reservoir within the subsurface region may change. As such, it may be useful to determine how the image or map of the subsurface region changes over time, such that the operations related to extracting the hydrocarbons may be modified to more efficiently extract the hydrocarbons from the subsurface region of the Earth.

SUMMARY

[0007] A summary of certain embodiments disclosed herein is set forth below. It should be understood that these aspects are presented merely to provide the reader with a brief summary of these certain embodiments and that these aspects are not intended to limit the scope of this disclosure. Indeed, this disclosure may encompass a variety of aspects that may not be set forth below.

[0007a] According to a first aspect of the present disclosure, there is provided a method of seismic exploration above a region of subsurface containing structural or stratigraphic features conducive to determining a presence, migration, or accumulation of hydrocarbons, the method including: accessing at least a portion of a blended seismic source survey, wherein the blended seismic source survey corresponds to at least two interfering seismic source excitation groups therein, and wherein the seismic source excitations are produced by at least two seismic source groups having different signatures or frequency characteristics; separating the at least two interfering seismic source excitation groups using a deblending operation, wherein the deblending operation is performed based at least in part on an iterative interpolation and deblending operation: predicting at least a portion of weak-coherence signals caused by the at least two interfering seismic source excitation groups based on a portion of the blended seismic source survey in which the least two interfering seismic source excitation groups overlap above threshold amount; and producing at least two source gather groups based on the separating and the predicted portion of weak-coherence signals to be used in exploration for hydrocarbons within the region of the subsurface.

[0007b] According to a second aspect of the present disclosure, there is provided a tangible, non-transitory, machine-readable media, including instructions configured to cause a processor to: access at least a portion of a blended seismic source survey, wherein the blended source seismic survey corresponds to at least two interfering seismic source excitation groups, wherein the seismic source excitations are produced by at least two seismic source groups including a first source group and a second

source group; separate the at least two interfering seismic source excitation groups based at least in part on an iterative interpolation and deblending operation: predict at least a portion of weak-coherence signals caused by the at least two interfering seismic source excitation groups based on a portion of the blended seismic source survey in which the least two interfering seismic source excitation groups overlap above threshold amount; produce at least two separate source gather groups based at least in part on the iterative interpolation and deblending operation and the predicted portion of weak-coherence signals, wherein the at least two separate source gather groups are respectively associated with the data sets that are non-overlapping or overlapping within the same source excitation group; and transmit the at least two separate source gathers for use in generating a seismic image, wherein the seismic image represents hydrocarbons in a subsurface region of Earth or subsurface drilling hazards.

[0007c] According to a third aspect of the present disclosure, there is provided a device, including: a memory storing instructions; and a processor coupled to the memory and configured to execute the instructions, which cause the processor to: access at least a portion of a blended seismic source survey, wherein the blended source seismic survey corresponds to at least two interfering seismic source excitation groups, wherein the seismic source excitations are produced by at least two seismic source groups including a first source group and a second source group; separate the at least two interfering seismic source excitation groups based at least in part on an iterative interpolation and deblending operation, wherein the deblending operation is performed based at least in part on an iterative interpolation and deblending operation; predict at least a portion of weak-coherence signals caused by the at least two interfering seismic source excitation groups based on a portion of the blended seismic source survey in which the least two interfering seismic source excitation groups overlap above threshold amount; produce at least two source gather groups based on the iterative interpolation and deblending operation and the predicted portion of weak-coherence signals, wherein the at least two source gather groups are respectively associated with the data sets that are non-overlapping or overlapping within the same source excitation group; and transmit the at least two source gathers for use in generating a seismic image, wherein the seismic image represents hydrocarbons in a subsurface region of Earth or subsurface drilling hazards.

[0008] Seismic acquisition utilizing sources and receivers may be useful in the generation of, for example, seismic images. Seismic images may be used, for example, in the determination of hydrocarbon deposits (e.g., areas within a subsurface that contain hydrocarbons) and/or subsurface drilling hazards. Seismic images are generally produced using seismic waveforms produced by a source, reflected off regions within a subsurface, and received by one or more receivers. The seismic image may be constructed using a high resolution seismic velocity model, such as full waveform inversion (FWI) model, a tomography model, or the like applied, for example, via a velocity model builder. The seismic velocity model may include data indicative of a change in velocity of the seismic waveforms during propagation through the subsurface region. The source that produces the seismic waveforms may be an active source (e.g., anthropogenic sources of seismic waves such as explosives or airguns), or a passive source (e.g., non-anthropogenic such as waves or wind). Certain techniques employ active sources due to the resulting high signal-to-noise ratio (SNR) of the seismic waveforms. Passive sources may complement active source seismic surveys. For example, passive sources may assist in the generation of velocity models of a near surface region (e.g., less than approximately 500 meters (m) below the surface of the Earth and/or a seafloor).

[0009] In addition to the examples provided above, image and/or data registration techniques may be used for various applications in seismic data processing, as described herein. For example, the systems and methods described below may be used for signal recovery associated with returned signals received during simultaneous source data acquisition. To elaborate, sometimes simultaneous sources

CLAIMS

What is claimed is:

1. A method of seismic exploration above a region of subsurface containing structural or stratigraphic features conducive to determining a presence, migration, or accumulation of hydrocarbons, the method comprising:

accessing at least a portion of a blended seismic source survey, wherein the blended seismic source survey corresponds to at least two interfering seismic source excitation groups therein, and wherein the seismic source excitations are produced by at least two seismic source groups having different signatures or frequency characteristics;

separating the at least two interfering seismic source excitation groups using a deblending operation, wherein the deblending operation is performed based at least in part on an iterative interpolation and deblending operation;

predicting at least a portion of weak-coherence signals caused by the at least two interfering seismic source excitation groups based on a portion of the blended seismic source survey in which the least two interfering seismic source excitation groups overlap above threshold amount; and

producing at least two source gather groups based on the separating and the predicted portion of weak-coherence signals to be used in exploration for hydrocarbons within the region of the subsurface.

2. The method of claim 1, wherein separating the at least two interfering seismic source excitations comprises:

selecting a first coherency constraint for a first seismic source group of the at least two seismic source groups;

selecting a second coherency constraint for a second seismic source group of the at least two seismic sources, wherein the second coherency constraint is different from the first coherency constraint; and

applying the first coherency constraint and the second coherency constraint during the deblending operation to the portion of the blended seismic source survey, wherein

producing the at least two source gather groups is based at least in part on applying the first coherency constraint and the second coherency constraint.

3. The method of claim 2, wherein the threshold amount corresponds to an amount of overlap which permits at least the first coherency constraint and the iterative interpolation and deblending operation to be used to separate at least a portion of data for the first seismic source group from at least an additional portion of data for the second seismic source group.

4. The method of claim 1, wherein the iterative interpolation and deblending operation comprises:

indicating at least one weak-coherence portion of a trace associated with the blended seismic source survey;

removing from the trace the at least one weak-coherence portion of the trace; and

predicting a value for the at least one weak-coherence portion of the trace based at least in part on at least one coherent portion of the trace.

5. The method of claim 4, wherein the at least one weak-coherence portion of the trace is indicated via null-defining symbol, character, or value stored within a mask.

6. The method of claim 4, wherein predicting the value for the at least one weak-coherence portion of the trace comprises referencing at least two data set portions logically disposed adjacent to the at least one weak-coherence portion.

7. The method of claim 1, wherein the iterative interpolation and deblending operation comprises applying interpolation operations to:

predict signals in a uniform grid; and

reconstruct signals back to an original non-uniform grid based on the predicted signals in the uniform grid, when the signals are acquired in the non-uniform grid.

8. The method of claim 1, wherein the at least two source gathers respectively comprise seismic data representative of a different frequency range and at least some predicted data corresponding to the weak-coherence signals generated based at least in part on the iterative interpolation and deblending operation.

9. The method of claim 1, wherein the iterative interpolation and deblending operation comprises:

determining at least one weak-coherence portion of a trace associated with the blended seismic source survey;

generating a mask to logically indicate a location of the at least one weak-coherence portion of the trace within a data set corresponding to the trace;

removing the at least one weak-coherence portion of the trace from the data set corresponding to the trace; and

combining at least one predicted value for the at least one weak-coherence portion of the trace based at least in part on at least one coherent portion of the trace.

10. The method of claim 9, wherein removing from the at least one weak-coherence portion of the trace from the data set comprises applying the mask to the data set to zero-out the at least one weak-coherence portion of the trace from the data set.

11. The method of claim 1, wherein the at least two seismic source groups comprise a combination of: vibrational sources, airgun sources, sparker sources, and low-frequency sources.

12. A tangible, non-transitory, machine-readable media, comprising instructions configured to cause a processor to:

access at least a portion of a blended seismic source survey, wherein the blended source seismic survey corresponds to at least two interfering seismic source excitation groups, wherein the seismic source excitations are produced by at least two seismic source groups comprising a first source group and a second source group;

separate the at least two interfering seismic source excitation groups based at least in part on an iterative interpolation and deblending operation;

predict at least a portion of weak-coherence signals caused by the at least two interfering seismic source excitation groups based on a portion of the blended seismic source survey in which the least two interfering seismic source excitation groups overlap above threshold amount;

produce at least two separate source gather groups based at least in part on the iterative interpolation and deblending operation and the predicted portion of weak-coherence signals, wherein the at least two separate source gather groups are respectively associated with the data sets that are non-overlapping or overlapping within the same source excitation group; and

transmit the at least two separate source gathers for use in generating a seismic image, wherein the seismic image represents hydrocarbons in a subsurface region of Earth or subsurface drilling hazards.

13. The tangible, non-transitory, machine-readable media of claim 12, wherein the at least two seismic sources each respectively transmit seismic source excitations comprising different signatures or frequency characteristics, and wherein the at least two seismic sources comprise a combination of one or more of: vibrational sources, airgun sources, sparker sources, or low-frequency sources, or any combination thereof.

14. The tangible, non-transitory, machine-readable media of claim 12, wherein the instructions for separating the at least two interfering seismic source excitation groups based at least in part on the iterative interpolation and deblending operation comprise instructions configured to cause the processor to:

determine at least one weak-coherence portion of a trace associated with the blended seismic source survey;

generate a mask to logically indicate a location of the at least one weak-coherence portion of the trace within a data set corresponding to the trace;

remove the at least one weak-coherence portion of the trace from the data set corresponding to the trace; and

combine at least one predicted value for the at least one weak-coherence portion of the trace based at least in part on at least one coherent portion of the trace.

15. The tangible, non-transitory, machine-readable media of claim 14, wherein the instructions for removing the at least one weak-coherence portion of the trace from the data set comprise instructions configured to cause the processor to:

zero-out the at least one weak-coherence portion of the trace from the data set at least in part by applying the mask to the data set.

16. The tangible, non-transitory, machine-readable media of claim 12, wherein the instructions for separating the at least two interfering seismic source excitation groups based at least in part on the iterative interpolation and deblending operation comprise instructions configured to cause the processor to:

indicate at least one weak-coherence portion of a trace in a data set associated with the blended seismic source survey;

remove from the data set the at least one weak-coherence portion of the trace;

predicting a value for the at least one weak-coherence portion of the trace based at least in part on the iterative interpolation and deblending operation being performed on the remaining portions of the trace in the data set; and

combining the remaining portions of the trace in the data set with the predicted value of the at least one weak-coherence portion in a separate source gather corresponding to the first source group.

17. The tangible, non-transitory, machine-readable media of claim 16, wherein the at least one weak-coherence portion of the trace corresponds to a time at which seismic source excitations of the first source group interfered with seismic source excitations of the second source group.

18. The tangible, non-transitory, machine-readable media of claim 16, wherein transmitting the at least two source gather groups comprising transmitting the separate

source gather despite an initial presence of the at least one weak-coherence portion of the trace.

19. A device, comprising:

a memory storing instructions; and

a processor coupled to the memory and configured to execute the instructions, which cause the processor to:

access at least a portion of a blended seismic source survey, wherein the blended source seismic survey corresponds to at least two interfering seismic source excitation groups, wherein the seismic source excitations are produced by at least two seismic source groups comprising a first source group and a second source group;

separate the at least two interfering seismic source excitation groups based at least in part on an iterative interpolation and deblending operation, wherein the deblending operation is performed based at least in part on an iterative interpolation and deblending operation;

predict at least a portion of weak-coherence signals caused by the at least two interfering seismic source excitation groups based on a portion of the blended seismic source survey in which the least two interfering seismic source excitation groups overlap above threshold amount;

produce at least two source gather groups based on the iterative interpolation and deblending operation and the predicted portion of weak-coherence signals, wherein the at least two source gather groups are respectively associated with the data sets that are non-overlapping or overlapping within the same source excitation group; and

transmit the at least two source gathers for use in generating a seismic image, wherein the seismic image represents hydrocarbons in a subsurface region of Earth or subsurface drilling hazards.

20. The device of claim 19, wherein the processor is configured to perform the separation of the at least two interfering seismic source excitation groups based at least in part on iterative processes that configured to be repeated until an end condition is met.

21. The device of claim 19, wherein the processor is configured to perform the separation at least in part by:

determining at least one weak-coherence portion of a trace associated with the blended seismic source survey;

generating a mask to logically indicate a location of the at least one weak-coherence portion of the trace within a data set corresponding to the trace;

removing the at least one weak-coherence portion of the trace from the data set corresponding to the trace by applying the mask to the data set; and

combining at least one predicted value for the at least one weak-coherence portion of the trace based at least in part on at least one coherent portion of the trace.