Multiples suppression scheme of waterborne GPR data

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1 part

Introduction

1. Background

In the field of water area engineering and underwater archaeology, it is often necessary to investigate the stratigraphic structure of water area in detail and detect the underwater buried body quickly and accurately. The multiple wave interference of radar data in water area is particularly prominent.

2. Multiples suppression scheme

Based on multiples suppression methods in single channel seismic exploration in water area, the multiples suppression methods suitable for GPR data - predictive deconvolution and Surface-Related Multiple Elimination (SRME) are selected.

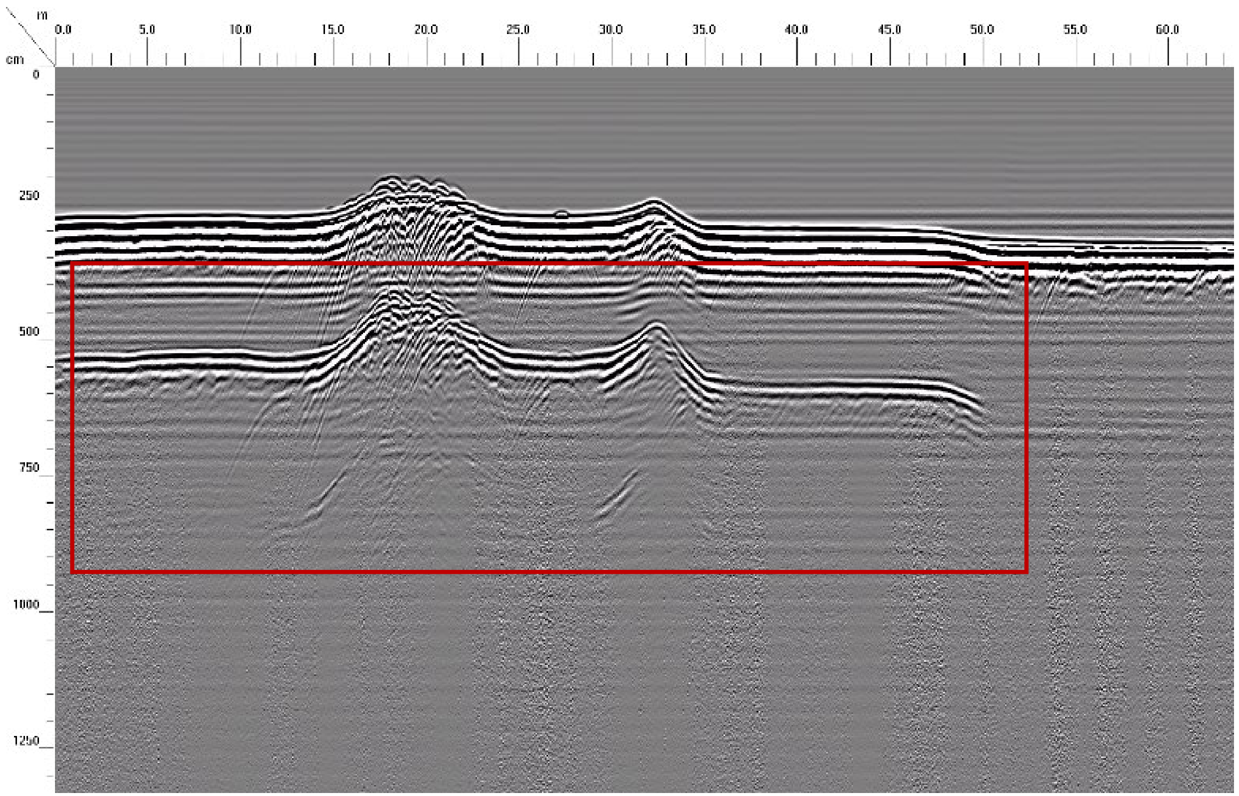


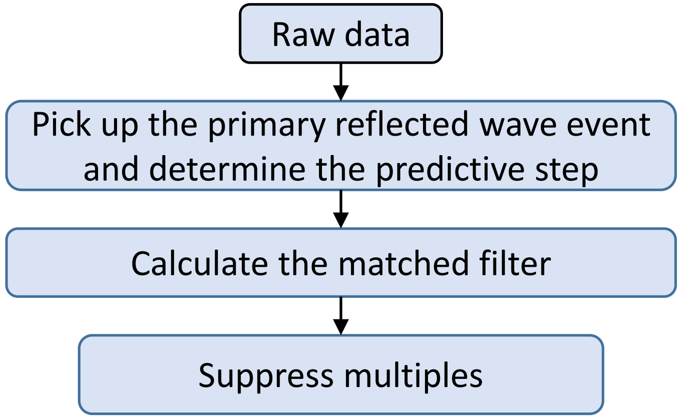
Fig. radar data in water area

Methodology

Predictive deconvolution

$$y_0(t) = y(t) - r_1 r_2 y(t - \Delta t) = [\delta(t) - r_1 r_2 \delta(t - \Delta\tau)] * y(t)$$

Where $y(t)$ is the original signal including mutiples, $y_0(t)$ is the signal without mutiples.



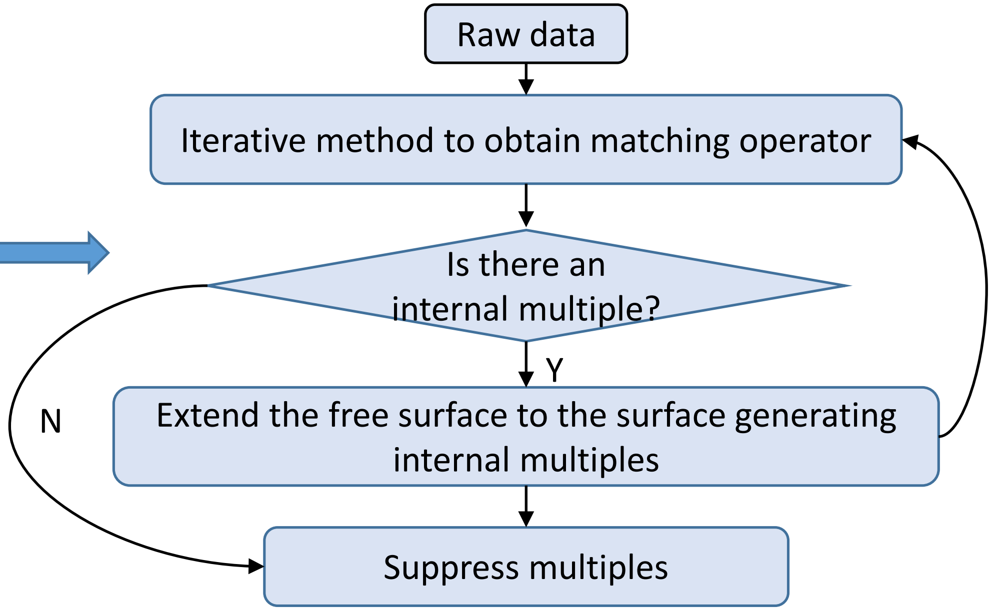
SRME

$y(t) = s(t) * x(t)$, and $y_0(t) = s(t) * x_0(t)$

Where $y(t)$ is a signal including mutiples, $y_0(t)$ is the signal without multiples, $s(t)$ is the source wavelet, $x(t)$ is the overall response including one response $x_0(t)$.
Define a deconvolution operator $a(t)$, $a(t) * s(t) = \delta(t)$

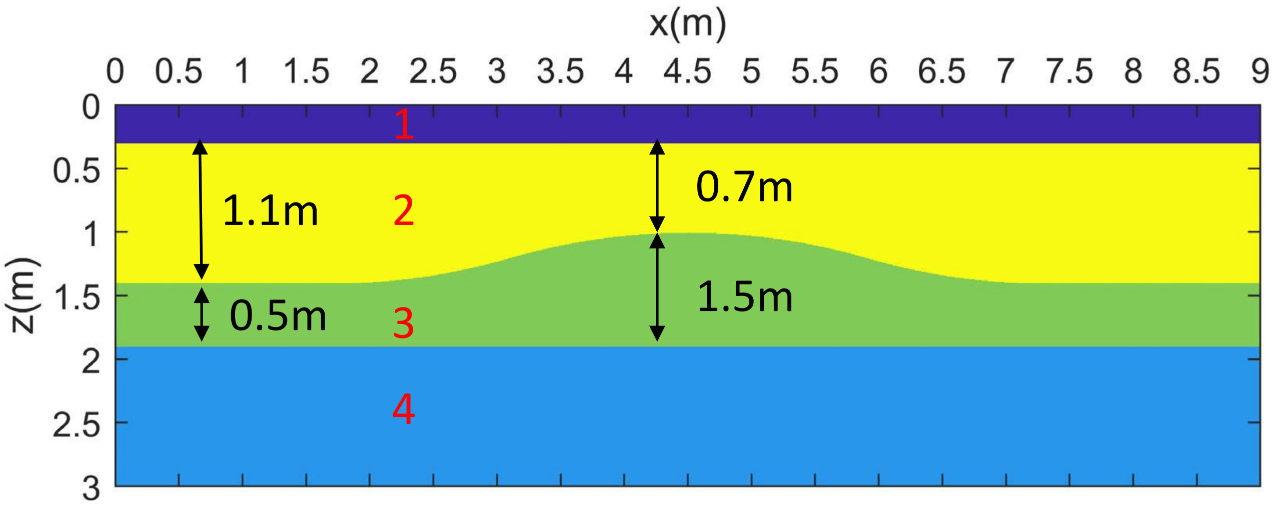
$$y_0(t) = y(f) - a(t) * y_0(t) * y(t)$$

$$y_0^{i+1}(t) = y(f) - a(t) * y_0^i(t) * y(t)$$

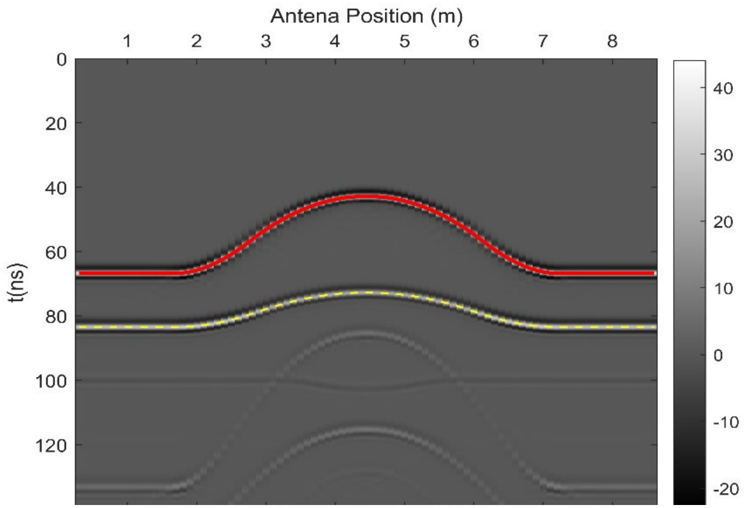


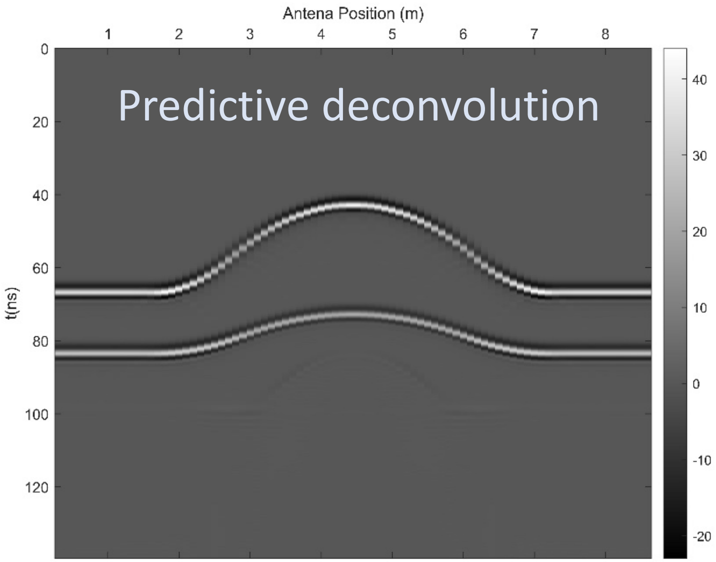
3 part

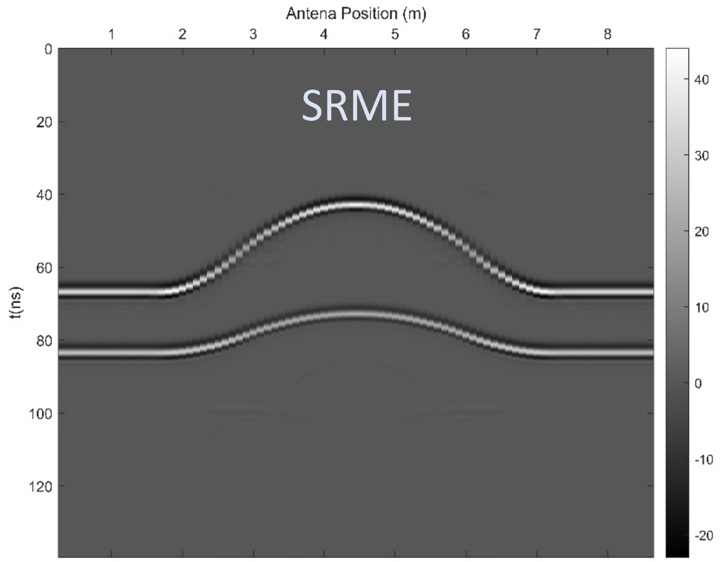
Theoretical data

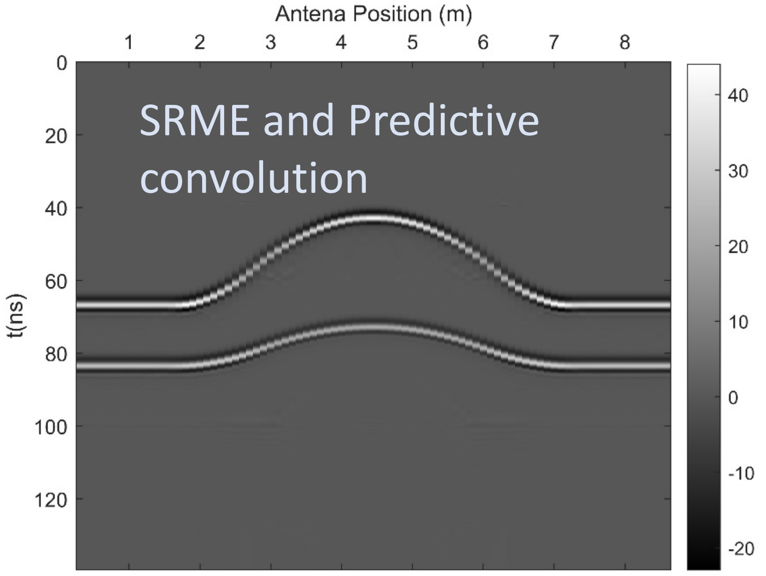


Layer 1: air
Layer 2: water
Layer 3: silt
Layer 4: bedrock









4 part

Real data

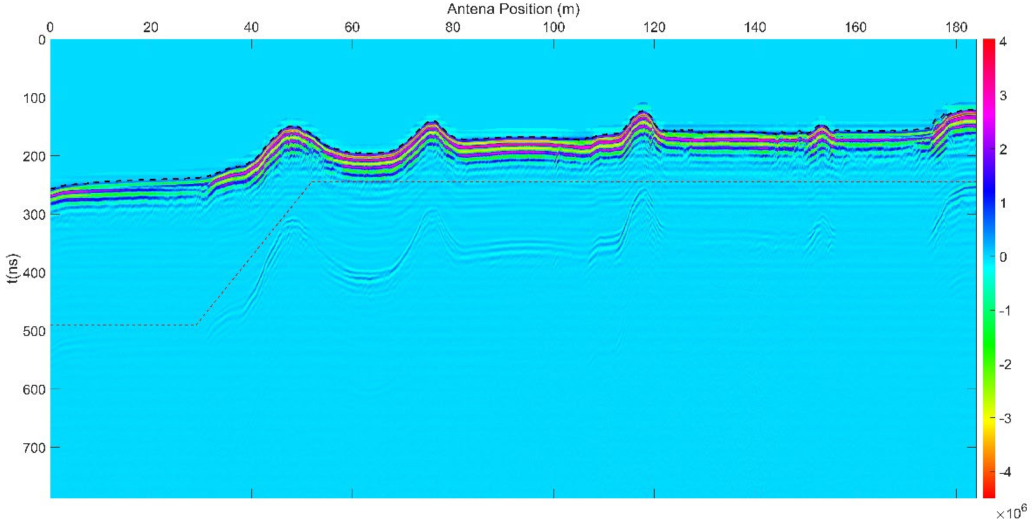


Fig1. raw radar data

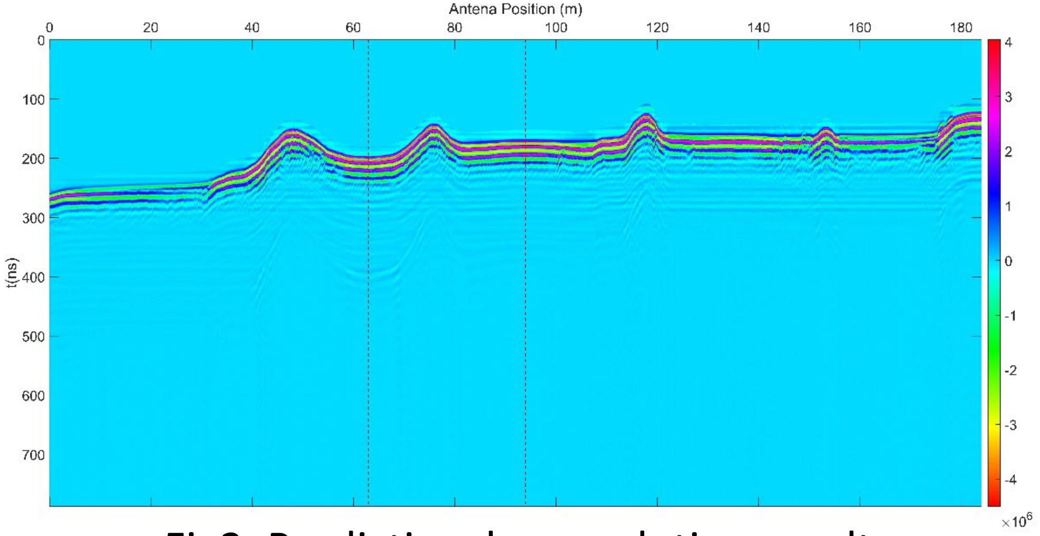


Fig2. Predictive deconvolution result

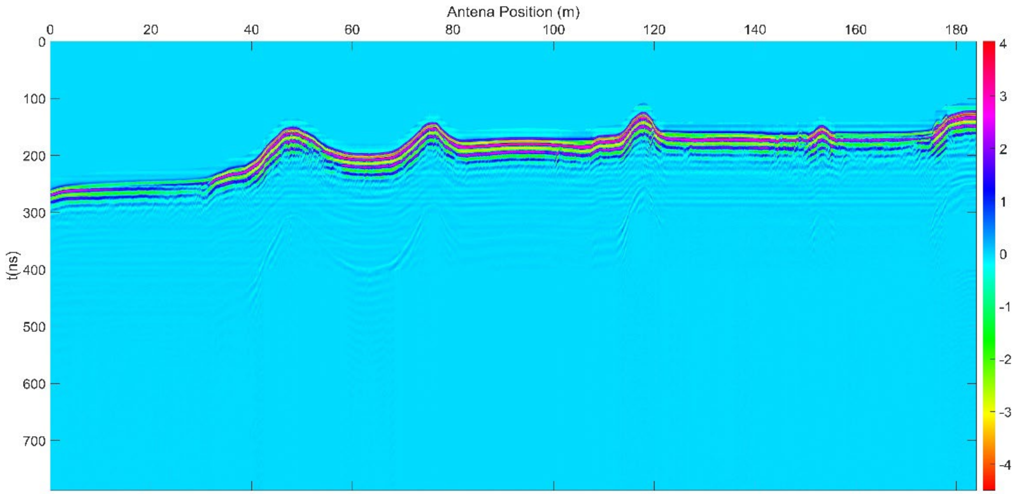


Fig3. SRME result

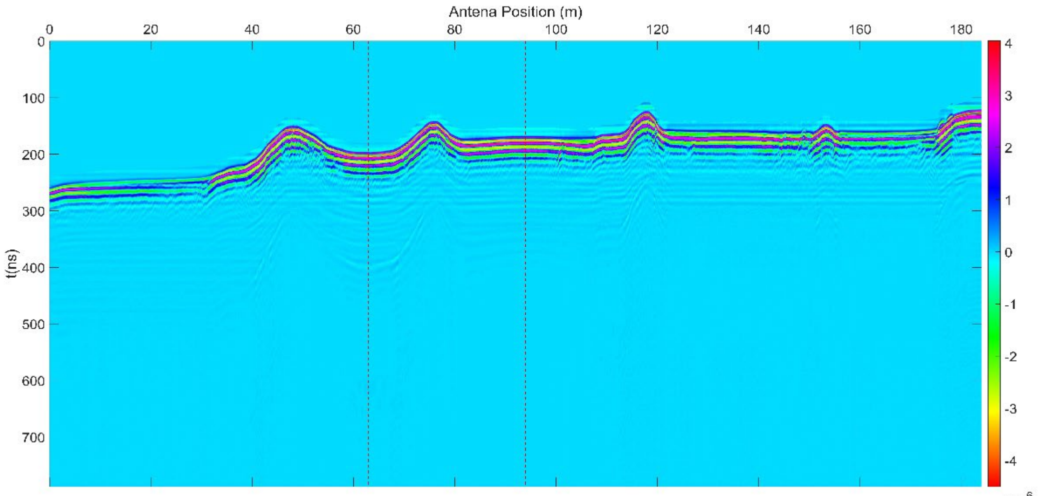


Fig4. SRME and predictive deconvolution result

Conclusion

1. Improve the adaptability of the setting of prediction step in the common prediction deconvolution methods.

2. Introduce the SRME method commonly used in offshore seismic exploration into the multiple suppression of GPR data.

3. The model test and practical application of water engineering verify the effectiveness of these two methods, suppress multiples as much as possible and protect effective signals, which provides a method basis for GPR to detect underwater and solve difficult problems in water engineering.