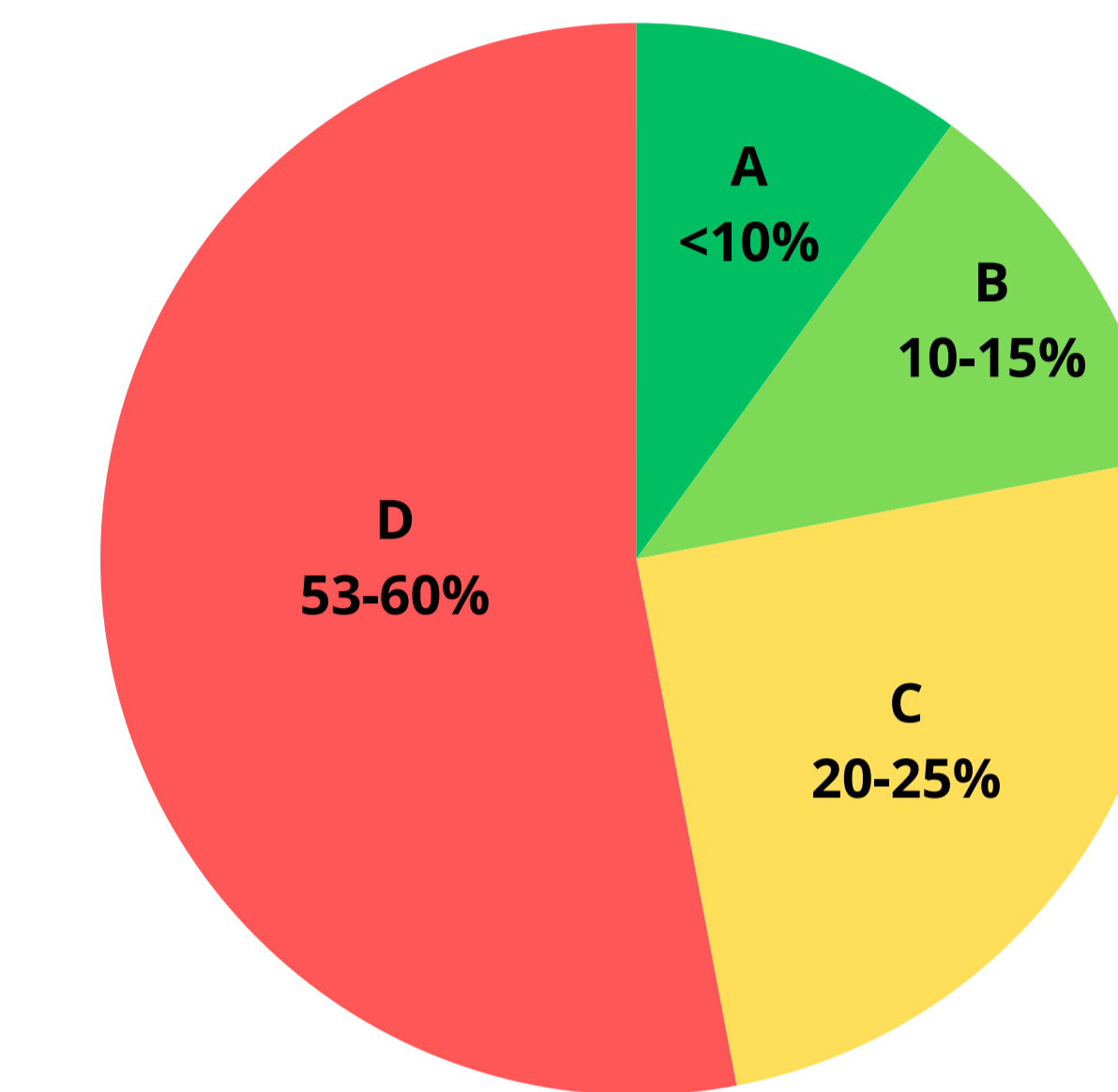


Fig 3. Distribution of events across classification categories A-D.

Category	Description
A	Clearly identifiable waveforms, detectable by STA/LTA
B	Identifiable waveforms, but with false positives in STA/LTA
C	Ambiguous signal but potentially recoverable with focused analysis near predicted arrival time
D	Not Detected

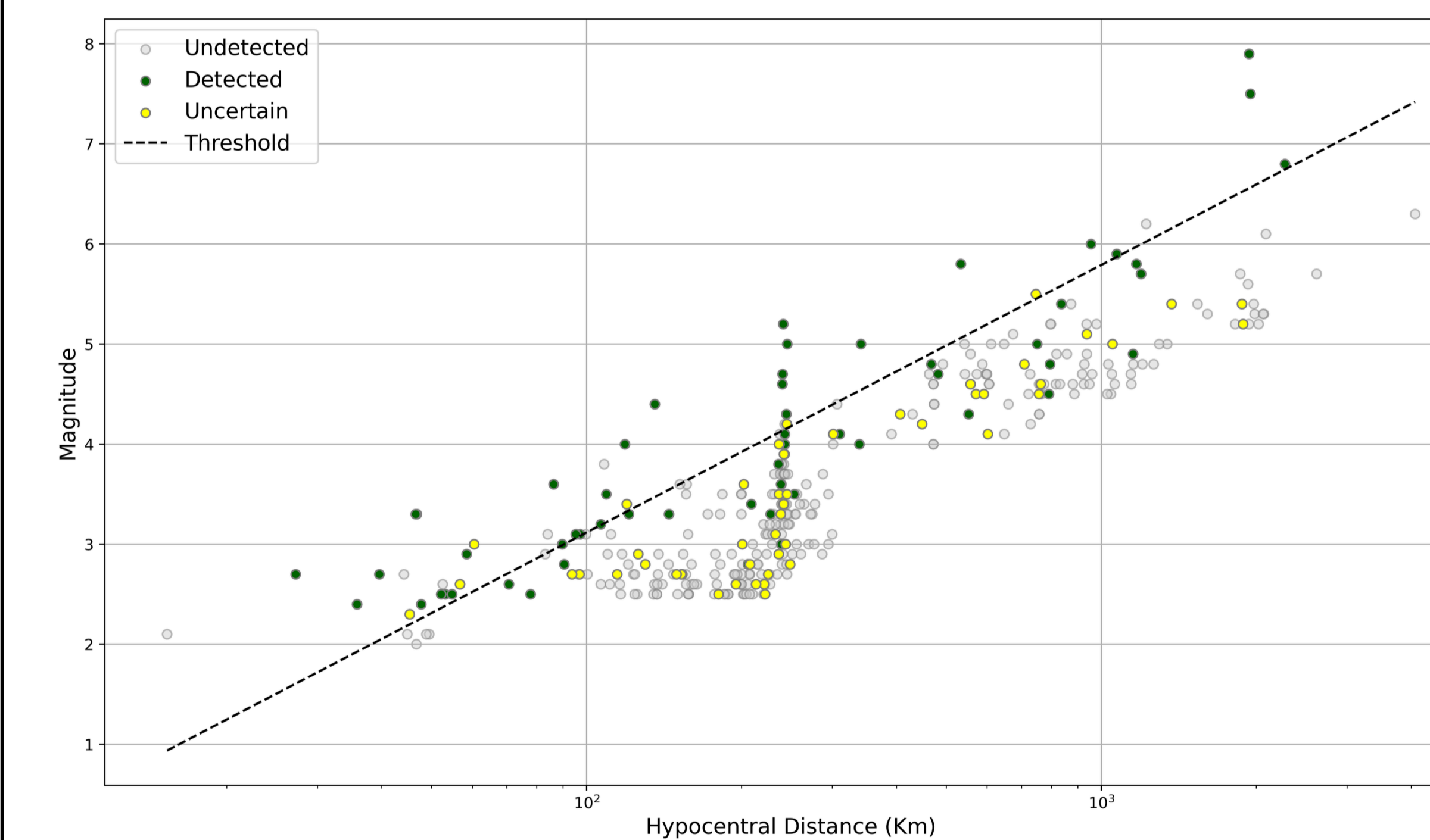


Fig 4. Magnitude-distance distribution with detected (A-B), uncertain (C), and undetected (D) events. The dashed curve shows the fitted detection threshold.

- The threshold represents a preliminary quantification of the sensitivity of the fiber, inferred from the distribution of detected events.
- Events classified as categories A and B are treated as detected, category C as uncertain, and category D as undetected
- The threshold is obtained by optimizing classification consistency, maximizing detected events above the curve and undetected events below, and fitting the empirical magnitude-distance attenuation relation

$$P = A_2 \frac{10^{A_1 M}}{d}$$

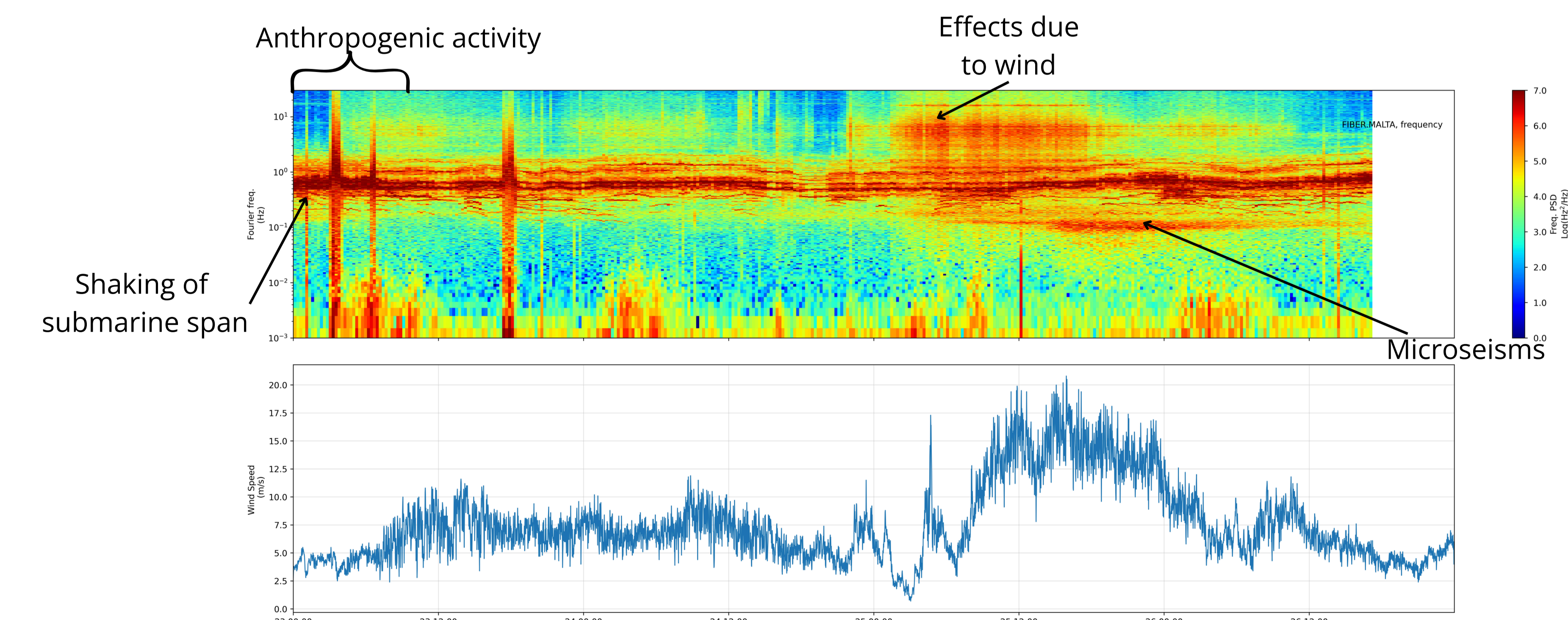


Fig 5. Spectrogram of fiber frequency deviations over multiple days, with corresponding wind speed shown below; discrepancies reflect spatial separation between fiber and weather station. Distinct spectral bands are visible, including anthropogenic activity, wind-related contributions, microseismic signals, and signals attributed to the shaking of the submarine span of the cable.