CLAIMS

1. A method for obtaining zero-offset and near zero offset seismic data from a marine survey, with separation of direct arrival information and reflectivity information, the method comprising:

modeling, with a computer, a direct arrival estimate at a passive near-field hydrophone array by using a notional source separation on active near-field hydrophone data;

generating, with a computer, reflection data for the passive near-field hydrophone array by subtraction of the modeled direct arrival estimate from data recorded by the passive near-field hydrophone array;

generating, with a computer, near zero-offset reflectivity traces by stacking the reflection data for the passive near-field hydrophone array on a string-by-string basis or on a combination of strings basis;

generating, with a computer, reflectivity information at an active near-field hydrophone array by subtracting the direct arrival estimate modeled using the notional source separation from the active near-field hydrophone data; and

2. The method of claim 1, further comprising:

generating a reflectivity estimate at active near field hydrophone locations by applying normal moveout timing corrections to the near zero-offset reflectivity traces and stacking;

generating active array near field hydrophone data without reflectivity information by adaptively subtracting the reflectivity estimate at active array hydrophone locations;

generating a notional source update using as input the active array hydrophone data without reflectivity information;

generating a reflectivity information update at the active array hydrophone data locations by subtracting a direct arrival estimate modeled using the notional source update; and

generating an updated estimate of zero-offset reflectivity traces by calculating a cross-correlation between the reflectivity information update at the active array hydrophone data locations and the near zero-offset reflectivity traces and performing an optimized stacking with summation weights based on coefficients of the cross-correlation.

3. The method of claim 1, wherein the generating the reflection data for the passive near-field hydrophone array includes muting an early residual of the direct arrival estimate prior to the water bottom reflection.

4. The method of claim 1, further comprising generating far-field estimates for the active and passive hydrophone arrays from notional source signatures generated from the notional source separation.

5. The method of claim 4, further comprising ranking data quality for sail lines in a seismic survey with variability of far-field signatures or string geometry variability.

6. The method of claim 1, further comprising updating estimates for near-field hydrophone geometry variations between the active and passive near-field hydrophone arrays by analyzing a relative distance between the active and passive near-field hydrophone arrays compared to timing differences measured on the direct arrivals in the data recorded by the passive near-field hydrophone array.

7. The method of claim 1, further comprising conducting a seismic survey, wherein additional near-field sensors are added to a source array in addition to near-field hydrophones disposed at each source station.

8. The method of claim 1, further comprising deriving notional signatures in the notional source separation by computing an initial source separation in a frequency domain and using frequency-domain-derived notional sources as initial guesses for a time-domain approach with non-zero bubble velocity and non-zero vessel velocity.

9. The method of claim 1, wherein a source array used in the marine survey includes at least two different marine sources.

10. The method of claim 1, further comprising:

obtaining an estimation of seafloor reflectivity and seafloor depth by computing the notional source separation and then modeling seafloor reflected waves with a trial seafloor reflectivity and a trail seafloor depth; and

minimizing a misfit between arrival time and amplitude by comparing modeled and real data.

11. The method of claim 1, further comprising:

reconstructing missing near-offset streamer data with an interpolation method and the estimate of zero-offset reflectivity traces and the near zero-offset reflectivity traces.

12. The method of claim 11, wherein the reconstructed missing near-offset streamer data are used for trace data estimation at small trace times and streamer data extrapolated to smaller offsets are used at longer trace times.

13. The method of claim 12, wherein the reconstructed missing near-offset streamer data generated through the interpolation method and the streamer data that was extrapolated are used to initialize an iterative estimation of primaries by sparse inversion (EPSI) algorithm or a closed-loop surface-related multiple estimation (CLSRME) method that estimates an update to the reconstructed missing near-offset streamer data and an update to predicted multiples.

14. The method of claim 1, further comprising removing direct arrival energy from streamer data using one or more of the modeled direct arrival estimate on the passive near-field hydrophone array or the modeled direct arrival estimate on the active near-field hydrophone array.

15. A non-transitory computer readable storage medium, encoded with instructions, which when executed by a computer causes the computer to implement a method for obtaining zero-offset and near zero offset seismic data from a marine survey, with separation of direct arrival information and reflectivity information, the method comprising:

modeling a direct arrival estimate at a passive near-field hydrophone array by using a notional source separation on active near-field hydrophone data;

generating reflection data for the passive near-field hydrophone array by subtraction of the modeled direct arrival estimate from data recorded by the passive near-field hydrophone array;

generating near zero-offset reflectivity traces by stacking the reflection data for the passive near-field hydrophone array on a string-by-string basis or on a combination of strings basis;

generating reflectivity information at an active near-field hydrophone array by subtracting the direct arrival estimate modeled using the notional source separation from active near-field hydrophone data; and

generating an estimate of zero-offset reflectivity traces by calculating a cross-correlation between the reflectivity information at the active near-field hydrophone array and the near zero-offset reflectivity traces and performing an optimized stacking with summation weights based on coefficients of the cross-correlation.