EGU23-11372

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The First Network of Ocean Bottom Seismometers in the Red Sea to Investigate the Zabargad Fracture Zone*

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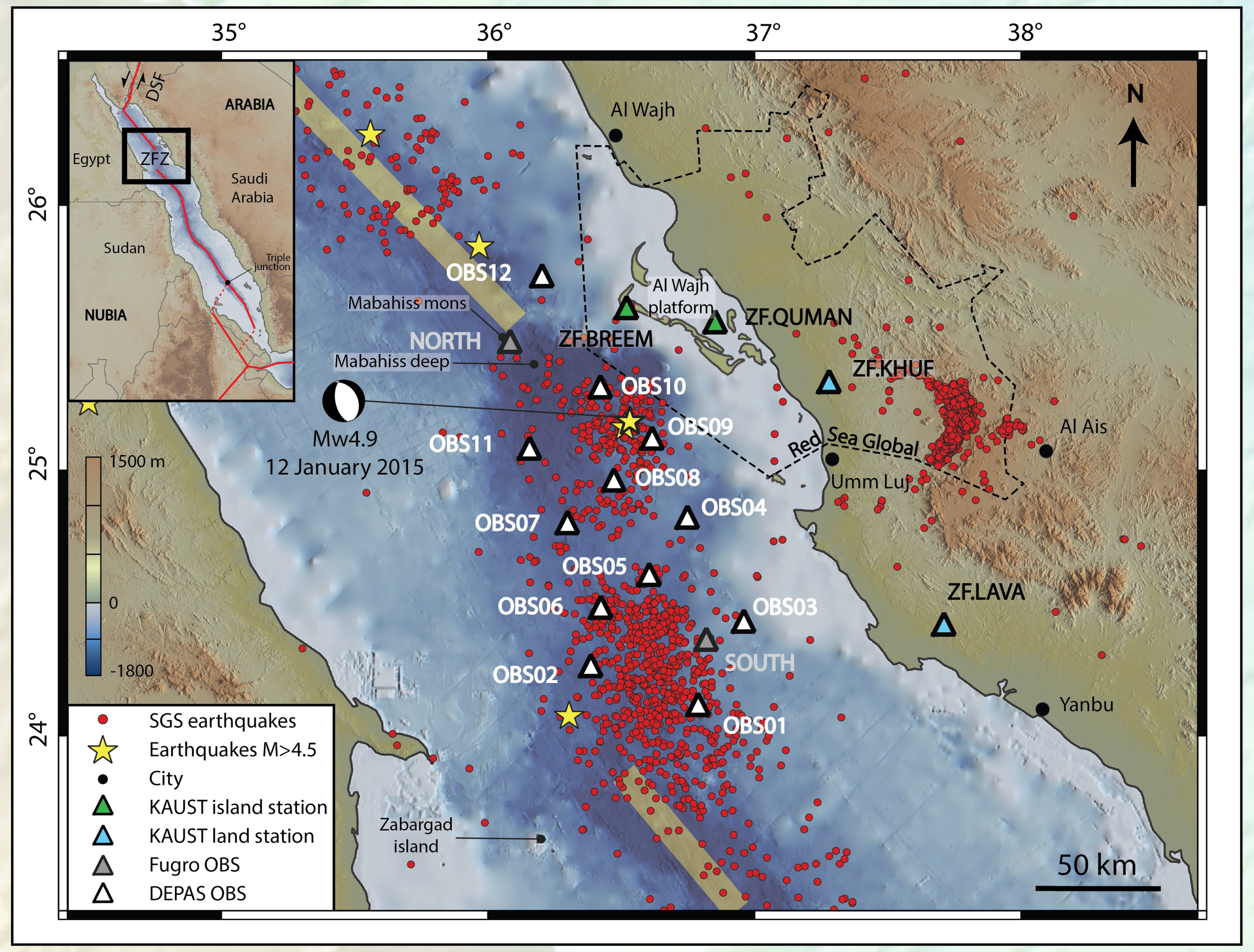

Figure 1. Study area and overview of the deployment. ZFZ: Zabargad Fracture Zone. DSF: Dead Sea Fault.

MOTIVATIONS The Red Sea is an ideal natural laboratory to study the transition from continental rifting to seafloor spreading and the formation of transform faults because it is one of the youngest ocean rift basins on Earth. The Zabargad Fracture Zone is located in the Northern Red Sea and significantly offsets the rift axis to the East. Thus, it is considered a key tectonic element to understanding the evolution of the Red Sea rift (Figure 1). Here we present the first passive seismic network in the Red Sea deployed within the Zabargad Fracture Zone (Figure 1-2-4) to study its faults system and lithospheric Earth structure.

FINDINGS

- Current-generated vortices could make the individual elements of the OBSs resonate at a frequency larger than 8-10 Hz (e.g., Essing et al., GJI, 2021; Corela et al., NHESD, 2022; Stahler et al., SRL, 2018; OBS02 and OBS07 of Figure 5) .
- Even OBSs that only include a sensor placed on a small frame with no additional elements can produce high-frequency (up to 40 Hz) noise modulated (SOUTH, Figure 5).
- The comparison of the noise levels between stations deployed at sea, on islands, and on land highlighted that noise at frequencies between 1 and 8-10 Hz is not due to resonance of the OBSs elements (figures 7-8).
- Site effects seen on local earthquake waveforms may reveal important information on the sedimentary coverage (Figure 9).

CONCLUSIONS Our analyses suggest that the ZAFRAN dataset has an overall good quality and is promising in answering our research questions on the Red Sea (Figures 3 to 9).

* A manuscript with the same title and the following author list will be submitted soon to Seismica for publication:
L. Parisi, N. Augustin, D. Trippanera, H. Kirk, A. Dannowski, R., R. Matrau, M. Fittipaldi, A. Nobile, O. Zielke, E. Valero Cano, G. Hoogewerf, T. Aspiotis, S. Manzo-Vega, A. Espindola Carmona , A. Barreto, M. Juchem, C. Suhendi, M. Schmidt-Aursch, P.M. Mai, S. Jónsson.

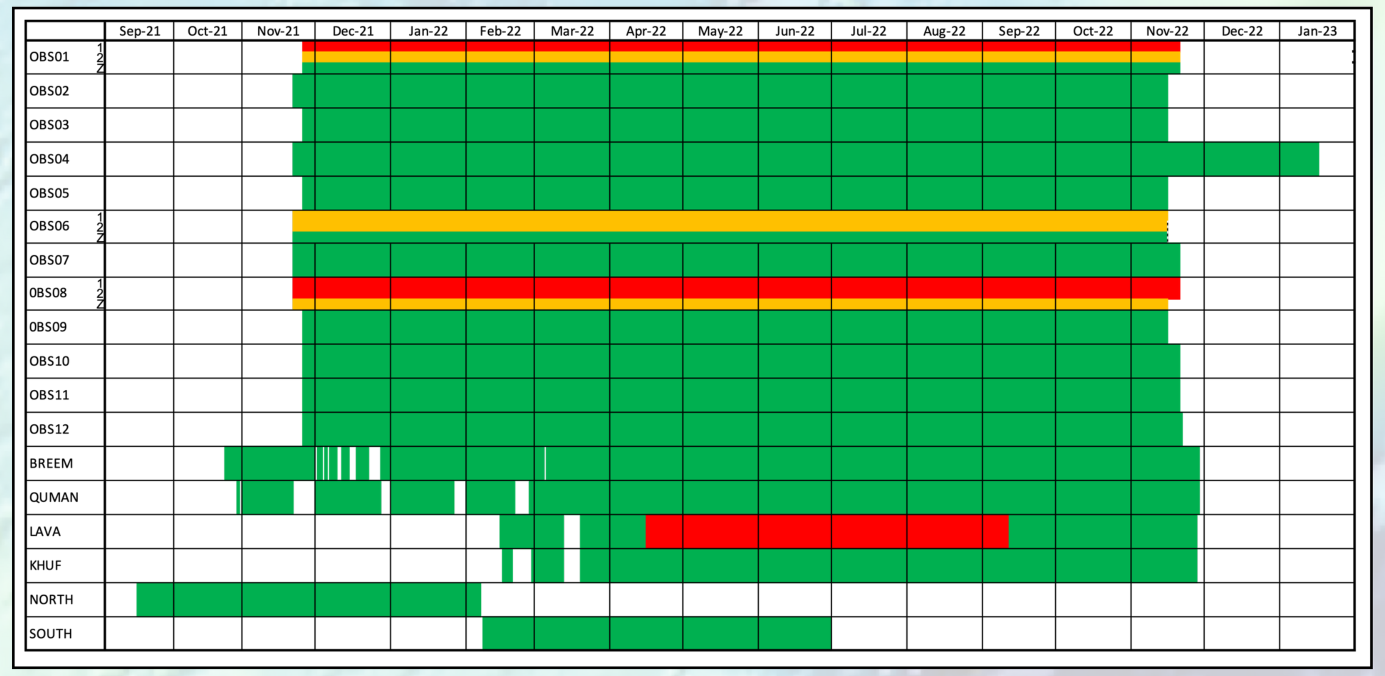

Figure 2. Timeline of the data availability from September 2021 to January 2023. White: unavailable. Green: 3-C available vertical-component. Yellow: available but in need of pre-preprocessing. Red: sensor failure.

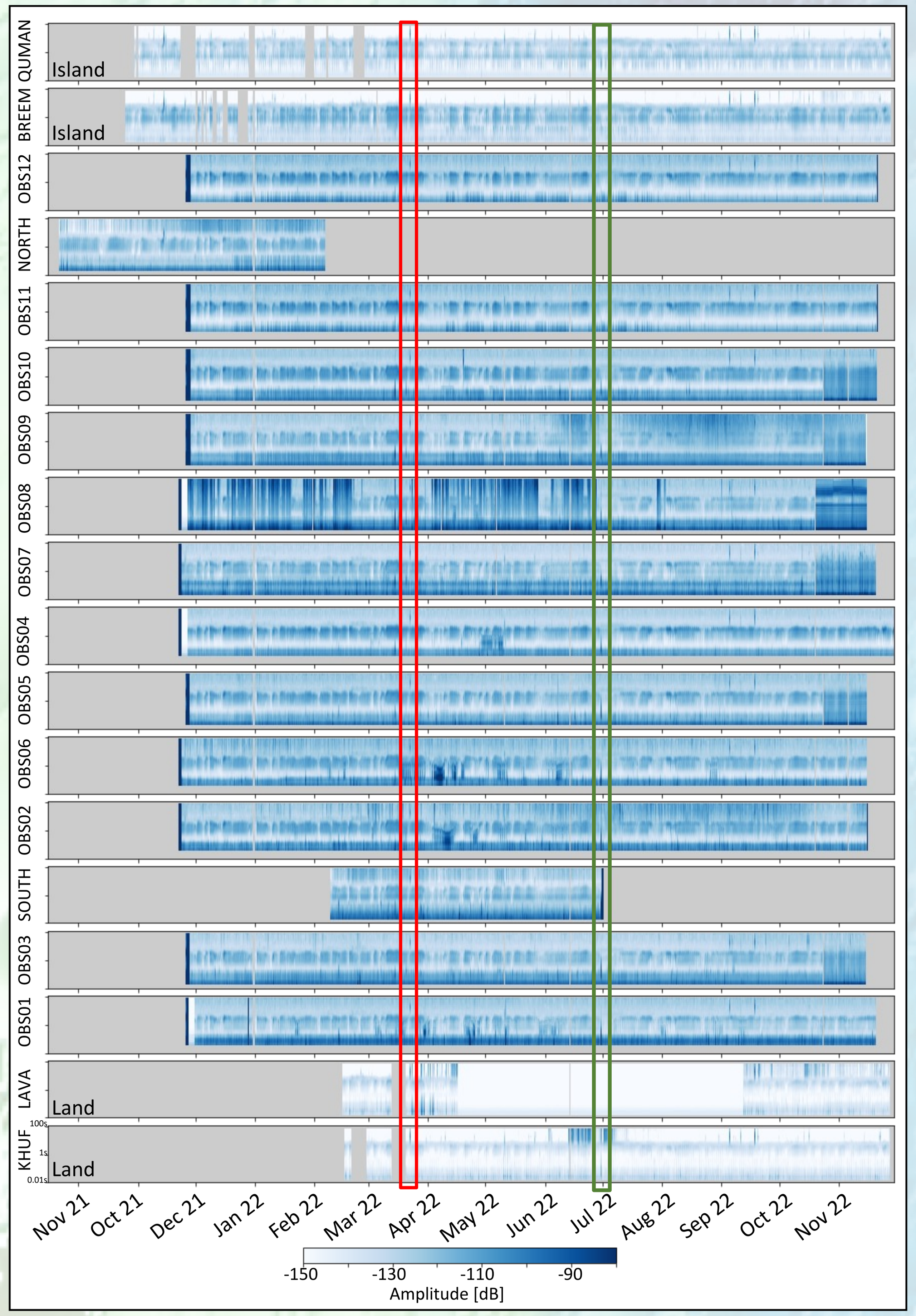

Figure 3. Z-component spectrograms for the entire deployment time. Stations are ordered from South (bottom) to North (top). Where not specified, spectrograms are from OBSs. The red (green) box picks the teleseismic (local) earthquakes in Figure 6 (9).

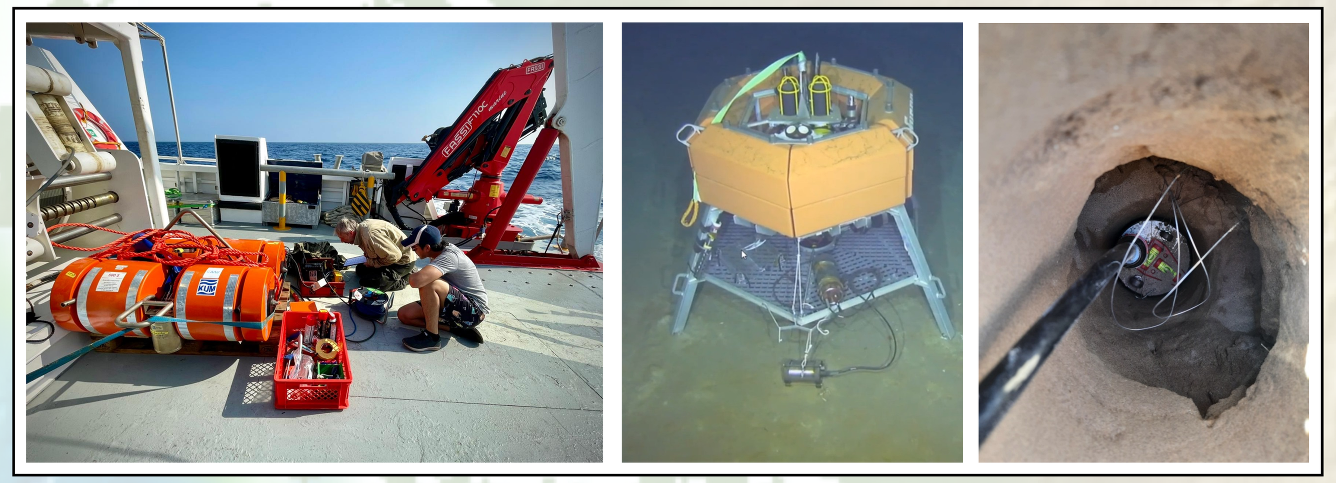

Figure 4. Left: DEPAS OBS on board the RV Thuwal just after recovery. Centre: Fugro deep-lander connected to seismometer on the seafloor. Right: Direct burial of the land/island station seismometer.

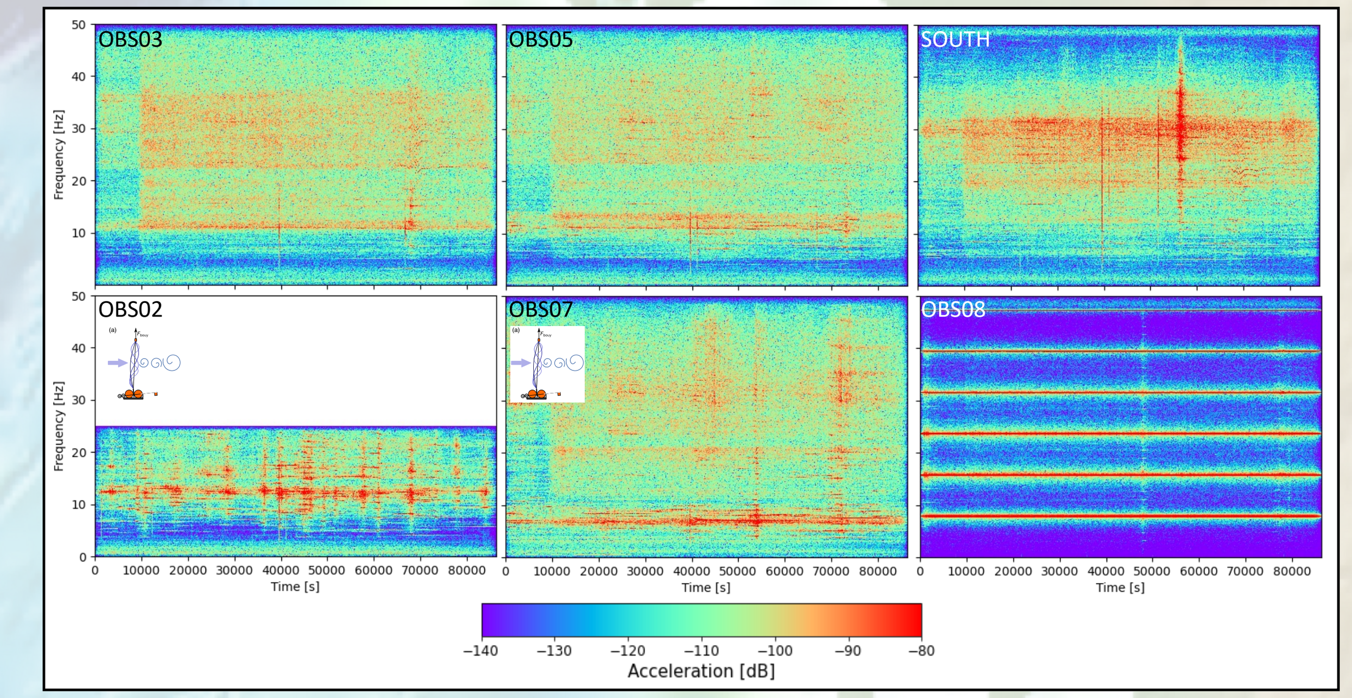

Figure 5. One-day-long 1-component spectrograms of acceleration waveforms for March 1, 2022. Top: OBSs with tight rope (OBS02 and OBS07) or no rope (SOUTH). Bottom: OBSs with free rope (OBS02 and OBS07) and a malfunctioning OBS (OBS08). Seismic energy generated by a M_b 5 earthquake occurred in New Guinea are seen from about 1000 s.

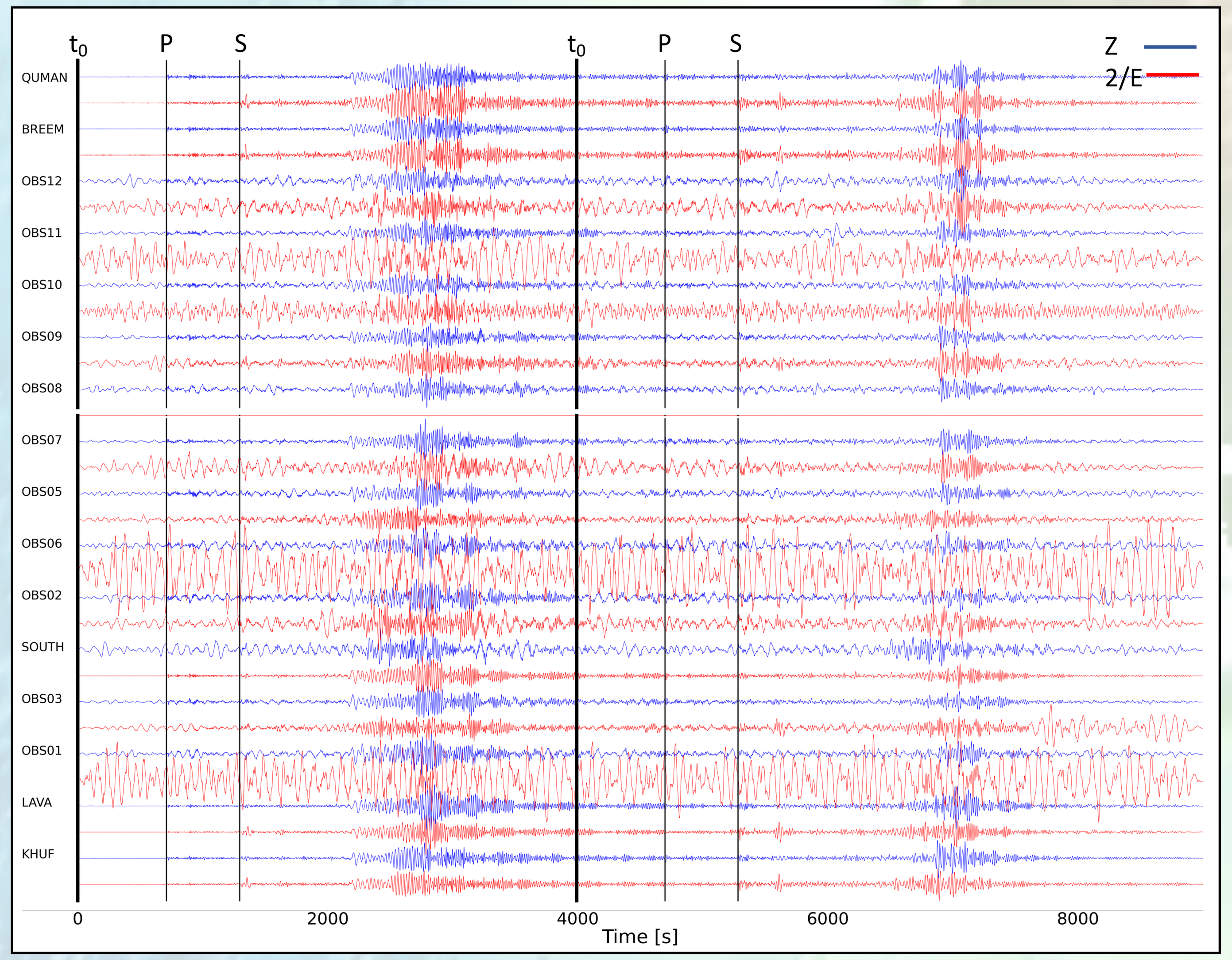

Figure 6. Lowpass filtered (T>1s) waveforms of two M_w6.7 teleseismic earthquakes occurred on 22 March 2022, about one hour after the other. Earthquakes are recorded at roughly the same epicentral distance of 73° distance and azimuths of 292° (first) 67° (second).

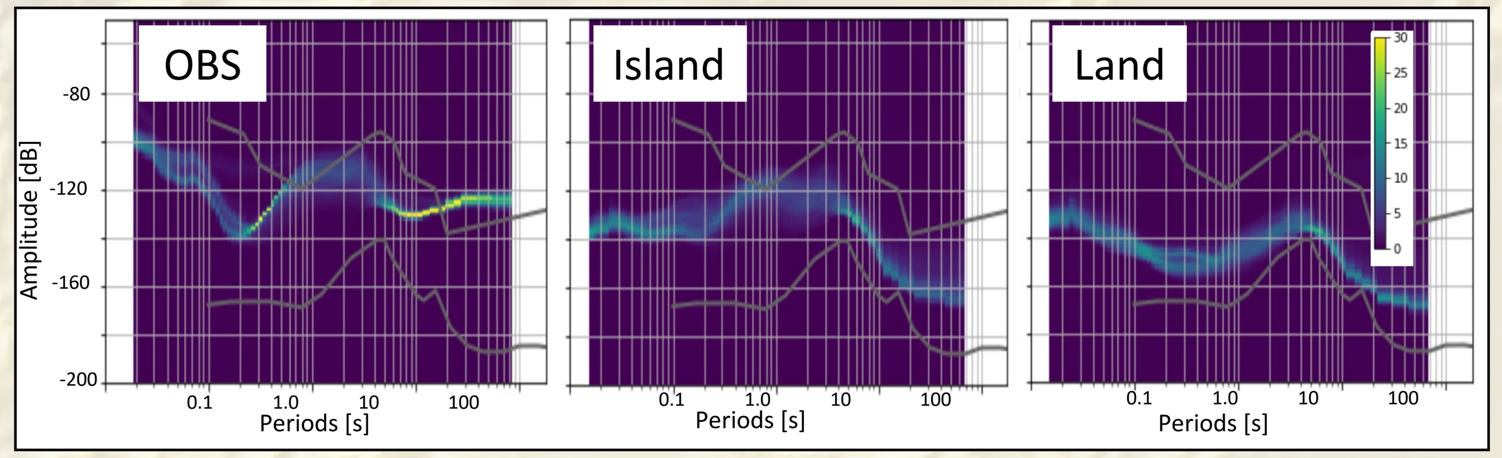

Figure 7. Comparison between the PPSD of an OBS (OBS10), island (BREEM), and land (KHUF) stations for the vertical component.

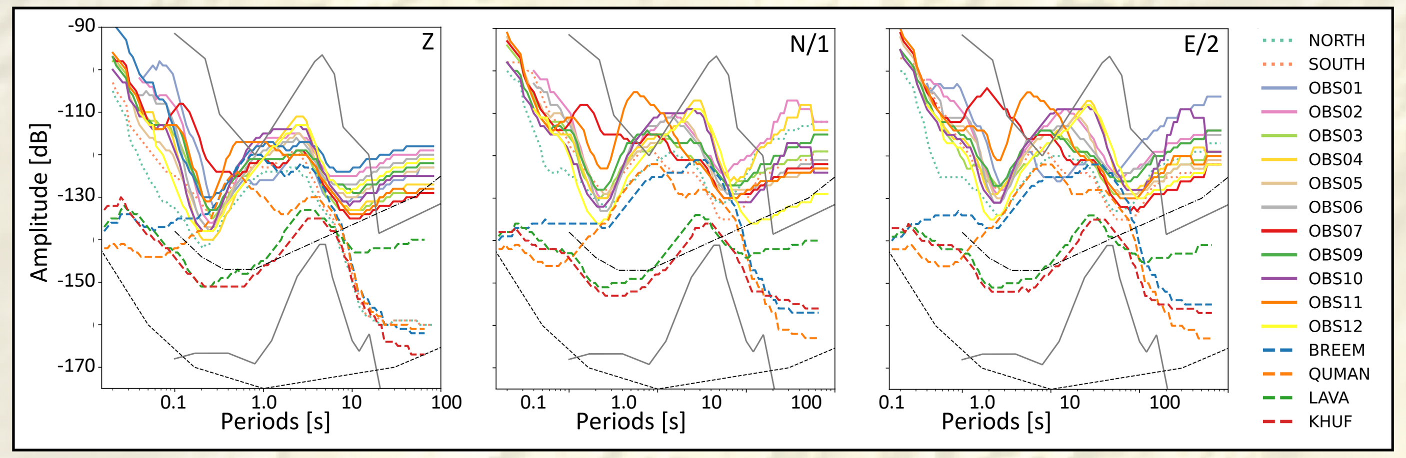

Figure 8. Noise levels (medians of the PPSD) for the vertical and horizontal components seismograms for the entire duration of the deployment. Gray lines: New High Noise Level and the New Low Noise levels. Black lines: self-noise of the CMG-40T-OBS (dot-dashed) sensor on the DEPAS OBSs and the Trillium compact (dashed) sensor on the Fugro OBSs.

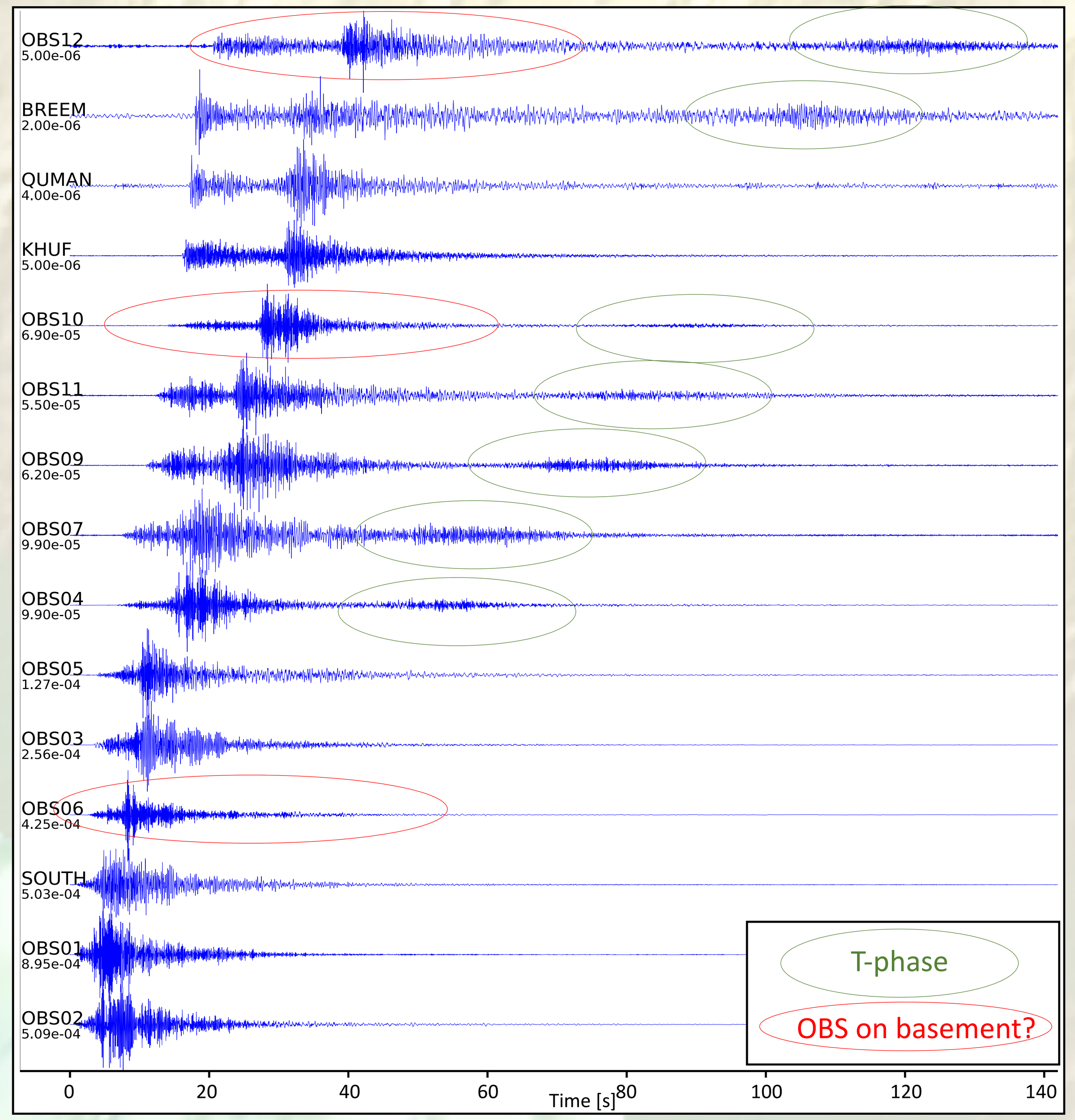

Figure 9. Vertical-component highpass filtered (f>1Hz) seismograms displaying a local event of M_L 3.4 occurred on 30 Jun 2022, in the proximity of OBS01 and OBS02.