Claims

1. A method of geophysical data acquisition and processing, the method comprising:

measuring seismic traces using a seismic source and an array of sensors to perform a seismic survey;

determining, for each grid point on the processing grid, a desired trace on a surface which corresponds to the array of sensors;

finding, for each grid point on a processing grid, best-fitting traces of the seismic traces, wherein finding the best-fitting traces comprises minimizing a weighted sum of differences that includes differences in common mid-point distances between the best-fitting traces and the desired traces;

computing spectral amplitudes of down-going and up-going wavefields using the best-fitting traces;

transforming the down-going and up-going wavefields to an output grid in a space-time domain; and

processing said wavefields transformed to the output grid to infer structures of earth formations below locations at which the seismic survey is performed.

2. The method of claim 1, wherein the array of sensors is towed during the acquisition.

3. The method of claim 1, wherein the sensors are multi-component sensors that measure both pressure and particle velocities.

4. The method of claim 1, wherein the common mid point distances are in the in-line and cross-line directions.

5. The method of claim 4, wherein the weighted sum of differences further includes a difference in offsets between the best-fitting traces and the desired traces.

6. The method of claim 1 further comprising: applying differential move-outs to the best-fitting traces to obtain offset-corrected traces.

7. The method of claim 6 further comprising: applying dip-based correction to the offset-corrected traces to obtain azimuth-corrected traces.

8. An apparatus for acquisition and processing of geophysical data, the apparatus comprising:

a seismic source for imparting seismic energy into subterranean material formations;

an array of sensors for generating signals in response to the seismic energy;

a recording system for recording the signals generated by the array of sensors; and

a computer apparatus comprising:

memory configured to store processor-executable code and data;

a processor configured to execute the computer-readable code so as to modify the data;

computer-readable code for obtaining measured traces, the measured traces including traces measured using the seismic source and the array of sensors and recorded using the recording system;

computer-readable code for determining, for each grid point on a processing grid, a desired trace on a surface which corresponds to the array of sensors;

computer-readable code for finding, for each grid point on the processing grid, best-fitting traces of the measured traces;

computer-readable code for computing spectral amplitudes of down-going and up-going wavefields using the best-fitting traces, wherein finding the best-fitting traces comprises minimizing a weighted sum of differences that

includes differences in common mid-point distances between the best-fitting traces and the desired traces; and

computer-readable code for transforming the down-going and up-going wavefields to an output grid in a space-time domain.

9. The apparatus of claim 8, wherein the array of sensors comprise multi-component sensors that measure pressure and particle velocities.

10. The apparatus of claim 8, wherein the common mid point distances are in the in-line and cross-line directions.

11. The apparatus of claim 10, wherein the weighted sum of differences further includes a difference in offsets.

12. The apparatus of claim 8 further comprising: computer-readable code for applying differential move-outs to the best-fitting traces to obtain offset-corrected traces.

13. The apparatus of claim 12 further comprising: computer-readable code for applying dip-based correction to the offset-corrected traces to obtain azimuth-corrected traces.

14. A method of generating a geophysical data product, the method comprising:

obtaining seismic traces measured using a seismic source and an array of sensors;

determining, for each grid point on a processing grid, a desired trace on a surface which corresponds to the plurality of sensors;

finding, for each grid point on the processing grid, best-fitting traces of the seismic traces, wherein finding the best-fitting traces comprises minimizing a weighted

sum of differences that includes differences in common mid-point distances between the best-fitting traces and the desired traces;

computing spectral amplitudes of down-going and up-going wavefields using the best-fitting traces;

transforming the down-going and up-going wavefields to an output grid in a space-time domain; and

storing said wavefields transformed to the putput grid in the geophysical data product for use in determining subsurface rock formation structures.

15. The method of claim 14, wherein the common mid point distances are in the in-line and cross-line directions.

16. The method of claim 15, wherein the weighted sum of differences further includes a difference in offsets.

Claims

What is claimed is:

1. A method of wavefield regularization for geophysical data acquisition, the method comprising:

obtaining measured traces, the measured traces including traces measured from an array of sensors;

finding, for each grid point on a processing grid, best-fitting traces of the measured traces;

computing spectral amplitudes of down-going and up-going wavefields using the best-fitting traces; and

transforming the down-going and up-going wavefields to an output grid in a space-time domain.

2. The method of claim 1, wherein the array of sensors is towed during the acquisition.

3. The method of claim 1, wherein the sensors are multi-component sensors that measure both pressure and particle velocities.

4. The method of claim 1 further comprising:

determining, for each grid point on the processing grid, a desired trace on a surface which corresponds to the array of sensors.

5. The method of claim 4, wherein finding the best-fitting traces comprises minimizing a weighted sum of differences between parameters for the best-fitting traces and the desired traces.

6. The method of claim 5, wherein the weighted sum of differences includes differences in common mid-point distances in the in-line and cross-line directions and a difference in offsets.

7. The method of claim 1 further comprising:

applying differential move-outs to the best-fitting traces to obtain offset-corrected traces.

8. The method of claim 7 further comprising:

applying dip-based correction to the offset-corrected traces to obtain azimuth-corrected traces.

9. An apparatus for wavefield regularization of geophysical data, the apparatus comprising:

memory configured to store processor-executable code and data;

a processor configured to execute the computer-readable code so as to modify the data;

computer-readable code for obtaining measured traces, the measured traces including traces measured from an array of sensors;

computer-readable code for finding, for each grid point on a processing grid, best-fitting traces of the measured traces from the arrays of sensors;

computer-readable code for computing spectral amplitudes of down-going and up-going wavefields using the best-fitting traces; and

computer-readable code for transforming the down-going and up-going wavefields to an output grid in a space-time domain.

10. The apparatus of claim 9, wherein the array of sensors comprise multi-component sensors that measure pressure and particle velocities.

11. The apparatus of claim 9 further comprising:

computer-readable code for determining, for each grid point on the processing grid, a desired trace on a surface which corresponds to the array of sensors.

12. The apparatus of claim 11, wherein finding the best-fitting traces comprises minimizing a weighted sum of differences between parameters for the best-fitting traces and the desired traces.

13. The apparatus of claim 12, wherein the weighted sum of differences includes differences in common mid-point distances in the in-line and cross-line directions and a difference in offsets.

14. The apparatus of claim 9 further comprising:

computer-readable code for applying differential move-outs to the best-fitting traces to obtain offset-corrected traces.

15. The apparatus of claim 14 further comprising:

computer-readable code for applying dip-based correction to the offset-corrected traces to obtain azimuth-corrected traces.

16. At least one tangible computer-readable storage medium with non-volatile executable code stored thereon which, when executed by one or more processors, performs steps comprising:

obtaining measured traces, the measured traces including traces measured from an array of sensors;

finding, for each grid point on a processing grid, best-fitting traces of the measured traces;

computing spectral amplitudes of down-going and up-going wavefields using the best-fitting traces; and

transforming the down-going and up-going wavefields to an output grid in a space-time domain.

17. The storage medium of claim 16, wherein the code stored thereon performs further steps comprising:

determining, for each grid point on the processing grid, a desired trace on a surface which corresponds to the array of sensors.

18. The storage medium of claim 17, wherein finding the best-fitting traces comprises minimizing a weighted sum of differences between parameters for the best-fitting traces and the desired traces.

19. The storage medium of claim 18, wherein the weighted sum of differences includes differences in common mid-point distances in the in-line and cross-line directions and a difference in offsets.

20. The storage medium of claim 16, wherein the code stored thereon performs further steps comprising:

applying differential move-outs to the best-fitting traces to obtain offset-corrected traces.

21. The storage medium of claim 17, wherein the code stored thereon performs further steps comprising:

applying dip-based correction to the offset-corrected traces to obtain azimuth-corrected traces.

22. A method of generating a geophysical data product, the method comprising:

obtaining measured traces, the measured traces including traces measured from an array of sensors;

finding, for each grid point on a processing grid, best-fitting traces of the measured traces;

computing spectral amplitudes of down-going and up-going wavefields using the best-fitting traces; and

transforming the down-going and up-going wavefields to an output grid in a space-time domain.

23. The method of claim 22 further comprising:

determining, for each grid point on the processing grid, a desired trace on a surface which corresponds to the array of sensors.

24. The method of claim 23, wherein finding the best-fitting traces comprises minimizing a weighted sum of differences between parameters for the best-fitting traces and the desired traces.

25. The method of claim 24, wherein the weighted sum of differences includes differences in common mid-point distances in the in-line and cross-line directions and a difference in offsets.