Distributed acoustic sensing using long-range submarine fiber-optic cables

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Overview

- Introduction
- Ocean signals
- Earthquake detection & fault zone illumination
- Submarine characteristic signatures

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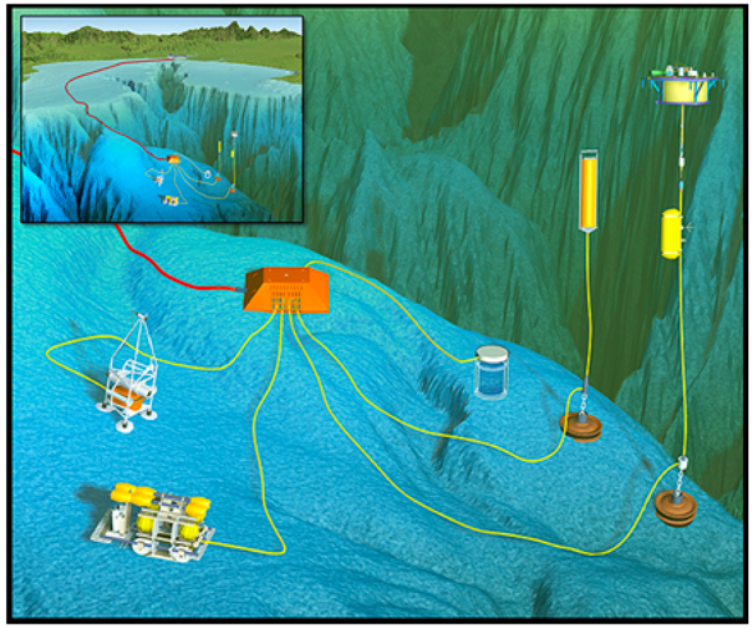
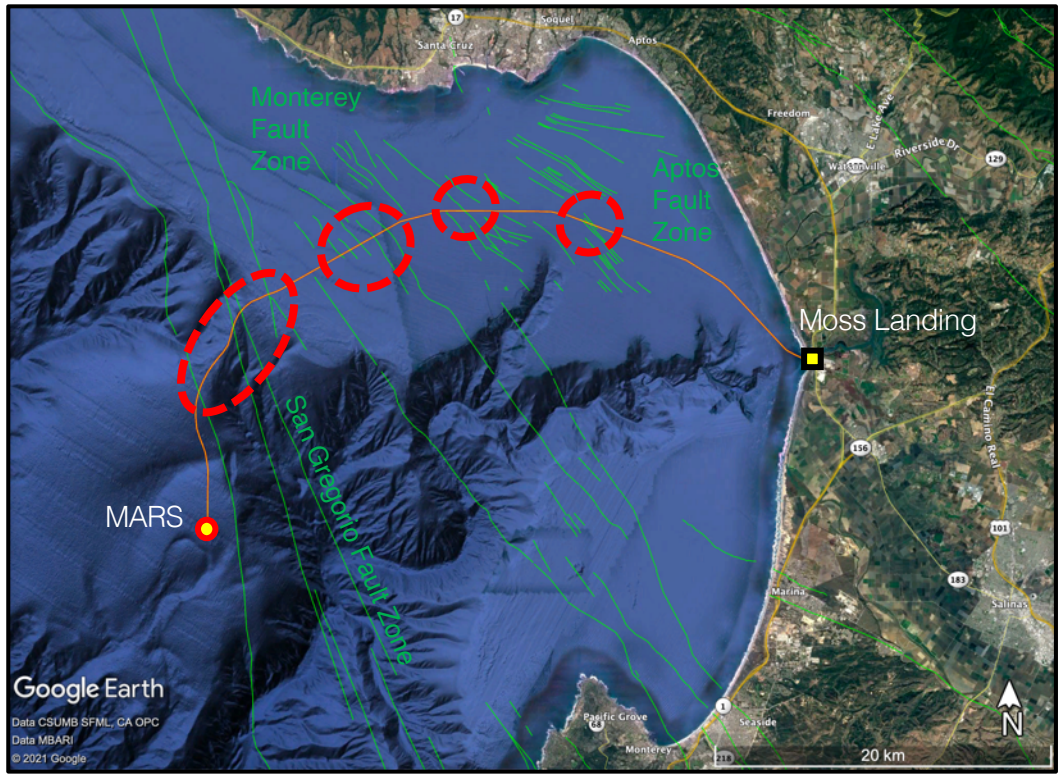
Submarine fiber-optic cable at Monterey Bay

- A 52-km-long submarine fiber-optic cable connecting to the MARS observatory
- The cable trajectory intersects with multiple fault zones





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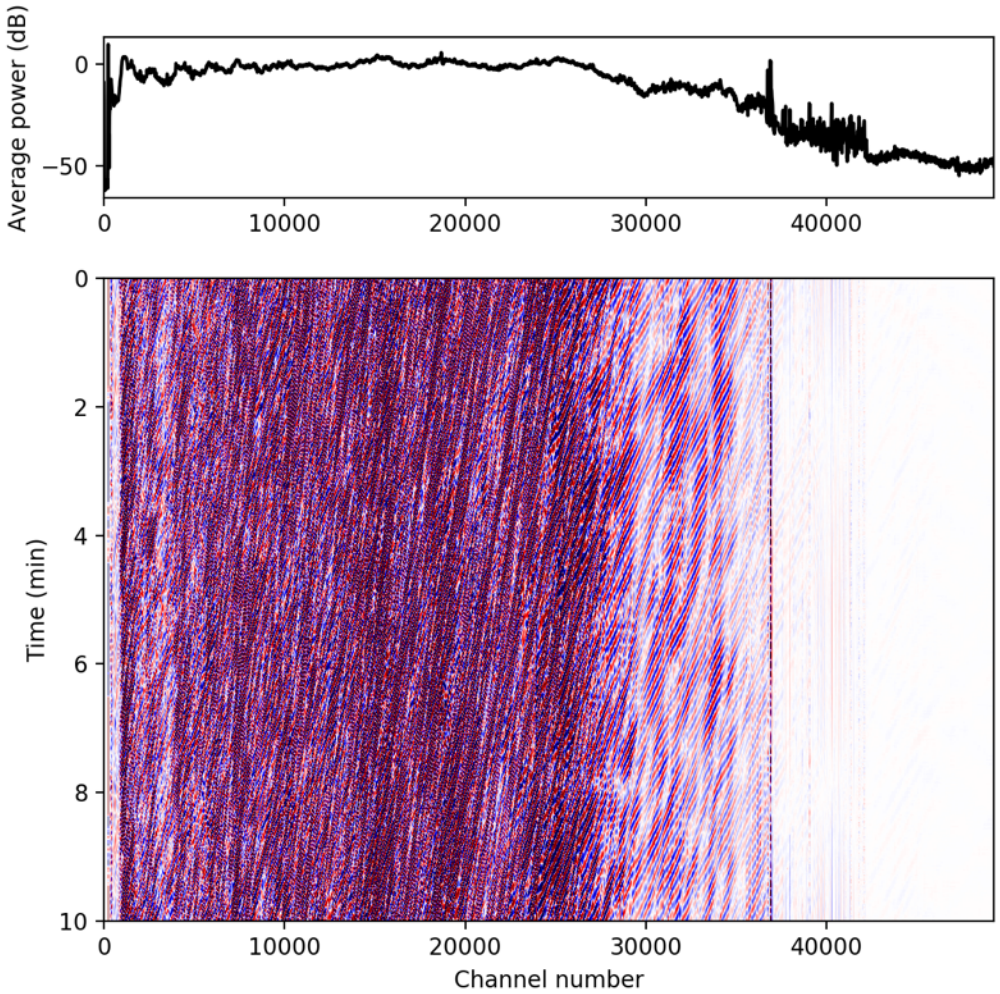
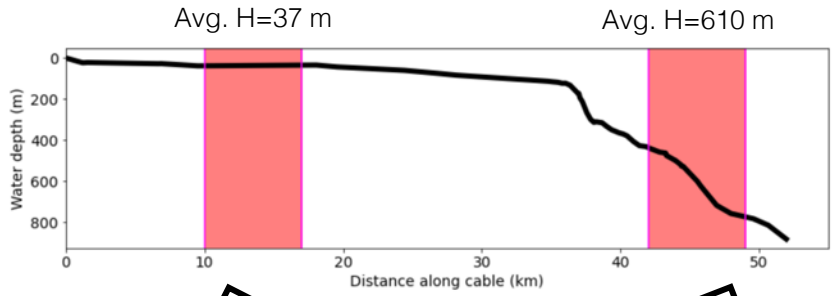
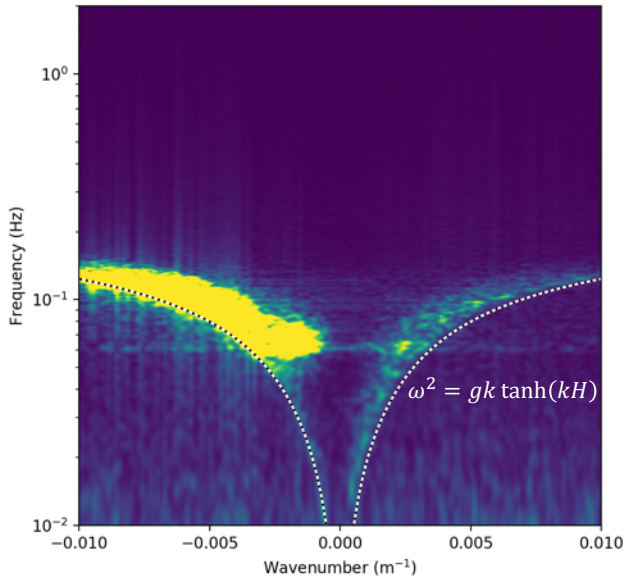
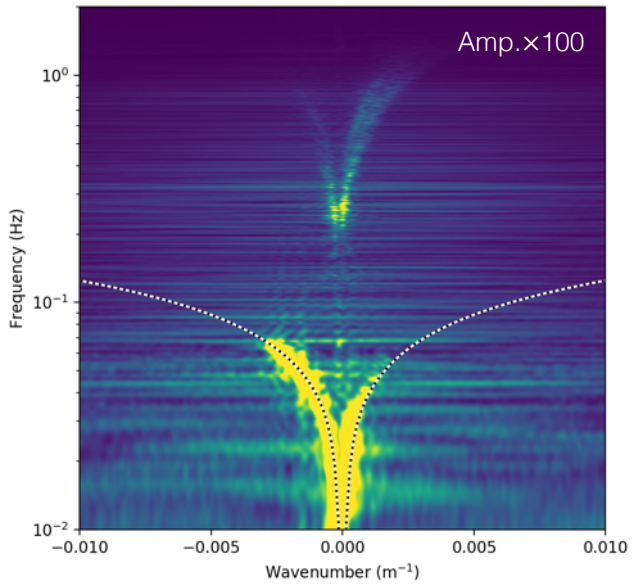
Submarine DAS recording









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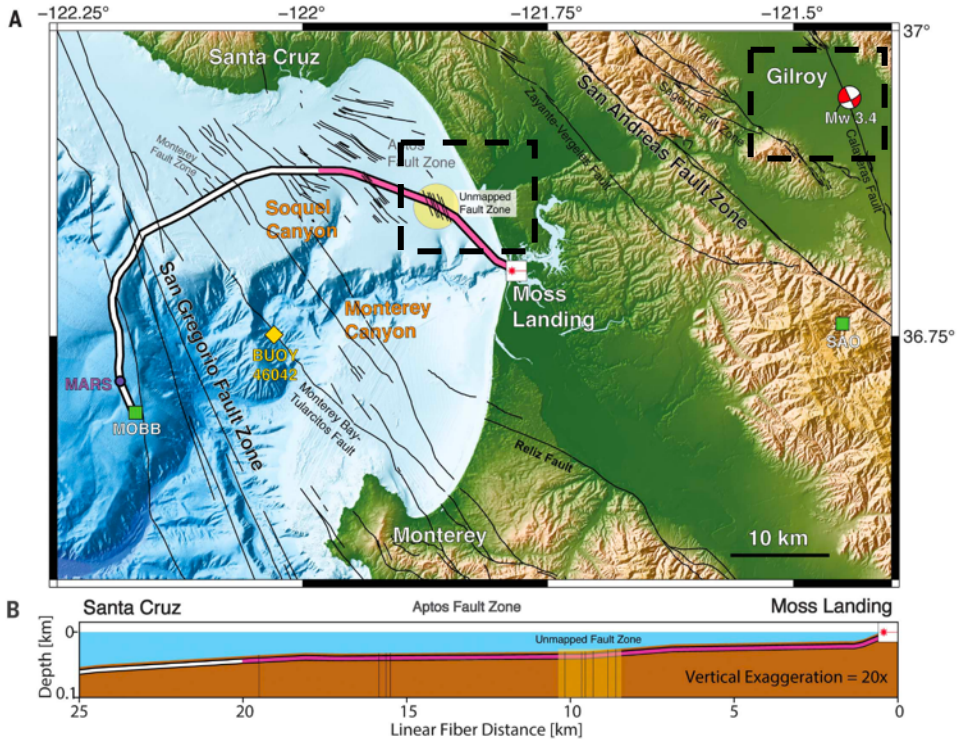
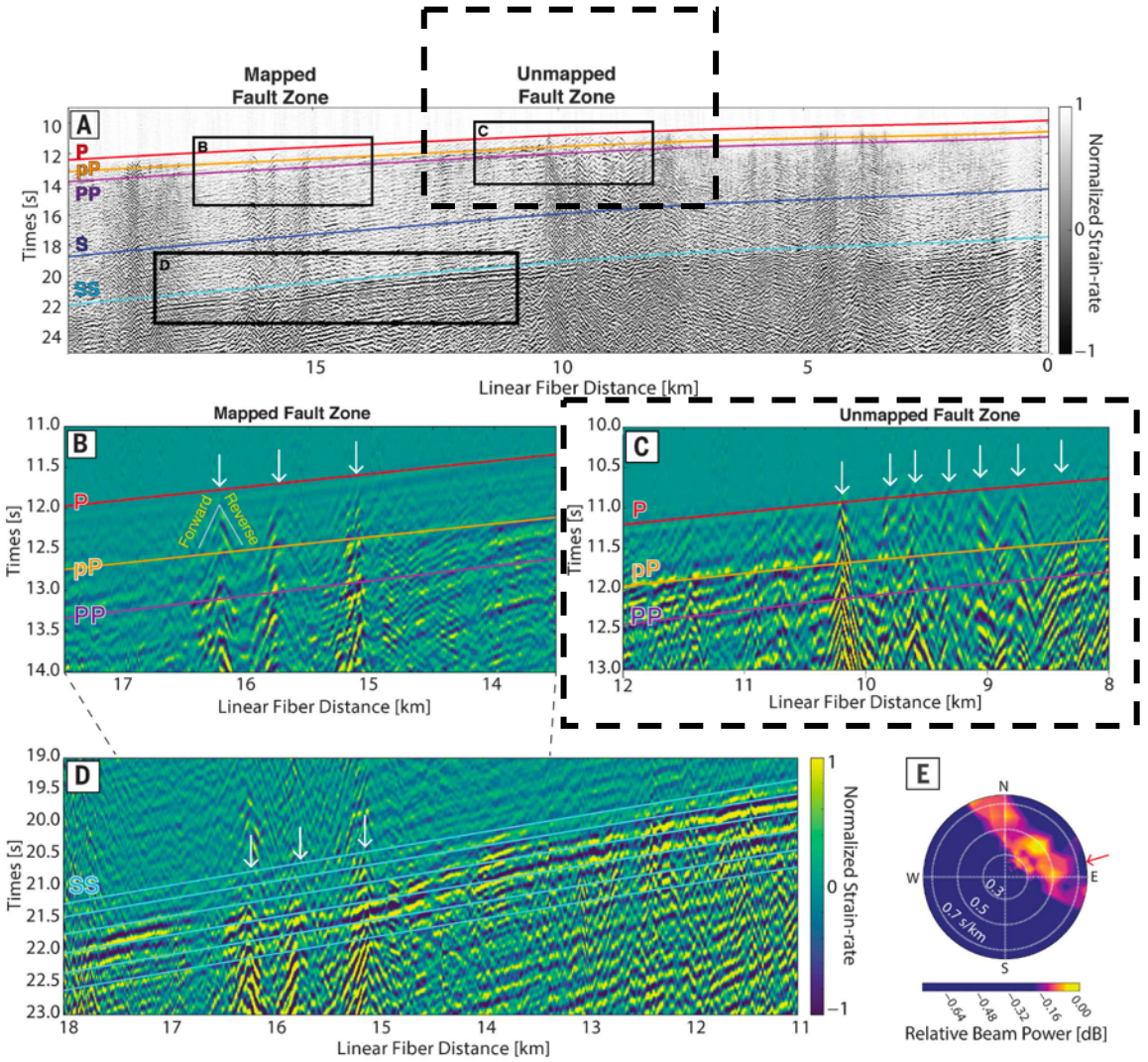
Fault zone illumination

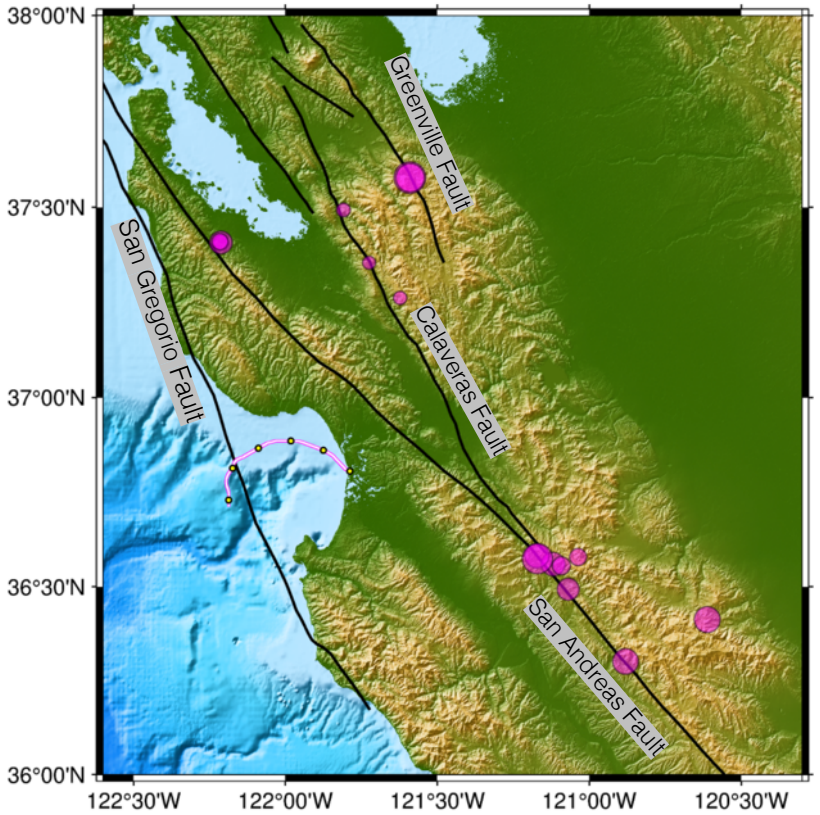


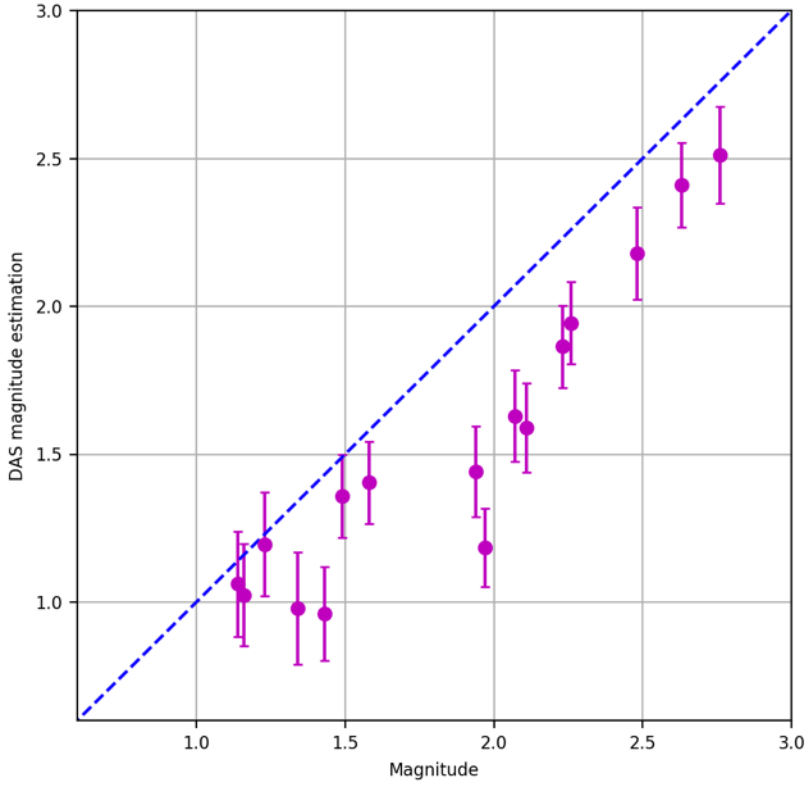


Lindsey et al., 2019, *Science*

Earthquake detection

M>1.1 earthquakes are detected

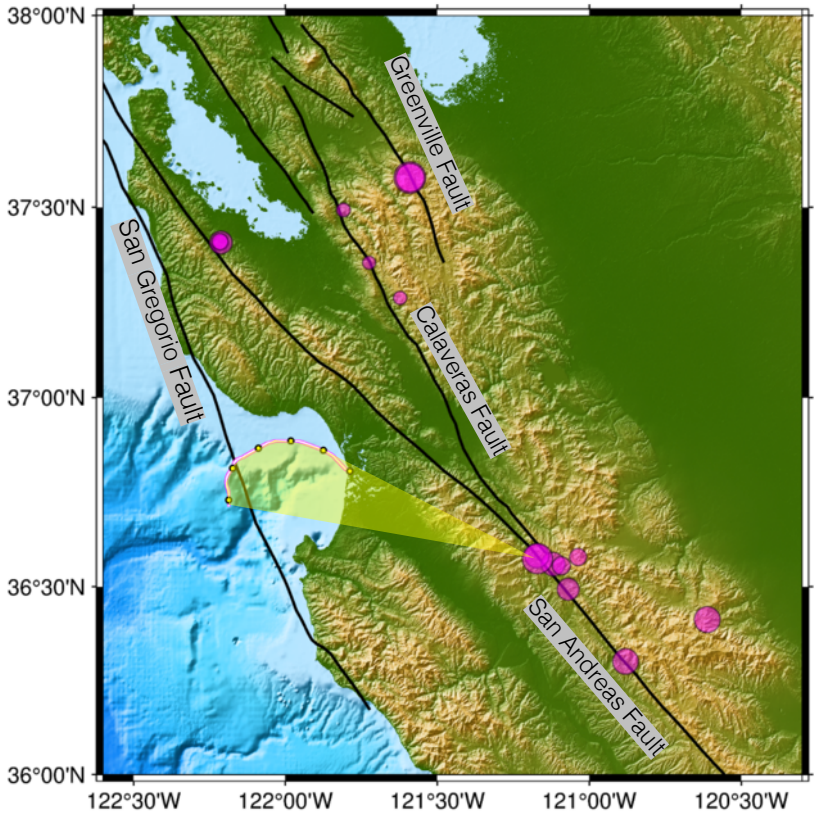


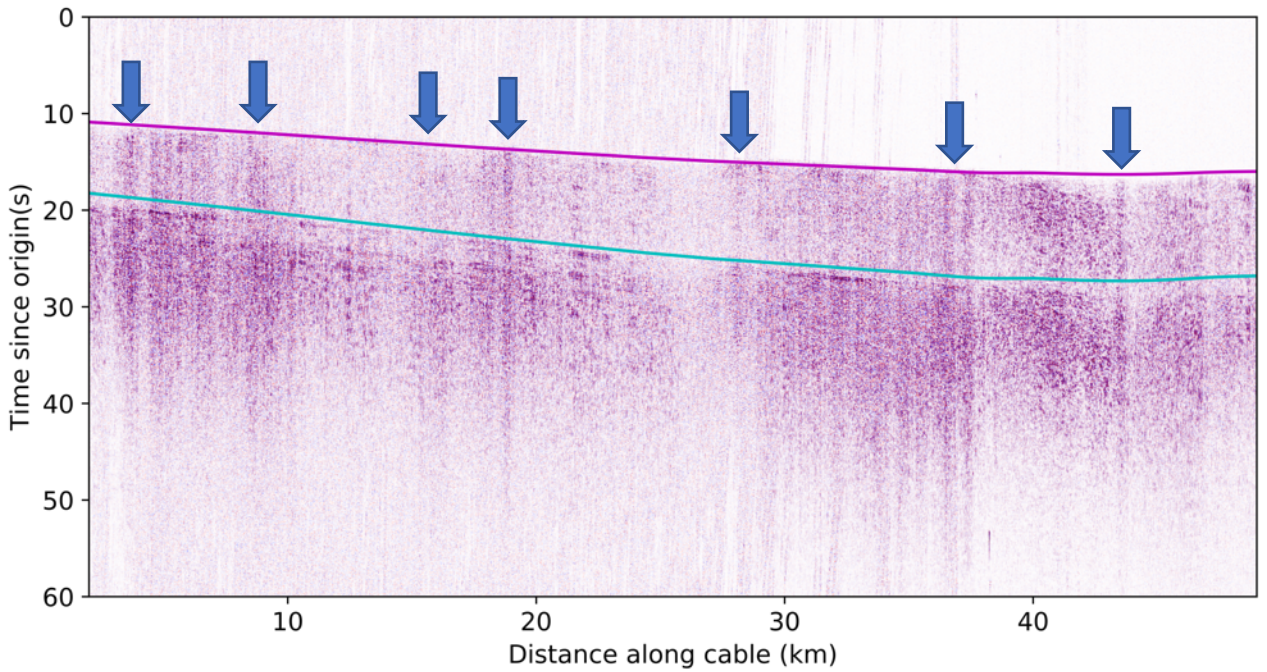


$$M_L = \log_{10}(S_{DAS}\times 10^6 \times GL) + 2.56\times \log_{10} R - 1.67$$

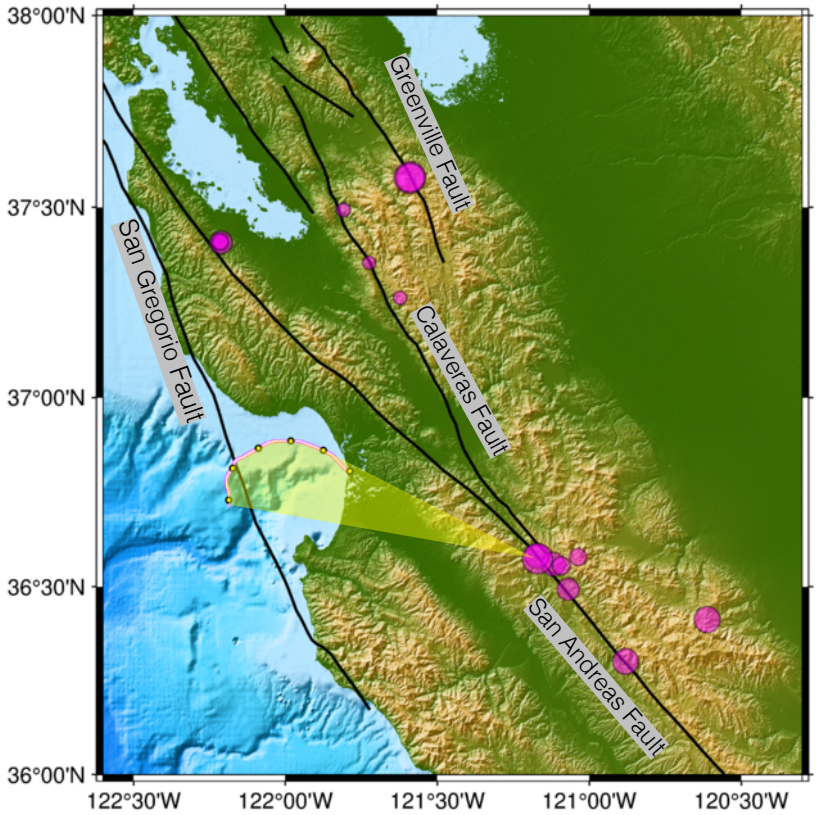
e.g., Lellouch et al., 2021, *SRL*

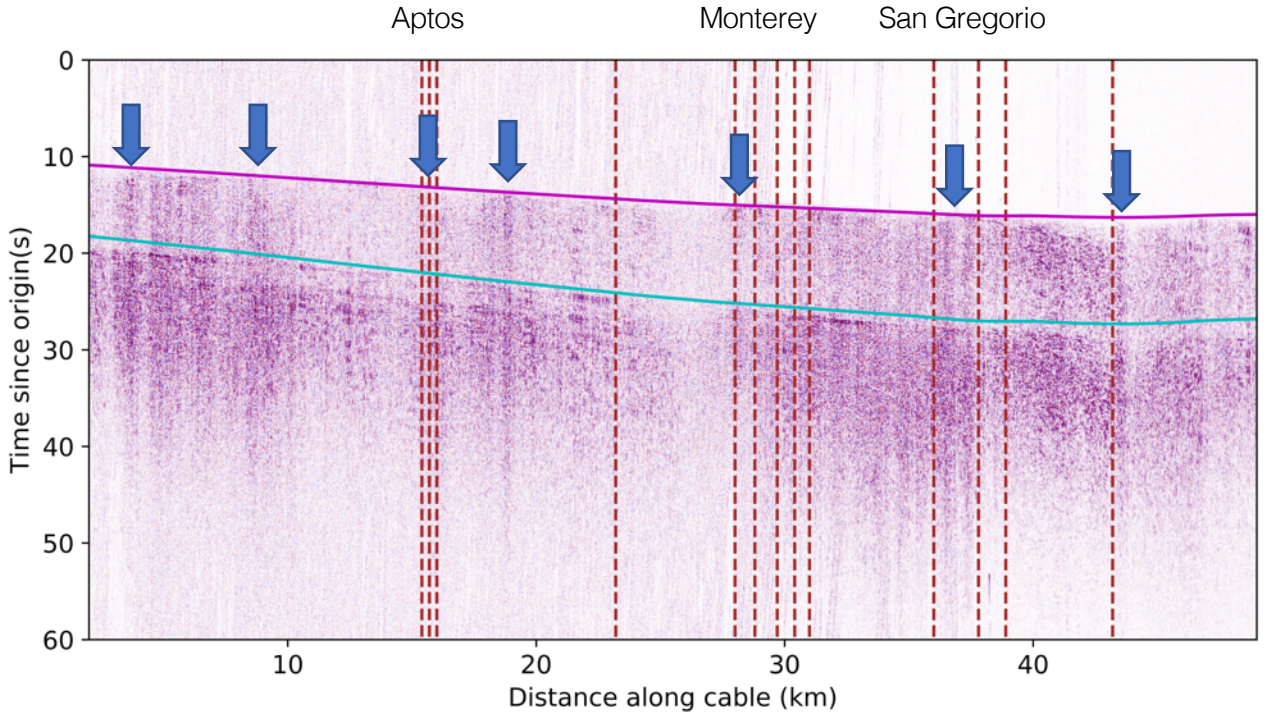
Fault zone illumination



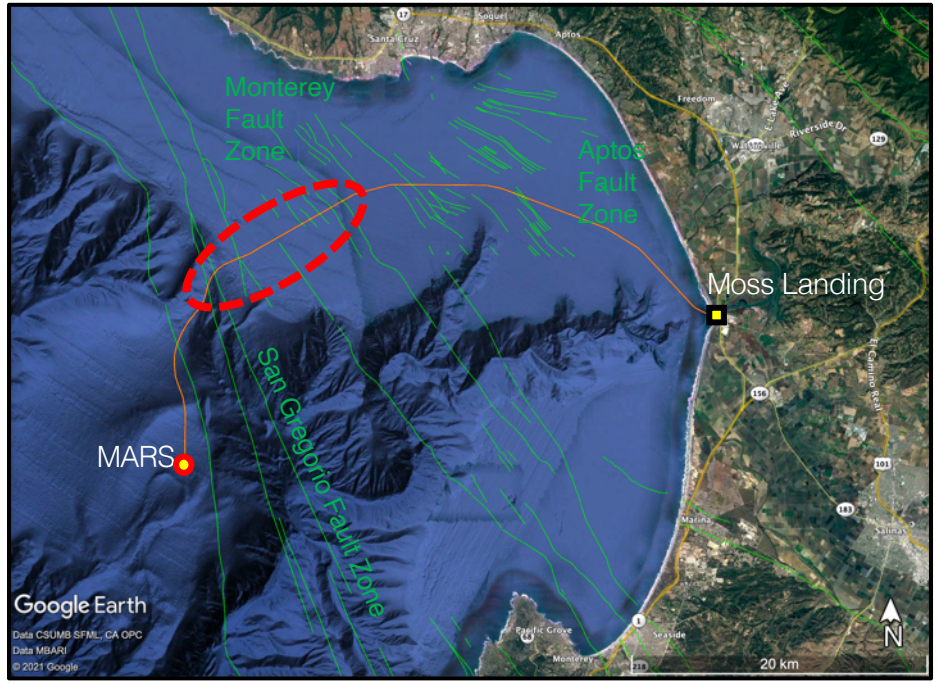


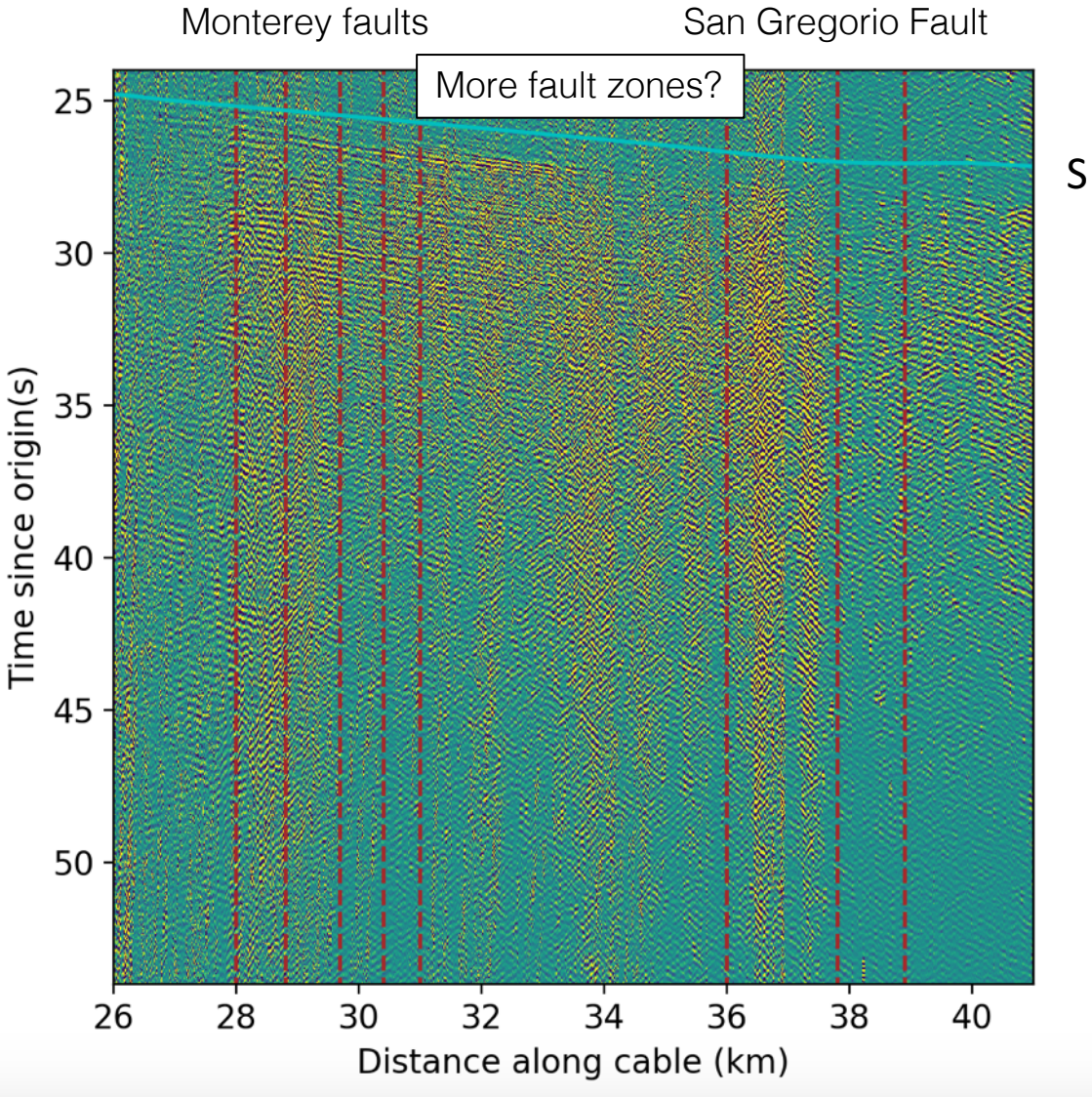
Fault zone illumination



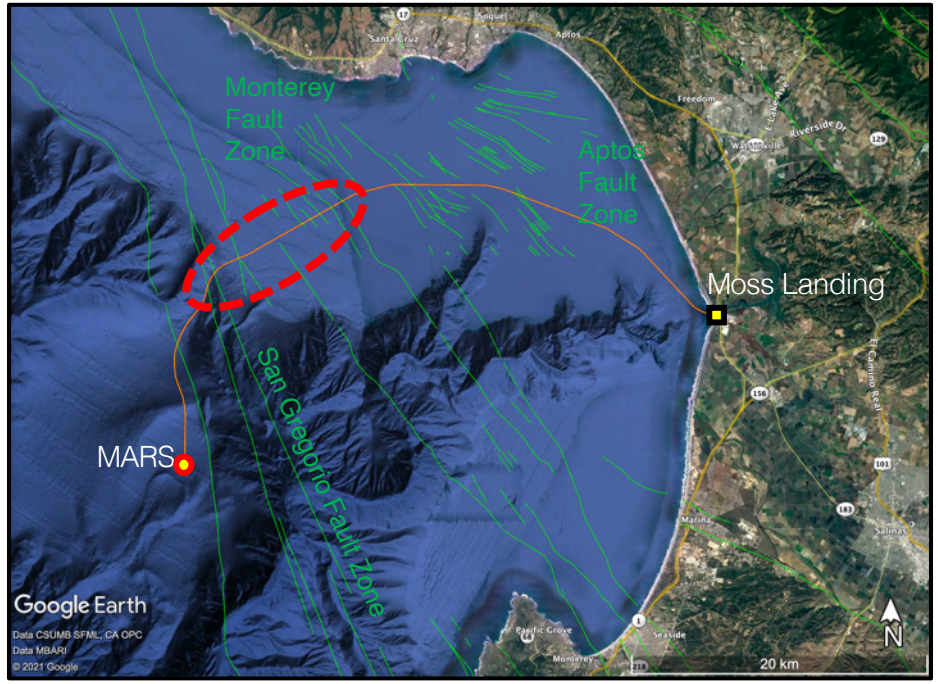


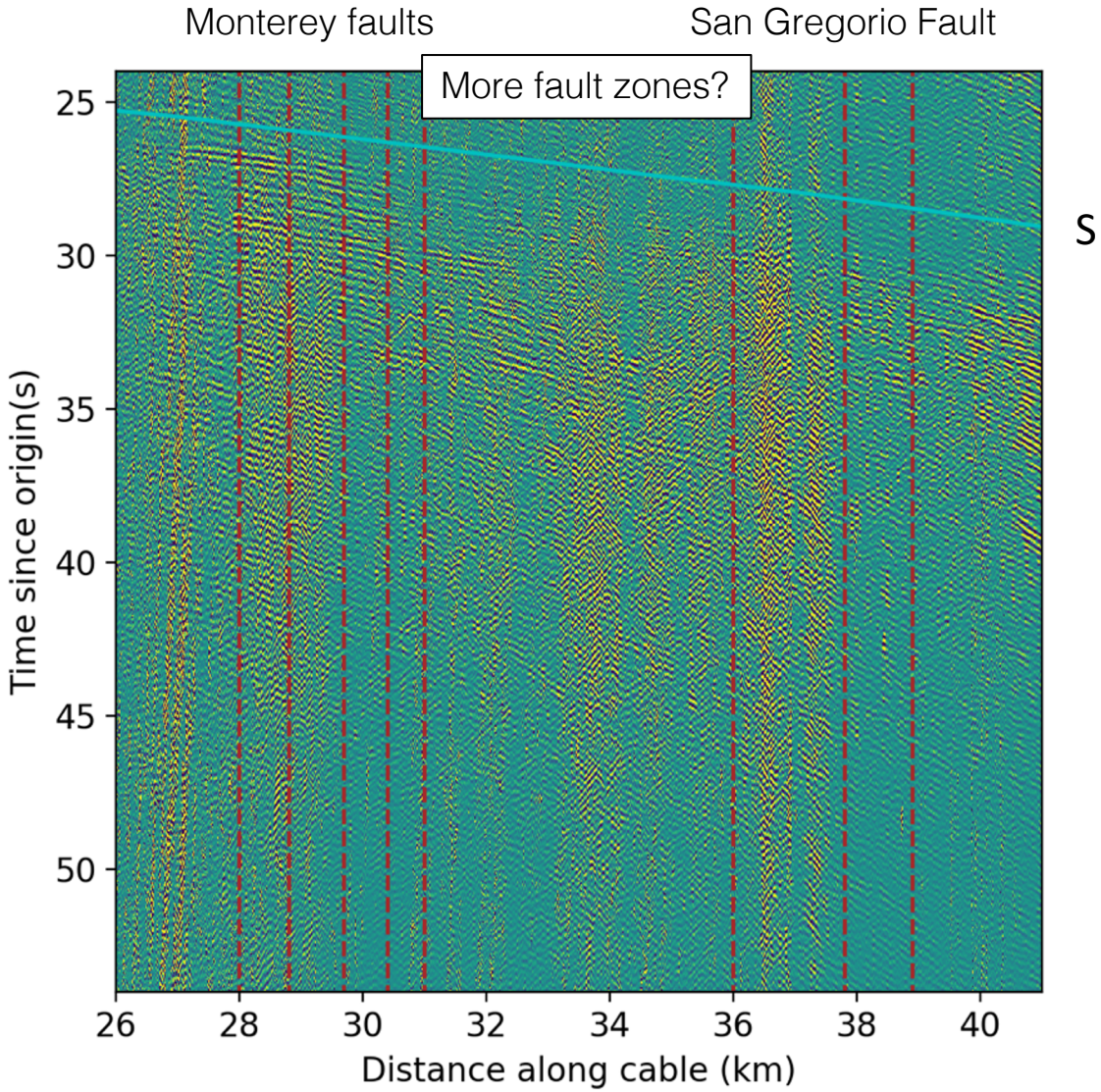
Fault zone illumination





Fault zone illumination





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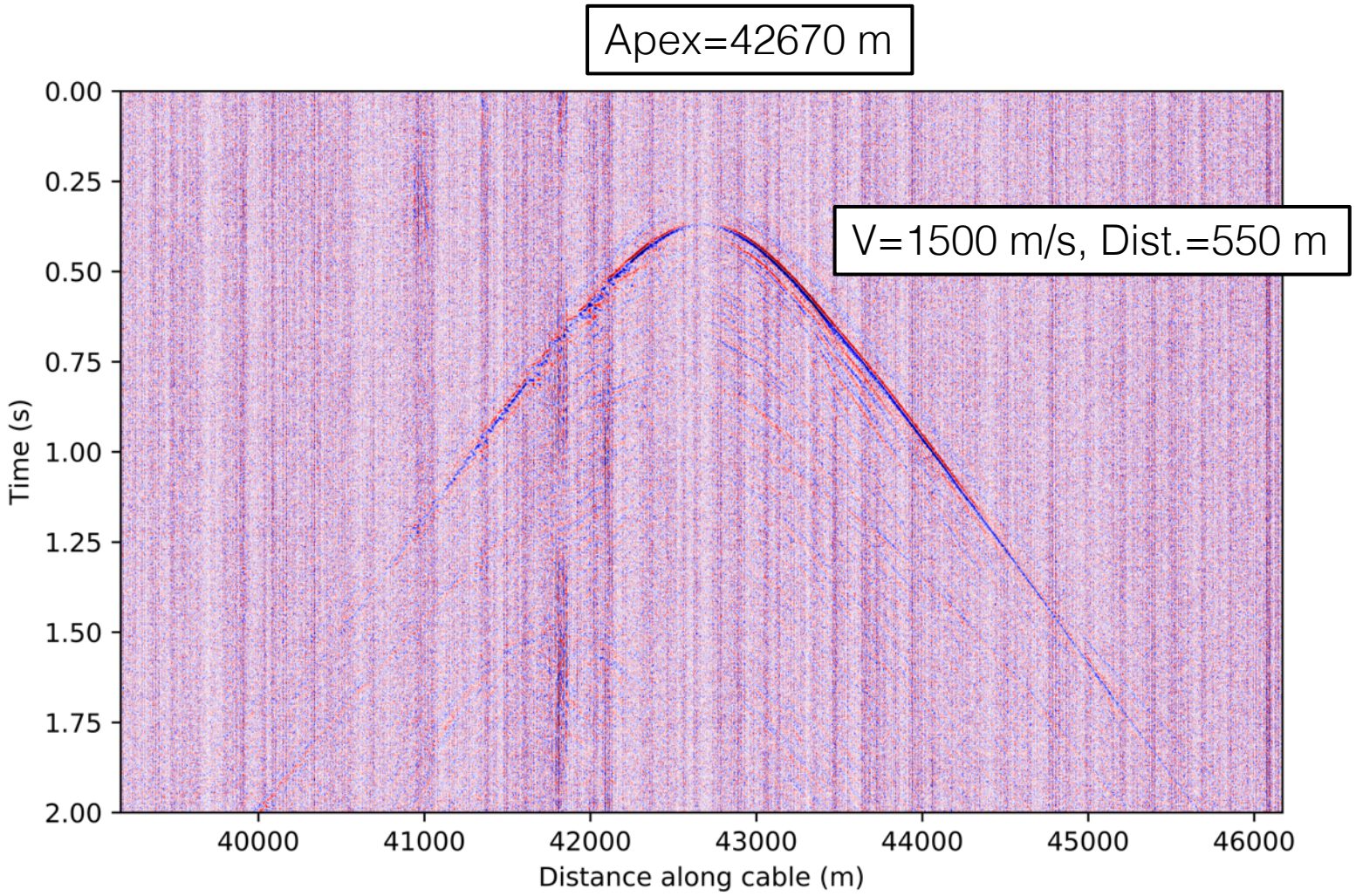
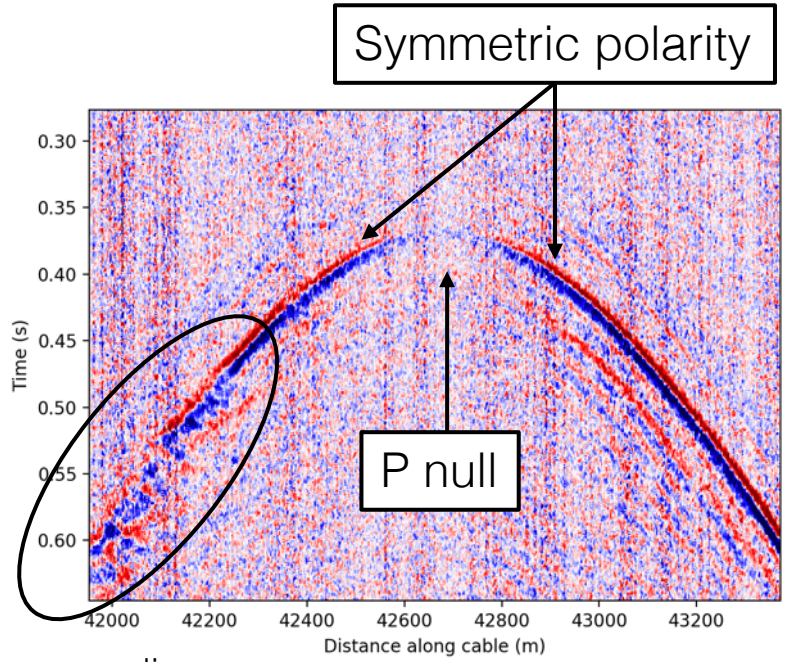
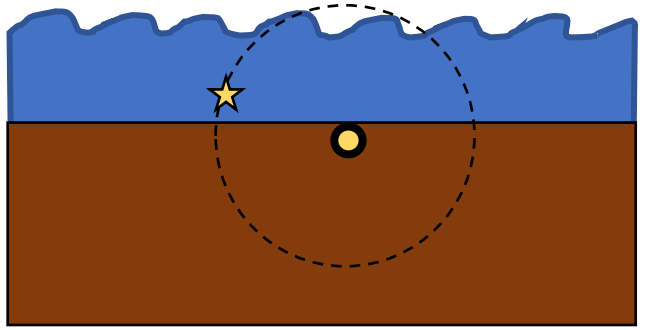
Special signatures

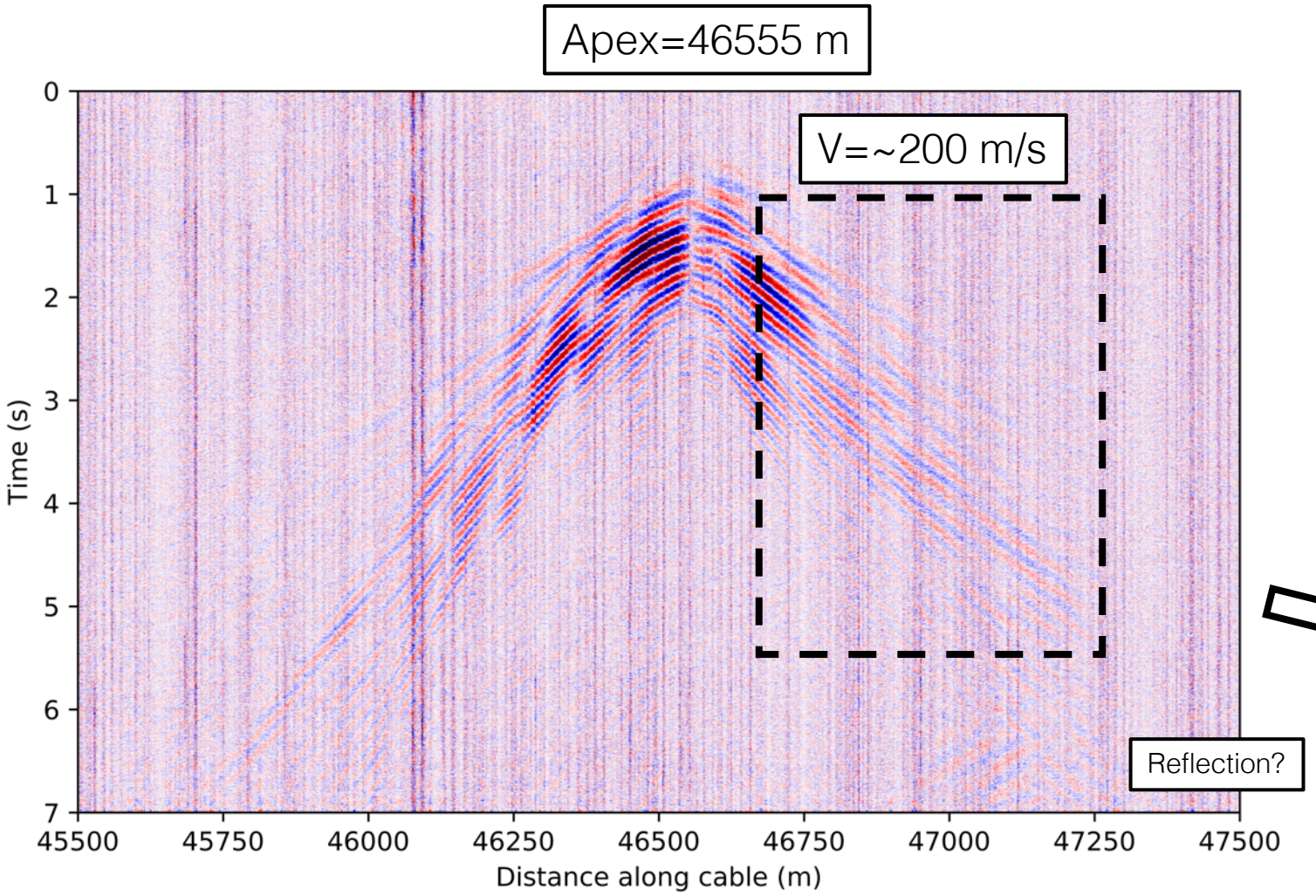


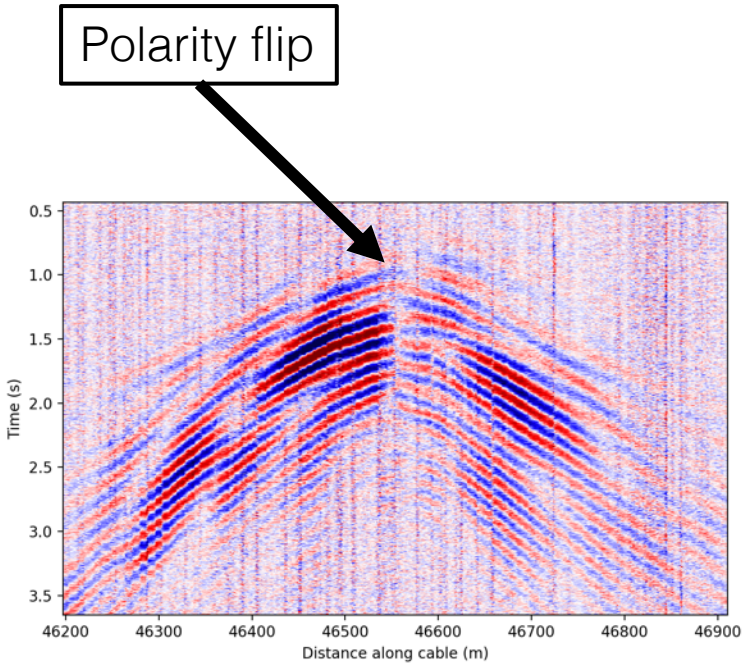


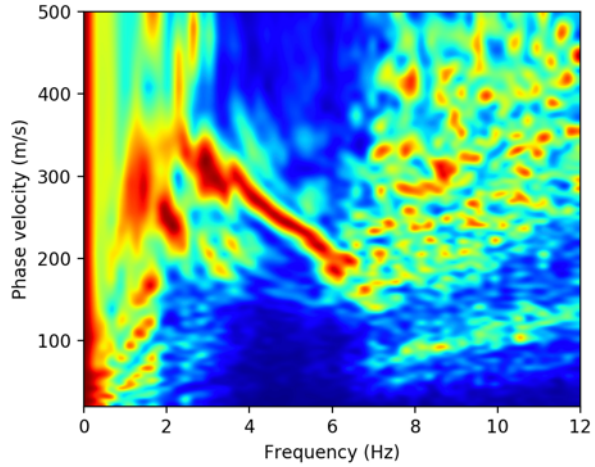
Poor coupling



Special signatures







Conclusion

- The DAS array using the 52-km-long submarine fiber-optic cable at Monterey Bay has observed a wide variety of seismological phenomena at the ocean bottom

- Multiple applications of the submarine DAS data:
  - Earthquake monitoring
  - Fault zone illumination
  - Ambient-noise-based seismic survey
  - Seafloor activity monitoring
  - …

Thank you!