second source is towed by a second vessel behind the first vessel and its towed equipment. There are disadvantages with this design as follows:

- The use of two vessels increases operational expense
- The two sources may not have identical characteristics
- There is a point in the middle of the streamer where no spectral differentiation occurs.

An objective of the present invention is to eliminate the above drawbacks.

In the system and method pertaining to the present invention, a source is positioned halfway down the streamer. A sound pulse is emitted and a first measurement is made into sensors both upstream and downstream of the source. The system progresses along the survey profile by a distance equal to the CMP interval, or some suitable multiple thereof, and a second measurement is made. This procedure is repeated along the length of the survey profile. As the measurement population builds, it can be seen that at each CMP position there will be pairs of observations taken whereby the distance between source and sensor is the same but their positions are mutually reversed. In other words, in each pair of observations the source is upstream of the sensor in one and downstream in the other. As each of the sensors will be from a different location in the streamer and therefore be towed at a different depth, they will have differing spectral notch characteristics. Because the same point in the ground is being sampled by the pair of observations, it can be assumed that the only variable differentiating the two observations is the spectrum. This assumption allows the de-ghosting of data during processing using established techniques.

An important advantage of the present invention is that the signals to be combined for de-ghosting purposes originate from one and the same source, so that the signals as transmitted by the source will have substantially the same characteristics, and the de-ghosting solution will have improved accuracy.

In a first aspect, the present invention provides a system for acoustically exploring structure of a floor below a water body, the system comprising:
a vessel;
at least one streamer placed in the water and towed by the vessel and comprising a plurality of acoustic sensors positioned at regular intervals along the length of the streamer, wherein the streamer has a slanted orientation making an angle with the

horizontal such that a sensor more remote from the vessel (1) is at a greater depth than a sensor closer to the vessel (1) and each of the sensors is at a different location in the streamer and therefore is towed at a different depth;
a source for generating acoustic pulses, the source being placed in the water and towed by the vessel;
a tow line connecting the source to the vessel;
wherein the tow line has such length that the horizontal distance between the vessel and the source is larger than the horizontal distance between the vessel and the first sensor closest to the vessel and smaller than the horizontal distance between the vessel and the last sensor most remote from the vessel.

In such design, there are always at least two sensors with the same offset arranged at mirrored sides of the source so that their signals can be de-ghosted.

In a preferred embodiment, the tow line has such length that the horizontal distance between the vessel and the source is substantially equal to half the summation of the horizontal distance between the vessel and the first sensor closest to the vessel and the horizontal distance between the vessel and the last sensor most remote from the vessel. In such design, for each sensor there exists another sensor with the same offset arranged at the mirrored side of the source.

Further, a second aspect of the present invention involves a method for acoustically exploring bottom structure of a floor below a water body, the method comprising the steps of:

a] arranging a series of N sensors equidistantly along a streamer, wherein N indicates the number of sensors;

b] arranging the streamer in the water in a slanting orientation;

c] arranging a source for generating acoustic pulses above the streamer, at a horizontal position approximately midway between the horizontal positions of the two extreme sensors;

d] towing the source and the streamer by a common vessel;

e] actuating the source to produce an acoustic pulse;

f] using an i-th sensor 4(i) positioned closer to the vessel than the source to receive a reflection signal and generate a first measurement signal S(i);

g] displacing the vessel over a distance equal to $(N+1-2i)\cdot d/2$, with d representing the horizontal distance between the sensors;

h] actuating the source to produce an acoustic pulse;

i] using the (N+1-i)th sensor 4(N+1-i) to receive a reflection signal and generate a second measurement signal S(N+1-i);

CLAIMS

1. System (300; 400) for acoustically exploring structure of a floor (20) below a water body (10), the system comprising:

a vessel (1);

at least one streamer (3) placed in the water (10) and towed by the vessel (1) and comprising a plurality of acoustic sensors (4) positioned at regular intervals along the length of the streamer, wherein the streamer (3) has a slanted orientation making an angle with the horizontal such that a sensor more remote from the vessel (1) is at a greater depth than a sensor closer to the vessel (1) and each of the sensors is at a different location in the streamer and therefore is towed at a different depth;

a source (2) for generating acoustic pulses, the source (2) being placed in the water (10) and towed by the vessel;

a tow line (5) connecting the source (2) to the vessel (1);

wherein the tow line (5) has such length that the horizontal distance between the vessel (1) and the source (2) is larger than the horizontal distance between the vessel (1) and the first sensor (4A) closest to the vessel and smaller than the horizontal distance between the vessel (1) and the last sensor (4H) most remote from the vessel.

2. System according to claim 1, wherein the tow line (5) has such length that the horizontal distance between the vessel (1) and the source (2) is substantially equal to half the summation of the horizontal distance between the vessel (1) and the first sensor (4A) closest to the vessel and the horizontal distance between the vessel (1) and the last sensor (4H) most remote from the vessel.

3. System according to claim 1 or 2, wherein the source (2) is located above the streamer (3).

4. System according to claim 3, wherein the source (2) is located at higher level than the first sensor (4A) closest to the vessel.

5. System (400) according to any of the previous claims, comprising two or more streamers arranged in parallel to each other.

6. System according to any of the previous claims, wherein the source (2) is controlled to generate sound pulses at a repetition frequency f equal to 2V/d, or at an integer multiple of this frequency, with d representing the horizontal distance between the sensors and V representing the horizontal velocity of the vessel.

7. System according to any of the previous claims, further comprising a processor (6) coupled to the sensors (4(i)) for receiving measurement signals (S(i)) from the respective sensors (4(i)), wherein the processor is adapted to combine signals S(i) and S(N+1-i) to perform de-ghosting, wherein i ranges from 1 to N while N indicates the number of sensors along the streamer.

8. Method for acoustically exploring bottom structure of a floor (20) below a water body (10), the method comprising the steps of:

a] arranging a series of N sensors (4) equidistantly along a streamer (3), wherein N indicates the number of sensors;

b] arranging the streamer (3) in the water (10) in a slanting orientation;

c] arranging a source (2) for generating acoustic pulses above the streamer (3), at a horizontal position approximately midway between the horizontal positions of the two extreme sensors (4A, 4H);

d] towing the source (2) and the streamer (3) by a common vessel (1);

e] actuating the source (2) to produce an acoustic pulse;

f] using an i-th sensor 4(i) positioned closer to the vessel than the source (2) to receive a reflection signal and generate a first measurement signal S(i);

g] displacing the vessel over a distance equal to $(N+1-2i)\cdot d/2$, with d representing the horizontal distance between the sensors;

h] actuating the source (2) to produce an acoustic pulse;

i] using the (N+1-i)th sensor 4(N+1-i) to receive a reflection signal and generate a second measurement signal S(N+1-i);

j] combining the first and second measurement signals to perform a de-ghosting operation and to provide a de-ghosted measuring signal.

9. Method for acoustically exploring bottom structure of a floor (20) below a water body (10), the method comprising the steps of:

a] arranging a series of N sensors (4) equidistantly along a streamer (3), wherein N indicates the number of sensors;

b] arranging the streamer (3) in the water (10) in a slanting orientation;

c] arranging a source (2) for generating acoustic pulses above the streamer (3), at a horizontal position approximately midway between the horizontal positions of the two extreme sensors (4A, 4H);

d] towing the source (2) and the streamer (3) by a common vessel (1);

e] actuating the source (2) to produce an acoustic pulse at a predetermined location (x);

f] using each sensor 4(i) to receive a reflection signal and generate a respective measurement signal S(i,x);

g] receiving and storing all measurement signals S(i,x) from all sensors 4(i);

h] displacing the vessel over a distance equal to d/2, with d representing the horizontal distance between the sensors;

i] repeating steps e], f], g] and h] at successive increments along the survey profile;

j] for each signal S(i, x+i-1) obtained from the i-th sensor 4(i) at a location (x+i-1), selecting the signal S(N+1-i, x+ N-i) obtained from the (N+1-i)th sensor 4(N+1-i) at location (x+ N-i) to obtain a set of N/2 pairs of matching measurement signals relating to the same reflection point;

k] for each pair in the set, comparing the matching measurement signals to perform a de-ghosting operation and to thus provide a set of de-ghosted measuring signals relating to the same common mid-points.