REMOVAL OF SURFACE WAVES FROM ACTIVE SEISMIC RECORDS USING SEISMIC INTERFEROMETRY

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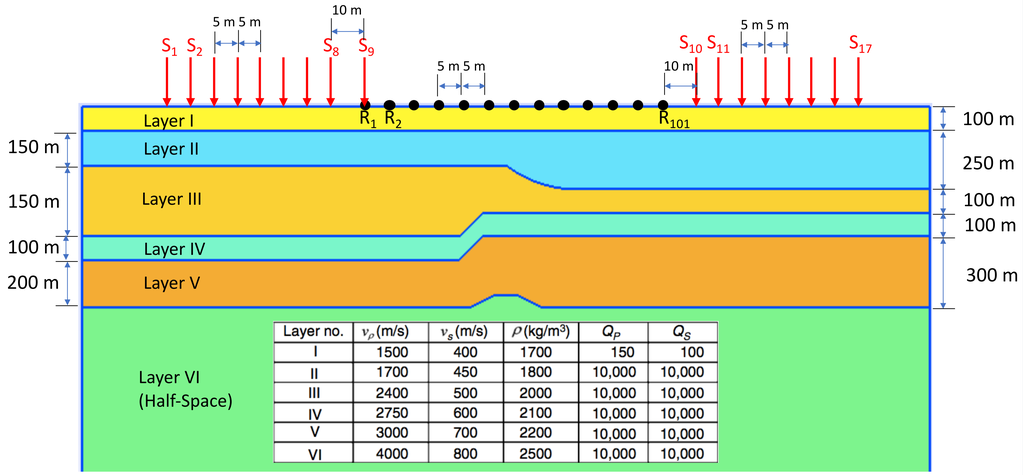
1. INTRODUCTION

- Seismic reflection surveys useful for imaging subsurface.
- Surface waves (ground-roll) dominate the reflection data and mask the reflection events, when source and receivers are at ground.
- Seismic interferometry is a data-driven method that can remove the surface waves from this data.
- Signals at two receivers are cross-correlated and summed over sources to obtain the "virtual" (interferometric) signal between the receivers.
- The interferometric signal is composed almost entirely of surface waves and can be "subtracted" from the original reflection data.

2. METHODOLOGY

Synthetic data of complex 2-D anelasic medium considered, comprising vertical velocities at 101 receivers (R_1, R_2, …, R_{101}) due to 17 sources (S_1, S_2, … S_{17}).

Figure 1: Source-receiver configuration at surface of 2-D anelastic medium



Layer no.	v_p (m/s)	v_s (m/s)	ρ (kg/m^3)	Q_P	Q_S
I	1500	400	1700	150	100
II	1700	450	1800	10,000	10,000
III	2400	500	2000	10,000	10,000
IV	2750	600	2100	10,000	10,000
V	3000	700	2200	10,000	10,000
VI	4000	800	2500	10,000	10,000

Procedure to remove ground-roll from source S_5 reflection data at receiver R_{50}

1. Obtain interferometric signals $x_{1,50}$, $x_{2,50}$, … $x_{101,50}$ between receiver pairs (R_1,R_{50}), (R_2,R_{50}), … (R_{101},R_{50}), respectively.
2. De-cross-correlate signals recorded at R_1, R_2, … R_{101} (due to source S_5) from interferometric signals $x_{1,50}$, $x_{2,50}$, … , $x_{101,50}$, respectively, to obtain 101 estimates of ground-roll at receiver R_{50} (due to source S_5): $h_{1,50}$, $h_{2,50}$, …, $h_{101,50}$.
3. Proposed estimate of ground-roll at R_{50} = Average of $h_{1,50}$, $h_{2,50}$, …, $h_{101,50}$.
4. Algebraically subtract estimated ground-roll from the original data at R_{50} .

Similar procedure applicable to other source-receiver pairs.

3. RESULTS

Figure 2: Outcome of proposed procedure when applied to data at R_{50} due to source S_5

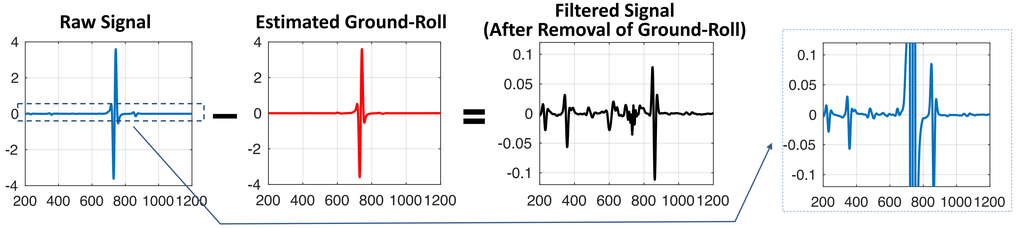
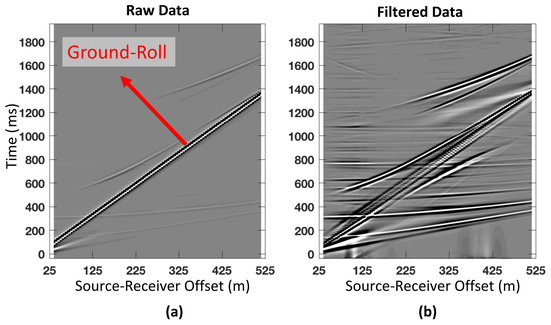


Figure 3: Outcome of proposed procedure when applied to synthetic shot gather of source S_5



- Raw signal is dominated by surface wave.
- Amplitude of surface wave is an order of magnitude higher than that of reflected waves.
- The direct and reflected waves are well-preserved in the filtered signal.

4. CONCLUSIONS AND FURTHER WORK

For the considered 2-D medium:

- Proposed interferometric technique removes surface waves effectively.
- Reflection data of multiple receivers used in an unbiased manner.
- Technique is completely data-driven.

Proposed technique needs to be tested against real land-seismic data.

5. REFERENCES

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