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High precision and high resolution monitoring of subsurface changes with DAS and airgun

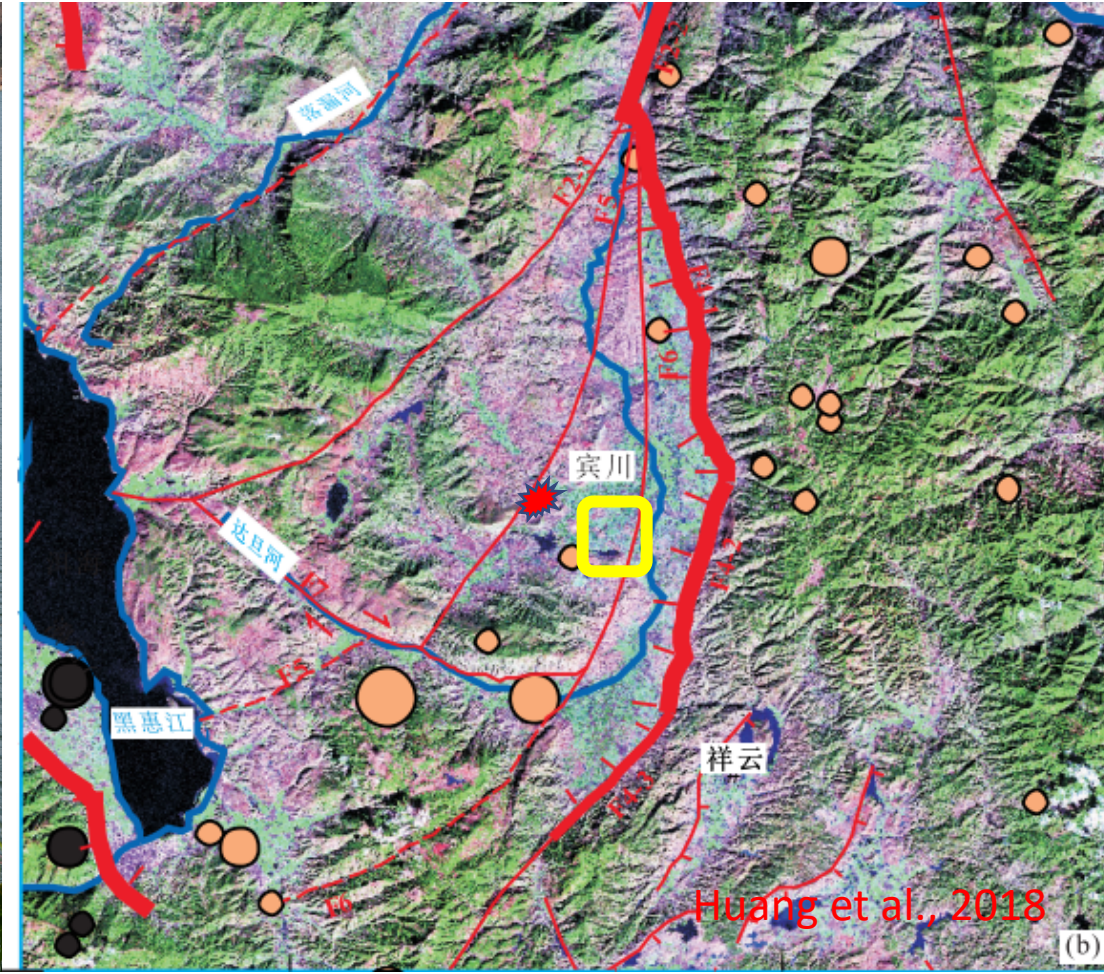
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Rongbing Lin, Manzhong Qin, Congxin Wei, Dianfeng Sun, Yahong Wang

Airgun sources



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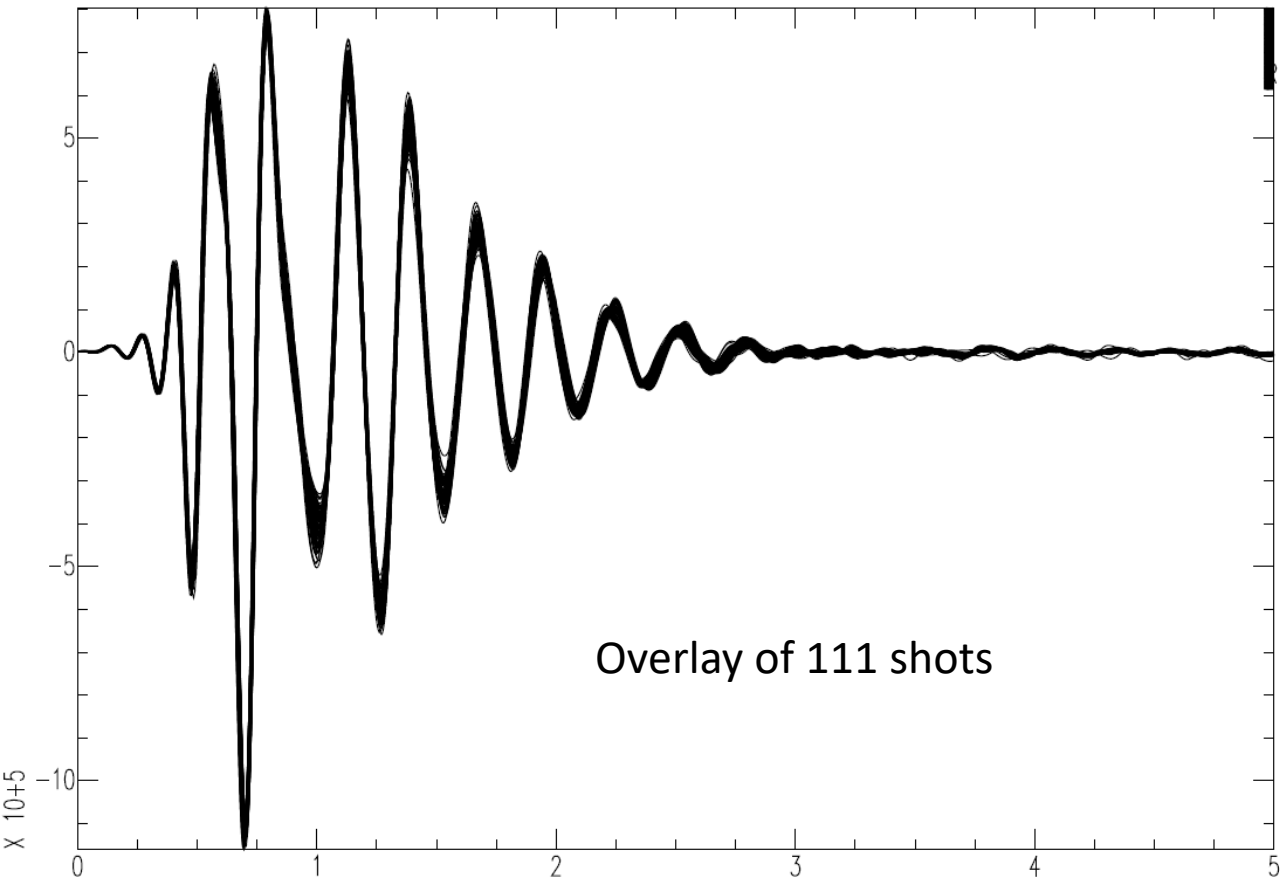


From 2012, three fixed airgun source was established in China (Chen et al., *Science China*).

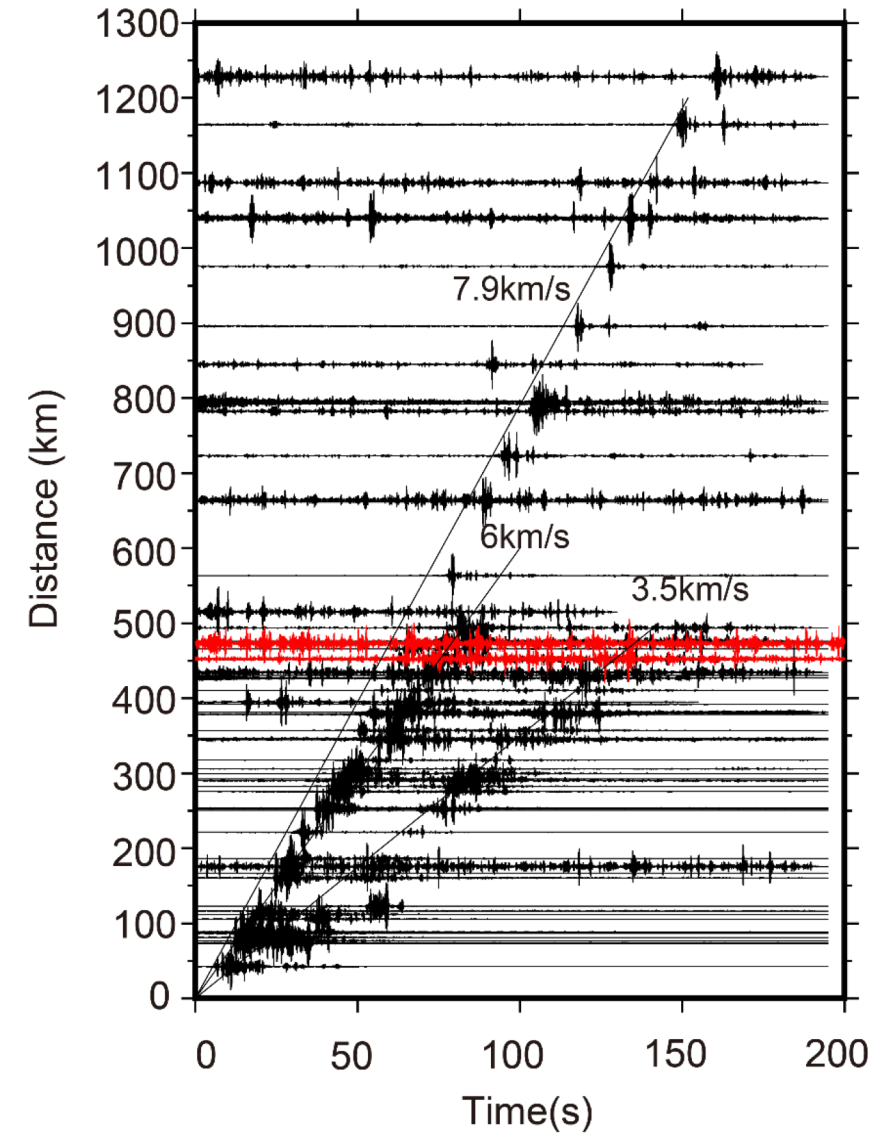
Airgun source



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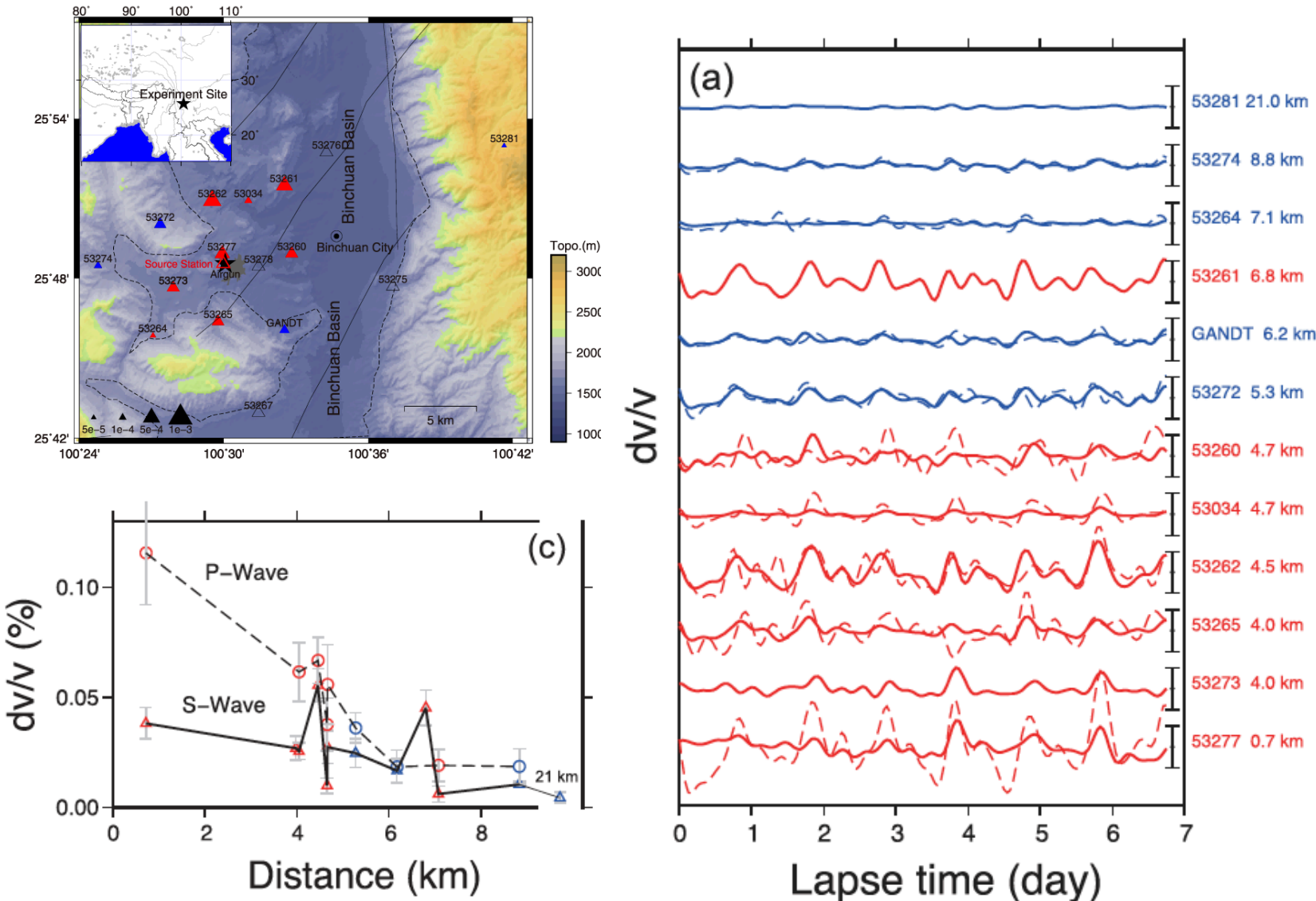
The airgun source is highly repeatable ($cc > 0.99$). The seismic signal can be traced up to several hundreds km (several hours stacking) even thousand km (years stacking).



Velocity Monitoring with airgun source



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Using the airgun source and portable seismic stations, we are able to monitor subtle diurnal and semi-diurnal P- and S-wave velocity changes. The amplitude of seismic velocity change decreases with the epicentral distance. (Wang et al., 2020, JGR)

However, subject to the sparse station distribution the mechanism of velocity change is to be further investigated.

The DAS technique provides ultra-dense and self-synchronized observation, which is favorable for subsurface monitoring.

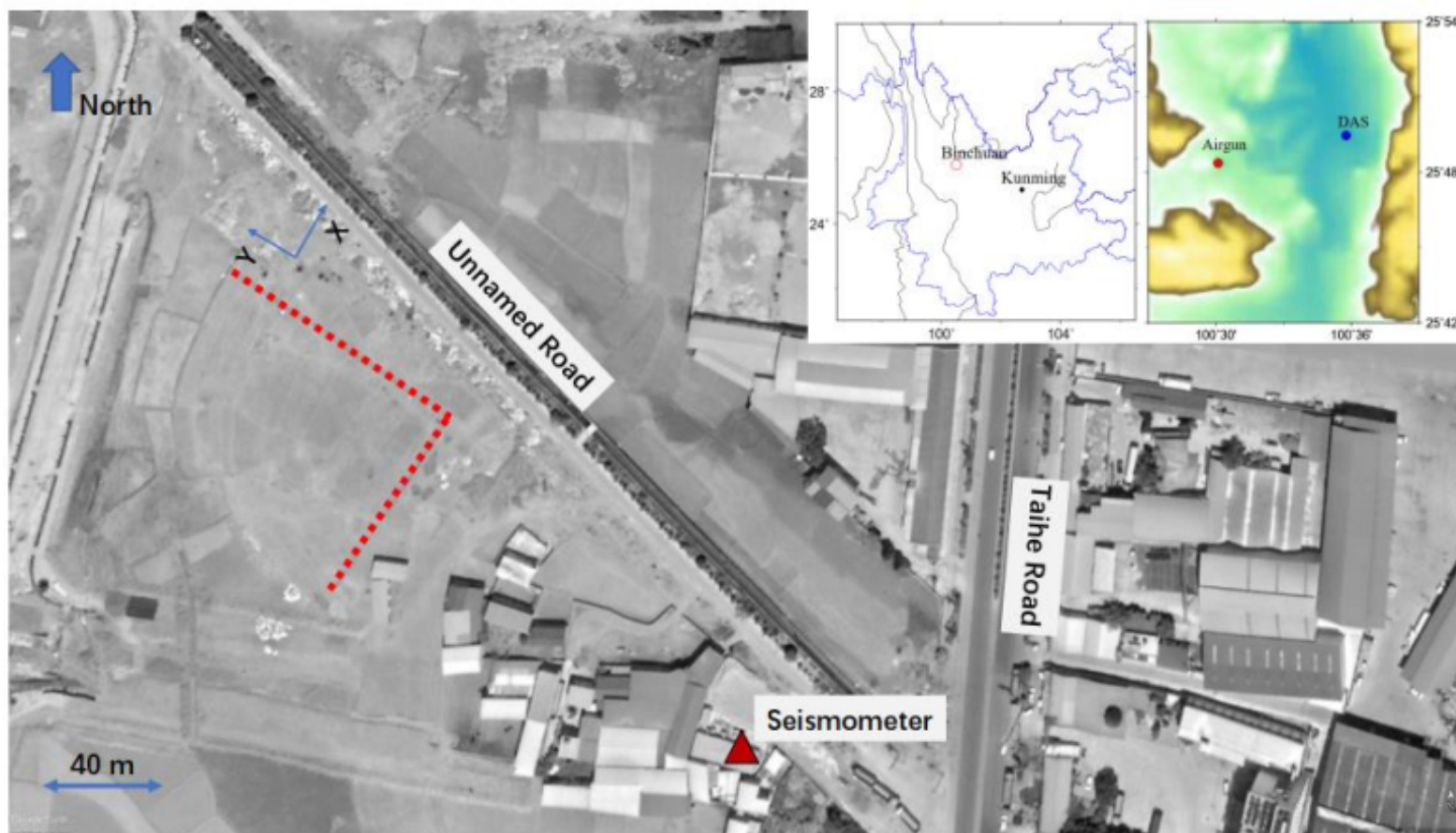
To test the feasibility of monitoring with DAS and Airgun, we carried out several experiments.

Binchuan experiment-specified cable

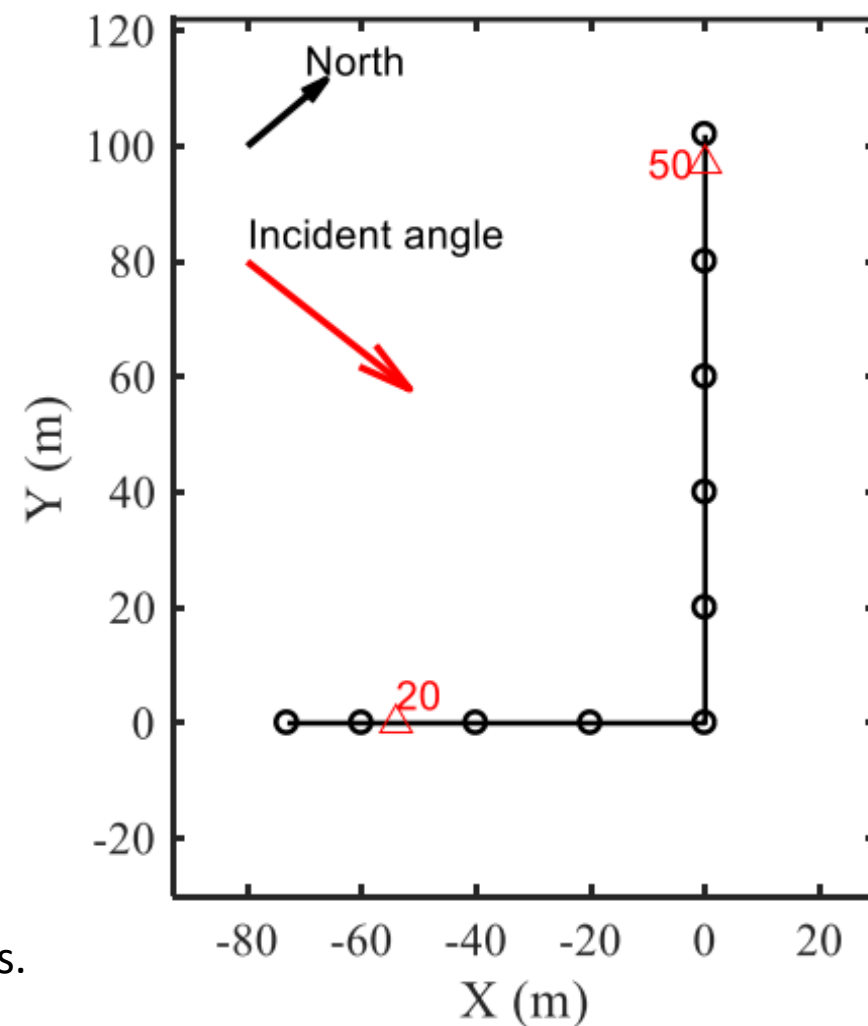


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(a)



(b)

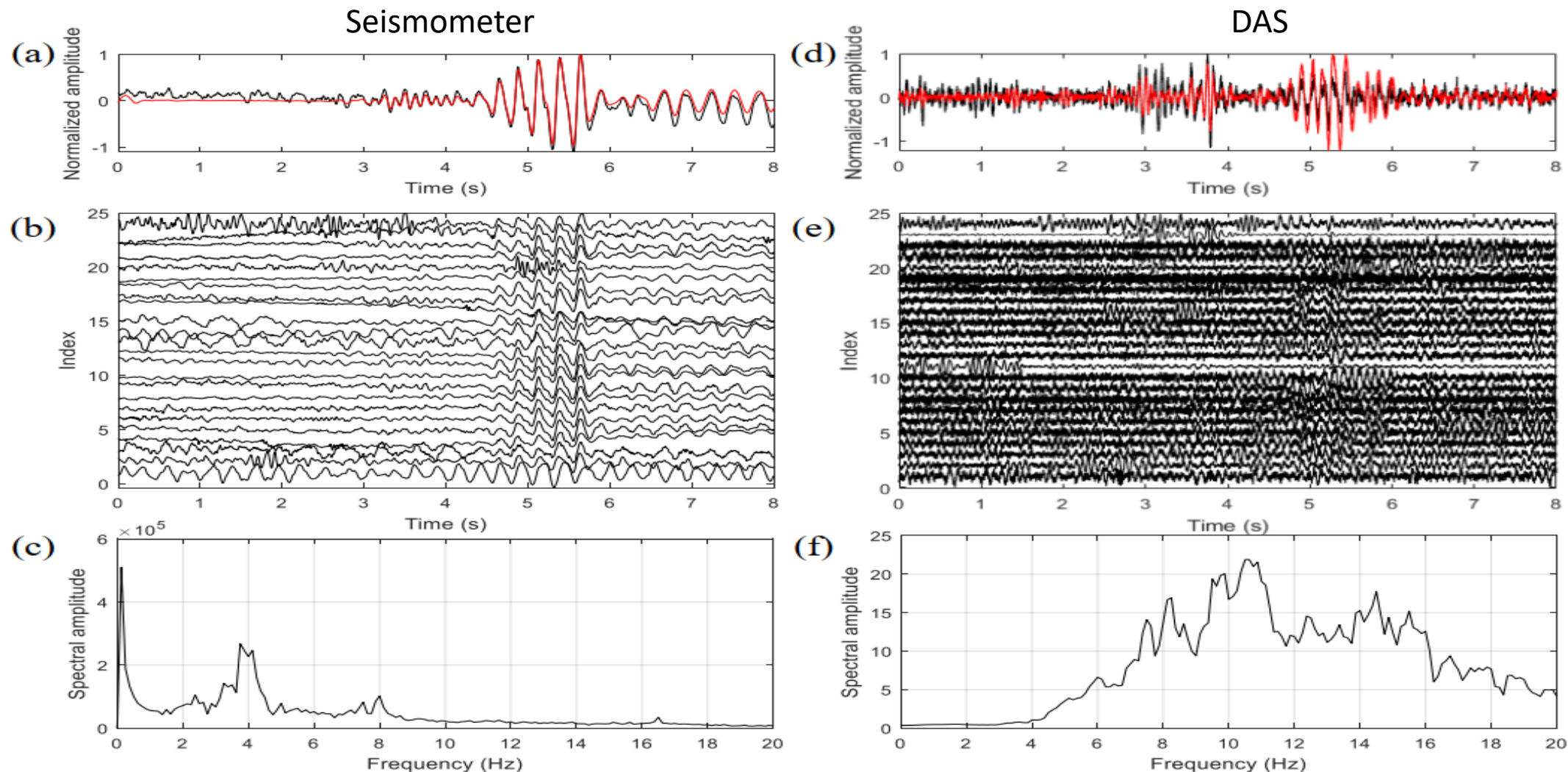


In this experiment we tested both specified and telecommunication fibre cables.

Binchuan experiment-specified cable



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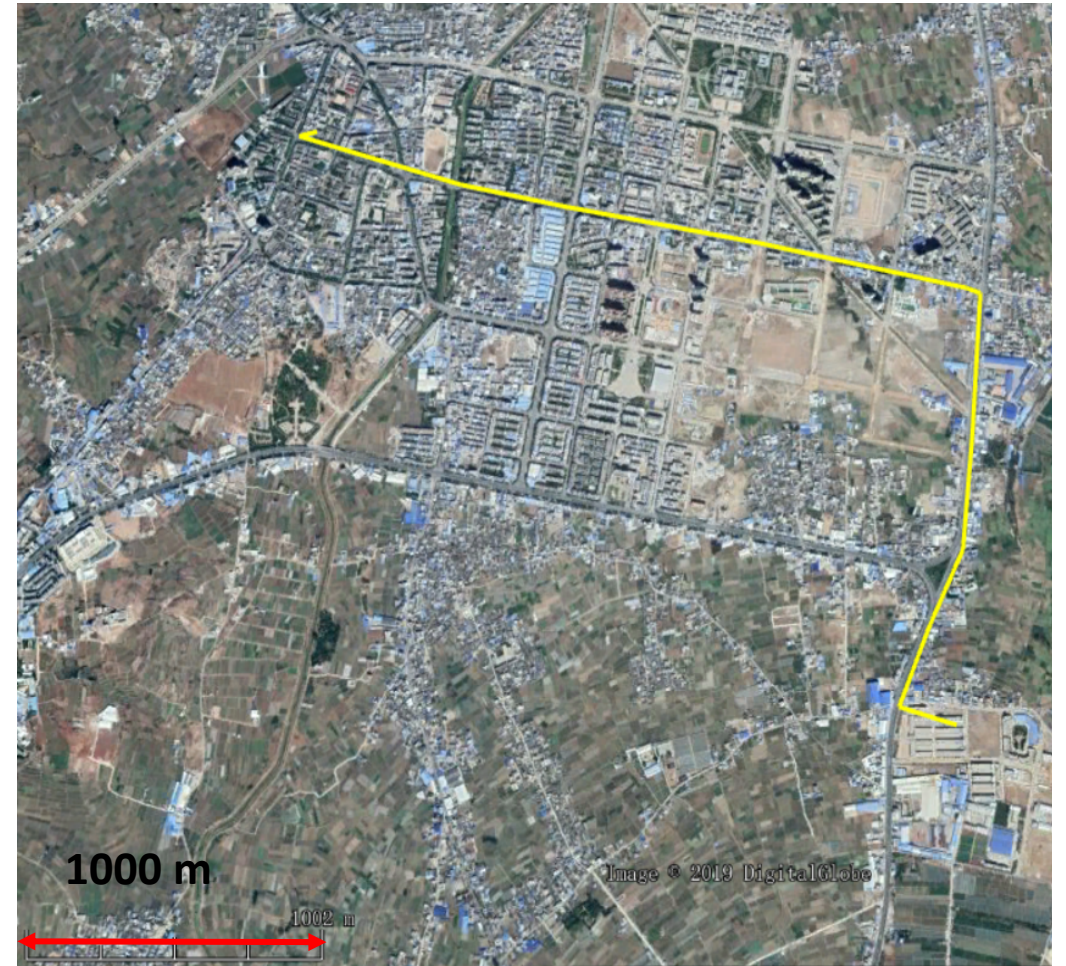
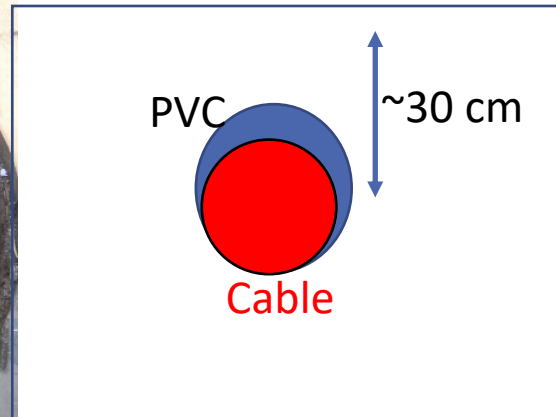
The records from DAS and seismometer are compared. Though less sensitive than seismometer, the DAS can clearly register the airgun signal after ~20 stacks.

Telecommunication cable



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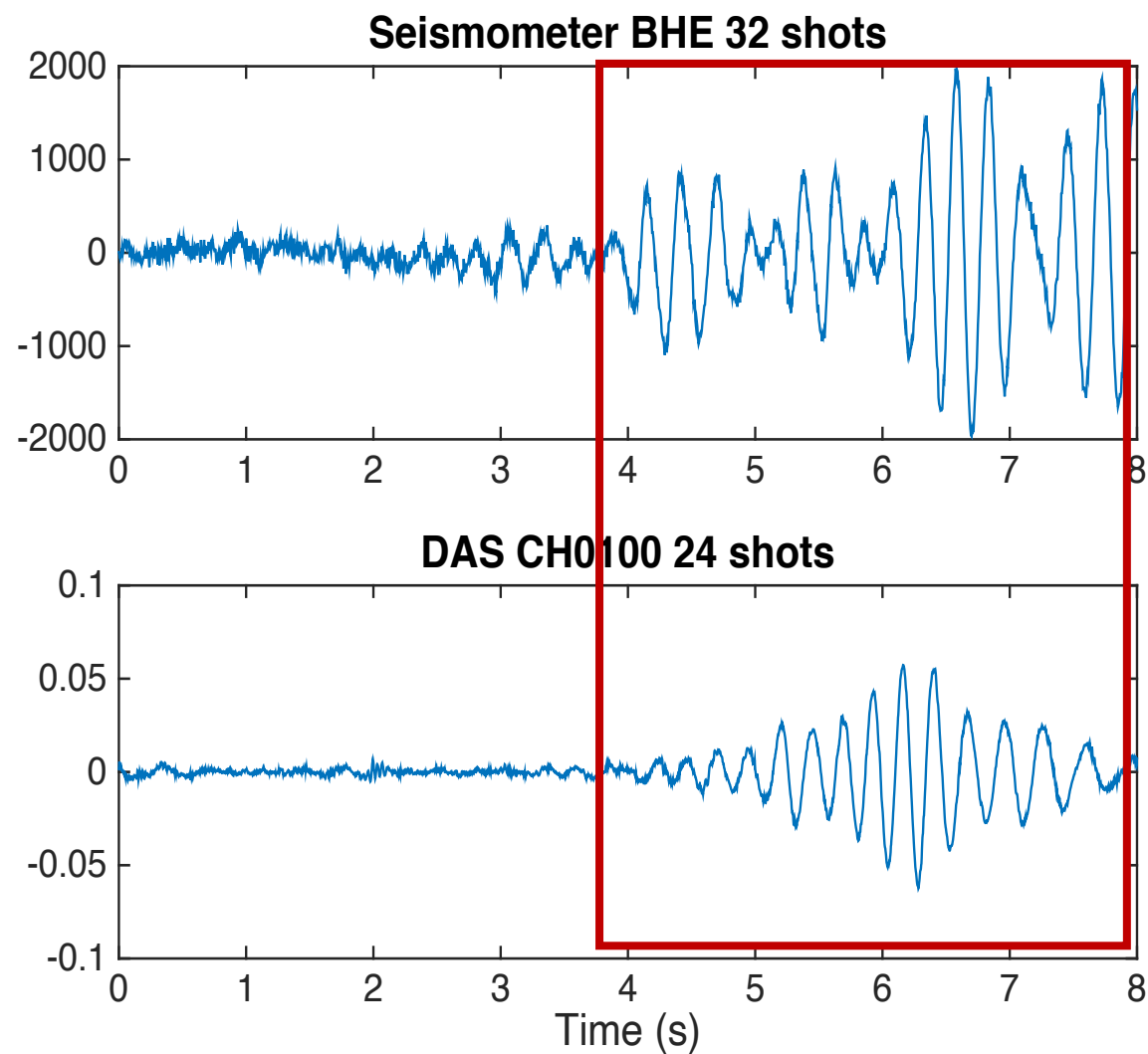
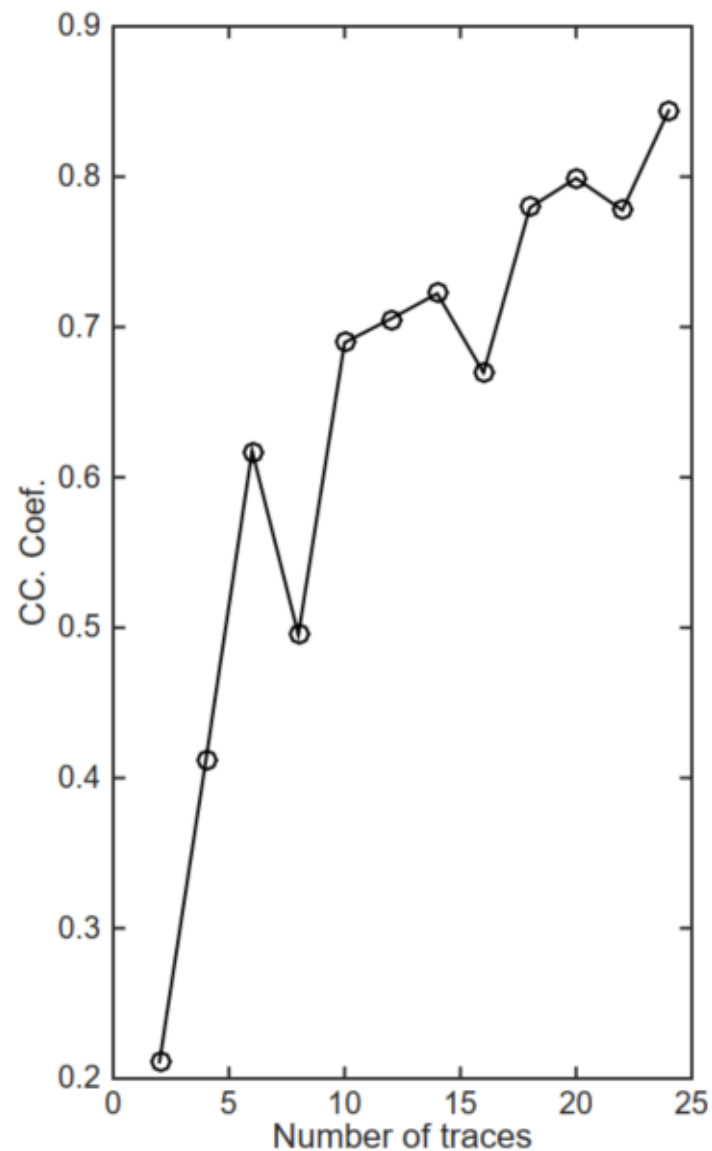
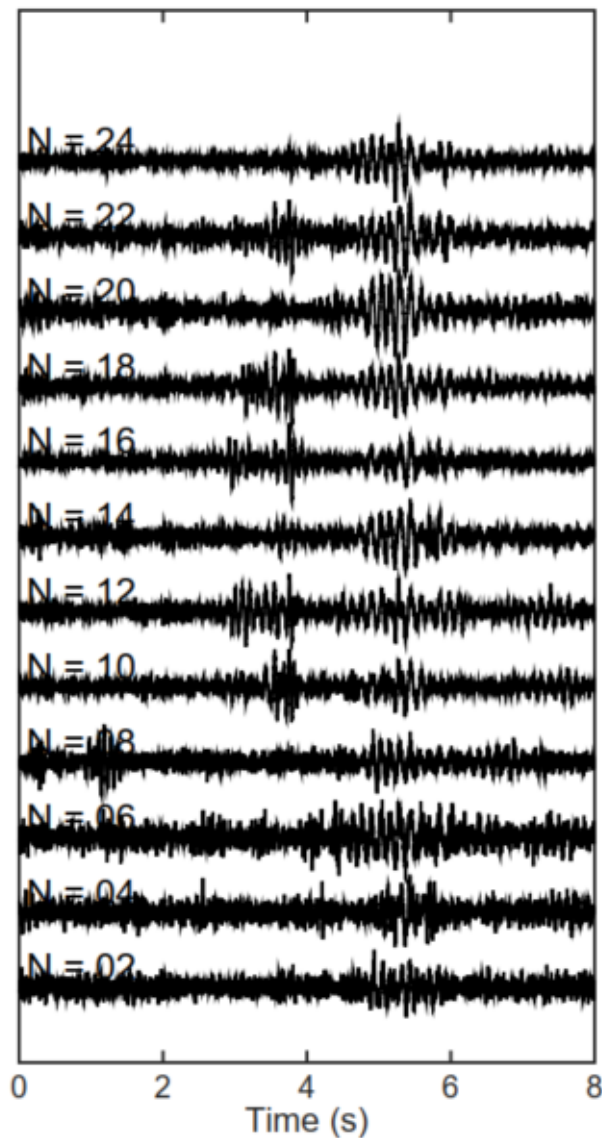
- 5300 m telecommunication fiber-optic cable
- 4m spacing (more than 1300 nodes)
- 5000 Hz sample rate
- Two days continuous record in Jan. 2019



Airgun signal recorded by Tel. DAS



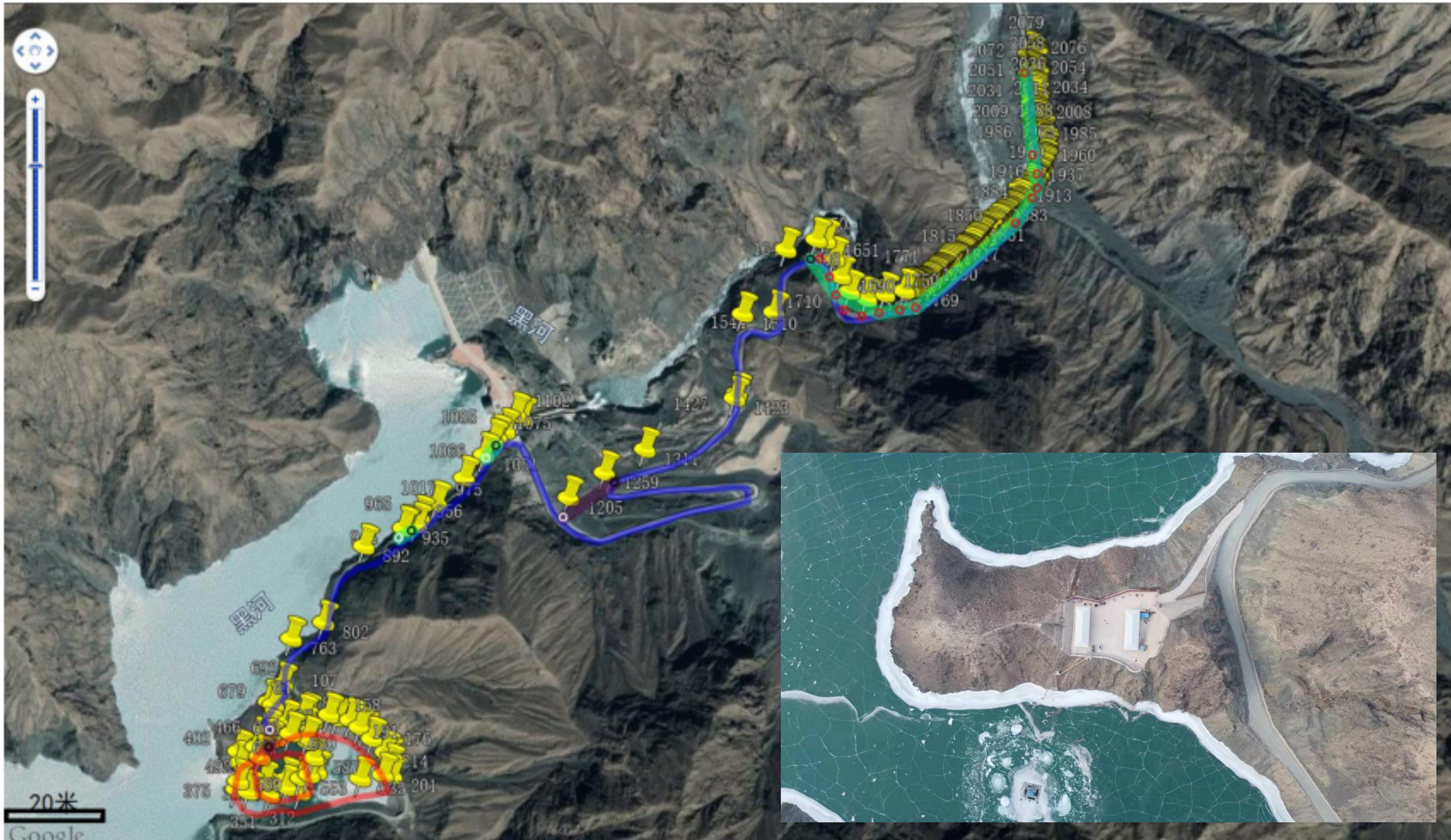
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Zhangye experiment



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2020.01.05-2020.01.08

5 km cable

4 m interval

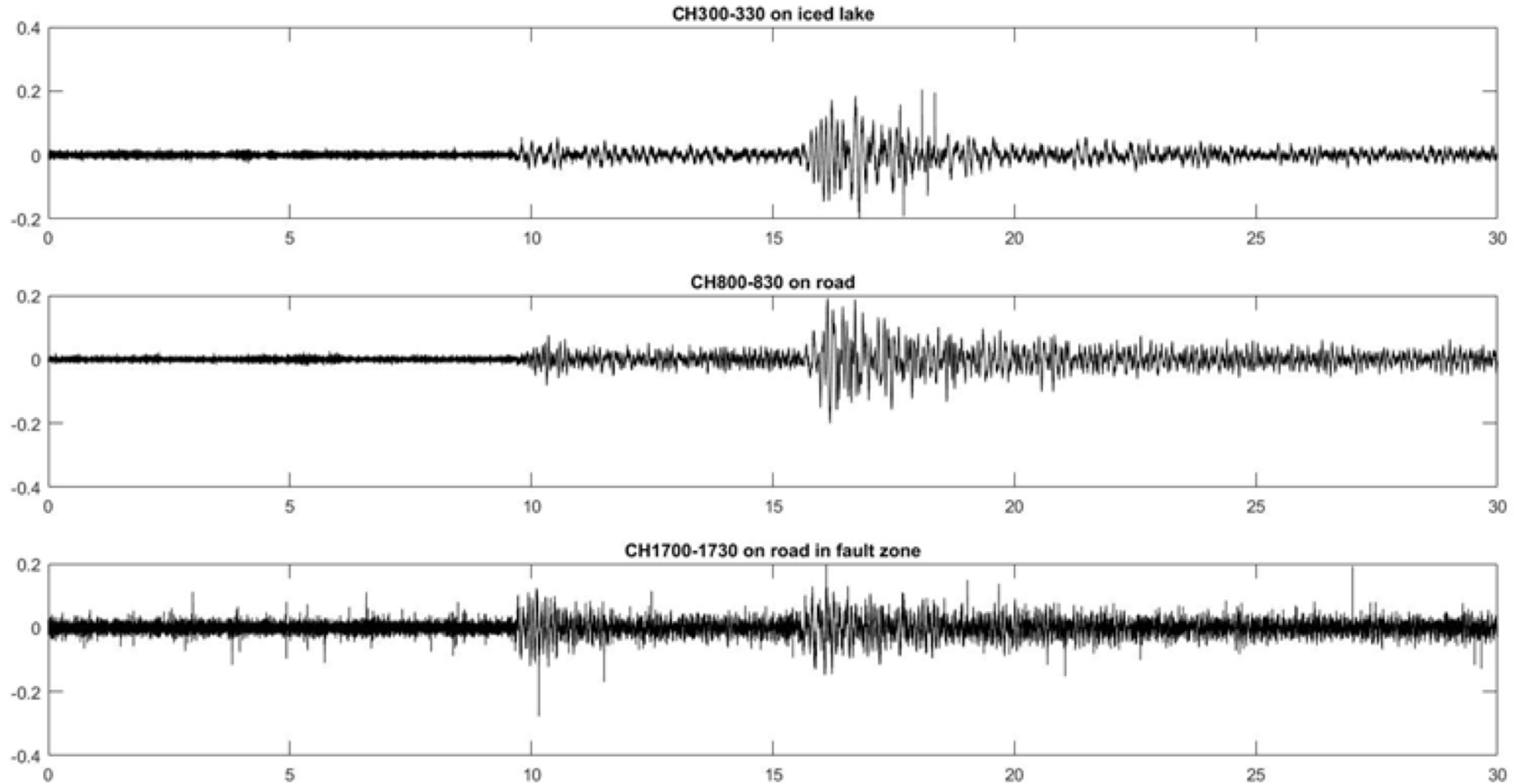
One shot per hour

Different welding

Zhangye experiment- earthquake



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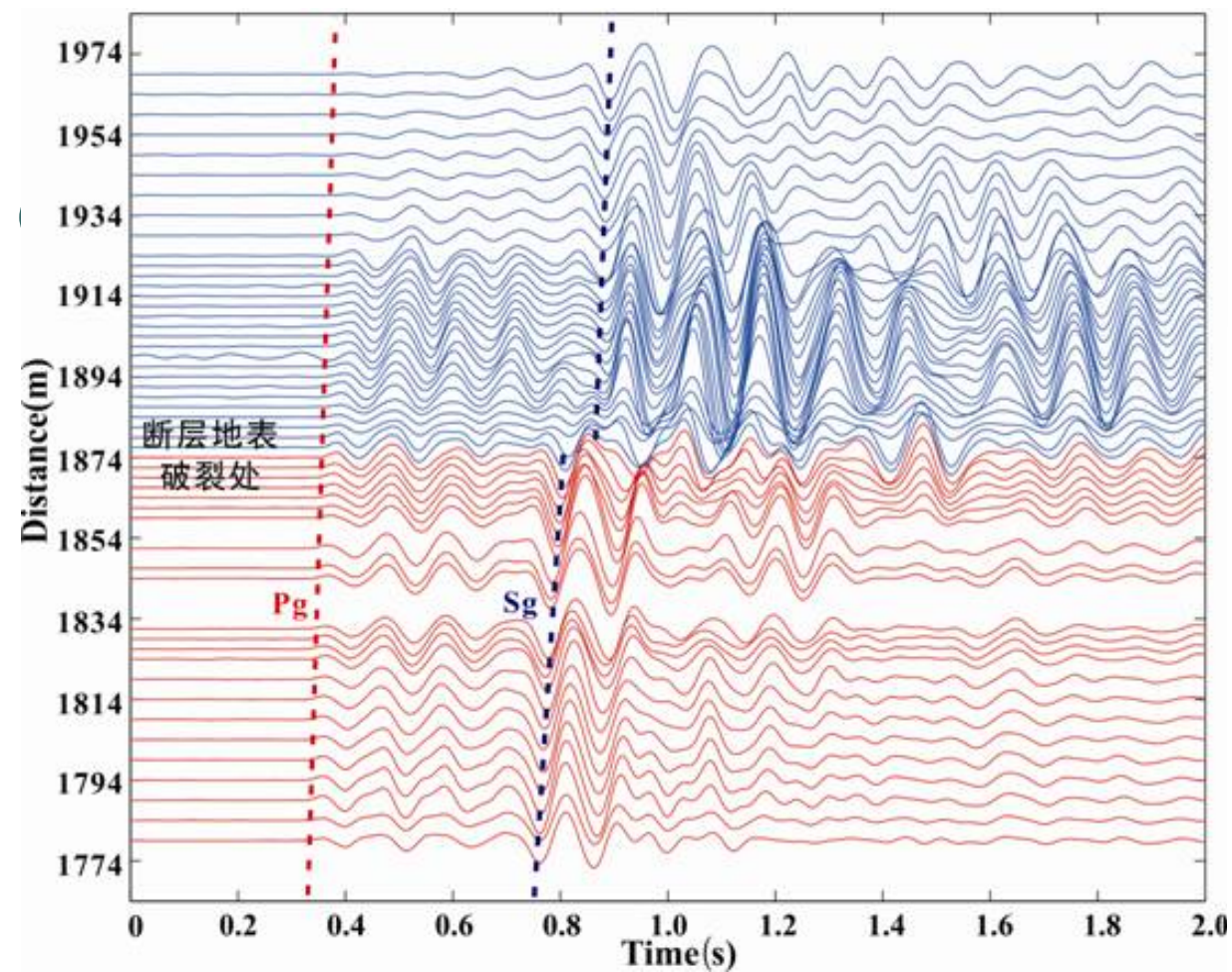
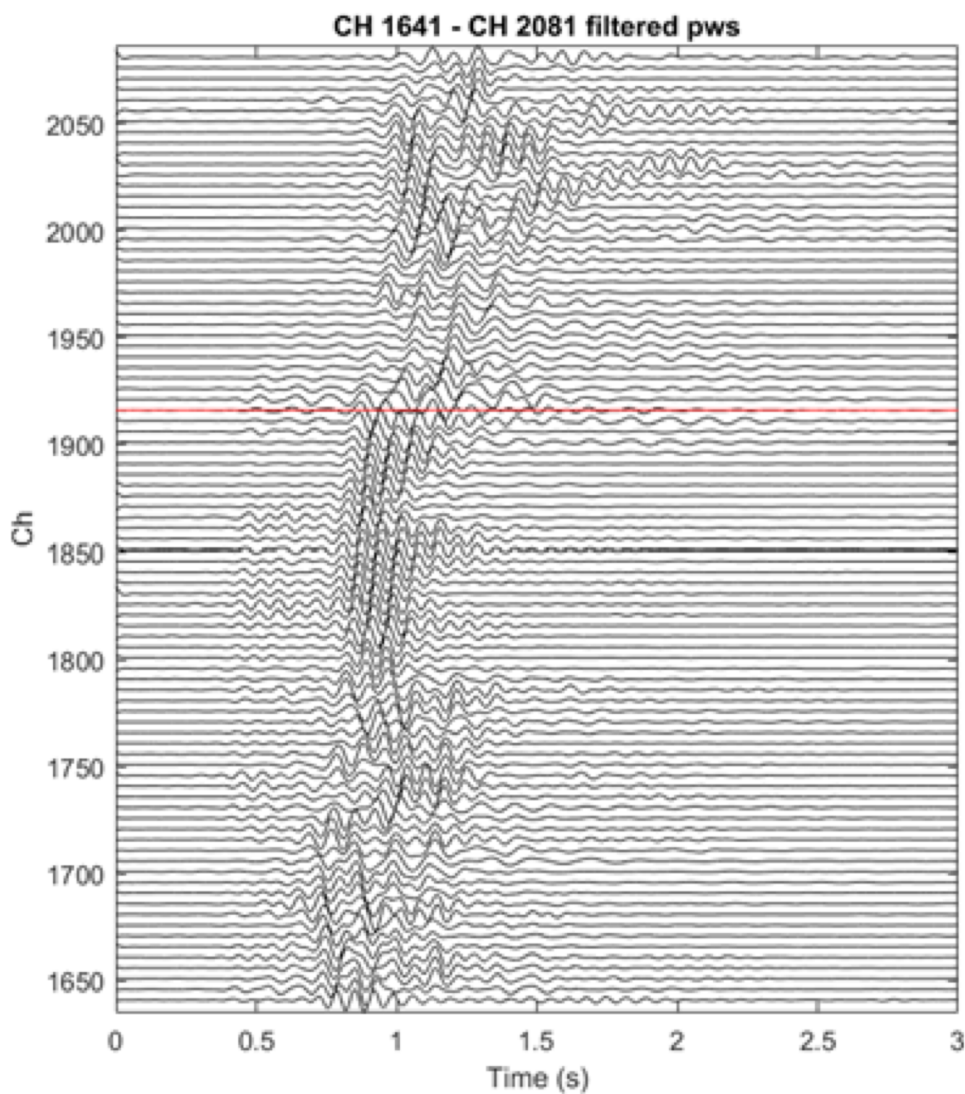


An $M_L 4$ earthquake occurred ~ 40 km from the DAS

Zhangye experiment – fault zone



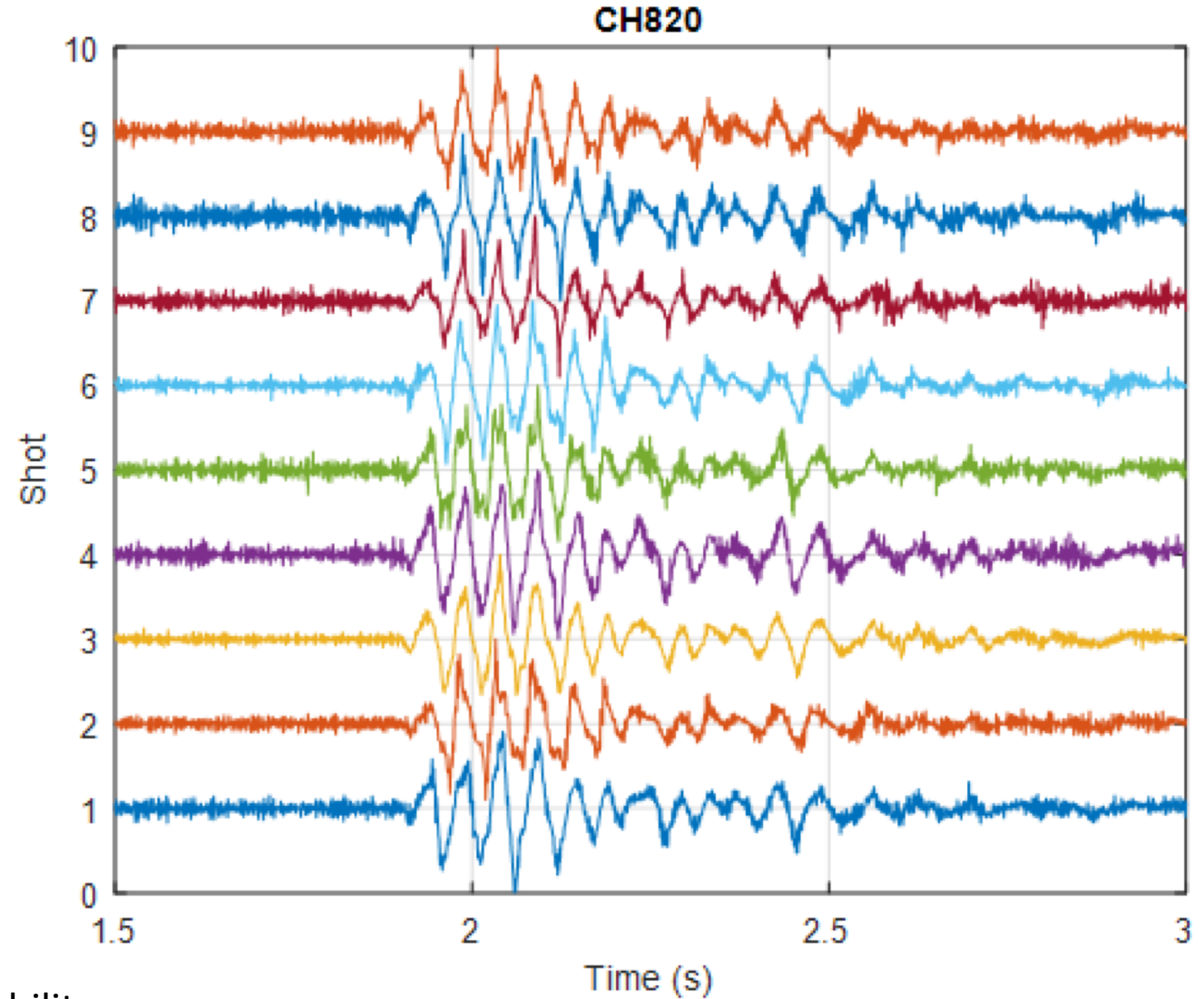
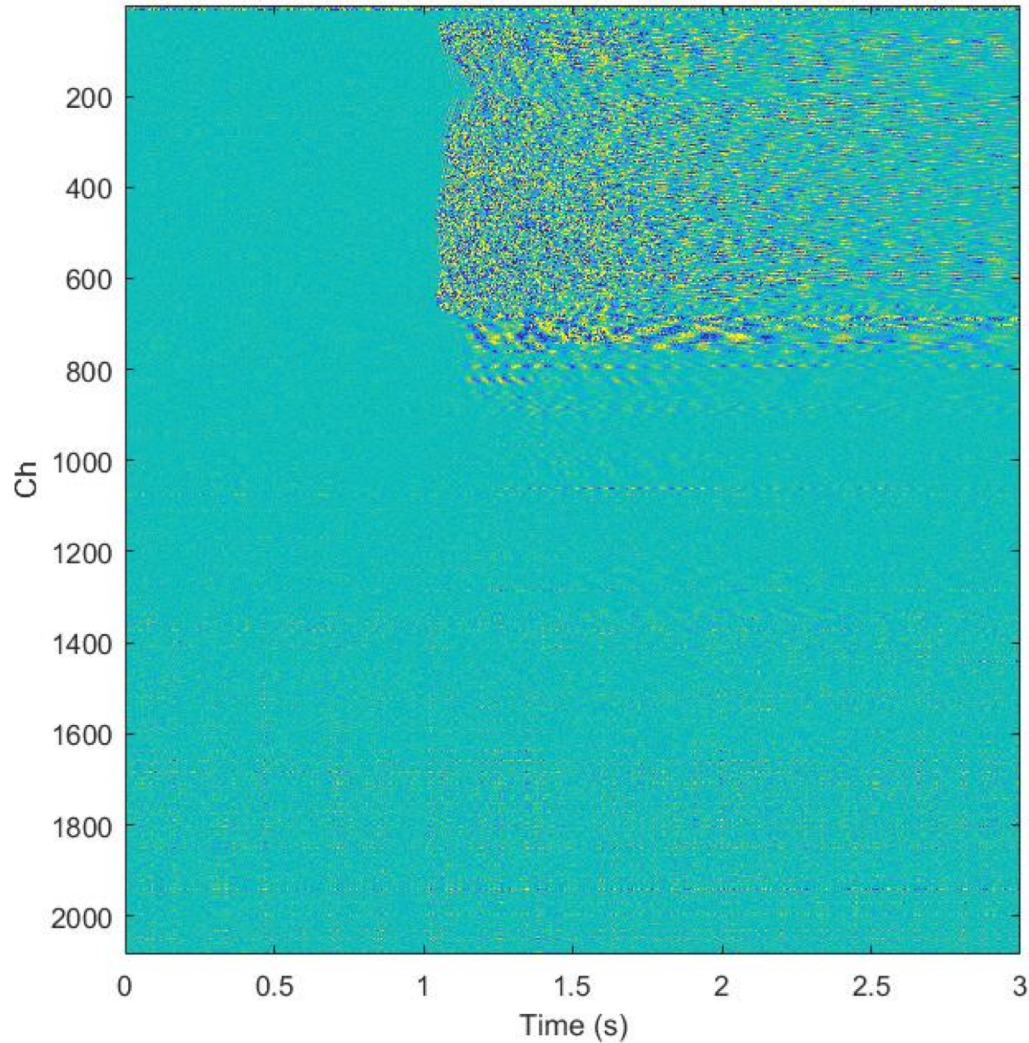
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Zhangye experiment - airgun



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Airgun signal can be registered by DAS with high repeatability



- The airgun signal is highly repeatable and is favorable for subsurface monitoring.
- The airgun signal can be clearly registered by DAS cable with high repeatability.
- Current study reveals the possibility to achieve high spatial resolution subsurface monitoring, but more works remain to be done.