CLAIMS

1. A method, comprising:

accessing, by a computing system, seismic data for a geophysical formation, wherein the seismic data is recorded during a seismic survey using one or more seabed sensors based on seismic signals generated using one or more sources;

separating, by the computing system, up-going and down-going wavefields based on the seismic data;

performing separately, by the computing system, for the up-going wavefield and the down-going wavefield:

determining a seismic gather for a location in the geophysical formation using the seismic data, wherein the seismic gather includes one or more source definitions and one or more sensor definitions;

modifying the seismic gather by interchanging one or more source and sensor definitions for the seismic gather; and

imaging the location using the modified gather, wherein the imaging uses higher-order reflections recorded in the seismic gather; and

combining, by the computing system, an output of the imaging of the geophysical formation generated based on the up-going wavefield with an output of the imaging of the geophysical formation generated based on the down-going wavefield to generate an output image.

2. The method of claim 1, wherein the modifying produces data for the modified gather representing a signal transmitted from a virtual source located at a position of one of the one or more seabed sensors and received by a virtual receiver located at a position of one of the one or more sources.

3. The method of claim 1, wherein the higher-order reflections include at least one of:

a signal that is up-going when received by one of the seabed sensors, wherein the signal is reflected at the location in the geophysical formation and also reflected by an air/water interface; and

a signal that is down-going when received by one of the seabed sensors, wherein the signal is reflected at least twice by the air/water interface.

4. The method of claim 1,

wherein the imaging includes deconvolving first data with second data;

wherein the first data represents a signal initiated from a virtual source, reflected one or more times before being reflected at a first virtual receiver, reflected by the location in the geophysical formation, and arriving at a second virtual receiver;

wherein the second data represents a signal initiated from the virtual source and reflected one or more times before arriving at the first virtual receiver; and

wherein a position of the second virtual receiver corresponds to a position of one of the one or more sources and wherein a position of the virtual source corresponds to a position of one of the one or more sensors.

5. The method of claim 1,

wherein the imaging includes cross-correlating first data representing a signal received at a first virtual receiver with second data representing a signal reflected from the location and received at a second virtual receiver; and

wherein positions of the first and second virtual receivers correspond to positions of the one or more sources.

6. The method of claim 1, wherein the one or more seabed sensors include a plurality of seabed sensors, wherein each of the one or more seabed sensors is located at least 300 meters from each of the other ones of the one or more seabed sensors.

7. The method of claim 1,

wherein the seismic gather includes data for a higher-order reflection generated by one of the one or more sources at a first position and received by one of the one or more sensors at a second position;

wherein the location in the geophysical formation is at least 75 meters, in an in-line direction, from a midpoint between the first position and the second position; and

wherein the location in the geophysical formation is nearer to the first position than to the second position.

8. The method of claim 1, further comprising:

generating the seismic data for the geophysical formation by performing the seismic survey.

9. The method of claim 1, further comprising:

repeating, by the computing system, the determining, modifying, and imaging for second seismic data;

wherein the seismic data is obtained during a first time portion of a four dimensional (4D) survey of the geophysical formation and wherein the second seismic data is obtained during a second portion of the 4D survey of the geophysical formation.

10. A system, comprising:

one or more processors; and

one or more memories having program instructions stored thereon that are executable by the one or more processors to perform operations comprising:

receiving seismic data for a geophysical formation, wherein the seismic data is recorded during a seismic survey using a plurality of seabed sensors based on seismic signals generated by one or more sources;

separating up-going and down-going wavefields based on the seismic data;

performing separately for the up-going wavefield and the down-going wavefield:

determining a seismic gather for a location in the geophysical formation, wherein the seismic gather includes:

data representing a higher-order reflection of a first signal generated by a first source of the one or more sources and received by a first sensor of the plurality of seabed sensors; and

a definition for the first source and a definition for the first sensor, wherein the definitions indicate respective positions of the first source and first sensor for the first signal;

modifying the seismic gather by inverting the definition for the first source and the definition for the first sensor for the first signal; and

imaging the location using the modified gather and the data representing the higher-order reflection; and

combining an output of the imaging of the geophysical formation generated based on the up-going wavefield with an output of the imaging of the geophysical formation generated based on the down-going wavefield to generate an output image.

11. The system of claim 10, wherein the imaging includes deconvolving the first signal with a second signal.

12. The system of claim 10, wherein the plurality of seabed sensors are each located at least 300 meters from each of the other ones of the plurality of seabed sensors.

13. A non-transitory computer-readable medium having instructions stored thereon that are executable by a computing device to perform operations comprising:

receiving seismic data for a geophysical formation, wherein the seismic data is recorded during a seismic survey using a plurality of seabed sensors based on seismic signals generated by one or more sources;

separating up-going and down-going wavefields based on the seismic data;

performing separately for the up-going wavefield and the down-going wavefield:

determining a seismic gather for a location in the geophysical formation, wherein the seismic gather includes one or more source definitions and one or more sensor definitions;

modifying the seismic gather by inverting one or more source and sensor definitions for the seismic gather; and

imaging the location using the modified gather, wherein the imaging uses higher-order reflections recorded in the seismic gather; and

combining an output of the imaging of the geophysical formation generated based on the up-going wavefield with an output of the imaging of the geophysical formation generated based on the down-going wavefield to generate an output image.

14. The non-transitory computer-readable medium of claim 13, wherein the higher-order reflections include at least one of:

a signal that is up-going when received by one of the seabed sensors, wherein the signal is reflected at the location in the geophysical formation and also reflected by an air/water interface; and

a signal that is down-going when received by one of the seabed sensors, wherein the signal is reflected at least twice by the air/water interface.

15. The non-transitory computer-readable medium of claim 13,

wherein the imaging includes deconvolving first data with second data;

wherein the first data represents a signal initiated from a virtual source, reflected one or more times before being reflected at a first virtual receiver, reflected by the location in the geophysical formation, and arriving at a second virtual receiver;

wherein the second data represents a signal initiated from the virtual source and reflected one or more times before arriving at the first virtual receiver; and

wherein a position of the second virtual receiver corresponds to a position of one of the one or more sources and wherein a position of the virtual source corresponds to a position of one of the one or more sensors.

16. The non-transitory computer-readable medium of claim 13, wherein the operations further comprise:

repeating the determining, modifying, and imaging for second seismic data;

wherein the seismic data is obtained during a first time portion of a four dimensional (4D) survey of the geophysical formation and wherein the second seismic data is obtained during a second portion of the 4D survey of the geophysical formation.