CLAIMS

1. A method for generating a high-resolution pseudo-reflectivity image of a subsurface region, the method comprising:

(a) receiving seismic data associated with a subsurface region and captured by one or more seismic receivers;

(b) constructing a velocity model of the subsurface region based on the received seismic data;

(c) performing a seismic migration of the received seismic data based on the constructed velocity model to obtain migrated seismic data;

(d) computing normal vectors associated with one or more subsurface reflectors of the subsurface region based on the migrated seismic data;

(e) computing a velocity gradient associated with the subsurface region based on the constructed velocity model; and

(f) generating a pseudo-reflectivity image of the subsurface region based on both the computed normal vectors and the computed velocity gradient.

2. The method of claim 1, wherein the migrated seismic data comprises a migration stack image of the subsurface region.

3. The method of claim 2, wherein the migration stack image comprises a Kirchhoff migration stack image.

4. The method of claim 2, wherein the migration stack image comprises a Reverse-Time-Migration (RTM) image.

5. The method of claim 1, wherein the normal vectors each extend orthogonally with respect to one of the one or more subsurface reflectors.

6. The method of claim 1, wherein the normal vectors comprise polarized normal vectors each having computed polarity.

7. The method of claim 1, wherein (f) comprises combining the computed velocity gradient with the computed normal vectors.

8. The method of claim 1, wherein:

the seismic migration is performed at a first frequency to obtain a migration stack image, and wherein the first frequency corresponds to a maximum frequency of the migration stack image; and

the pseudo-reflectivity image is generated at the first frequency, the first frequency corresponding to a maximum frequency of the pseudo-reflectivity image.

9. A method for generating a high-resolution pseudo-reflectivity image of a subsurface region, the method comprising:

(a) receiving seismic data associated with a subsurface region and captured by one or more seismic receivers;

(b) constructing a velocity model of the subsurface region based on the received seismic data;

(c) performing a seismic migration of the received seismic data based on the constructed velocity model to obtain migrated seismic data;

(d) computing polarized normal vectors associated with one or more subsurface reflectors of the subsurface region based on the migrated seismic data; and

(e) generating a pseudo-reflectivity image of the subsurface region based on both the computed polarized normal vectors.

10. The method of claim 9, wherein at least some of the polarized normal vectors have a negative polarity corresponding to local troughs in the migrated seismic data and at least some of the polarized normal vectors have a positive polarity corresponding to local peaks in the migrated seismic data.

11. The method of claim 9, wherein (e) comprises:

(e1) computing a velocity gradient associated with the subsurface region based on the constructed velocity model; and

(e2) combining the computed velocity gradient with the computed polarized normal vectors.

12. The method of claim11, wherein combining the computed velocity gradient with the computed polarized normal vectors comprises taking the dot product of the computed velocity gradient and the computed polarized normal vectors.

13. The method of claim 9, wherein (b) comprises applying a Full Waveform Inversion (FWI) process on the received seismic data.

14. The method of claim 9, wherein the migrated seismic data comprises a migration stack image of the subsurface region.

15. The method of claim 9, further comprising:

(f) computing a velocity gradient associated with the subsurface region based on the constructed velocity model.

16. The method of claim 9, wherein:

the seismic migration is performed at a first frequency to obtain a migration stack image, and wherein the first frequency corresponds to a maximum frequency of the migration stack image; and

the pseudo-reflectivity image is generated at the first frequency, the first frequency corresponding to a maximum frequency of the pseudo-reflectivity image.

17. A system for generating a high-resolution pseudo-reflectivity image of a subsurface region, the system comprising:

a processor;

a non-transitory memory; and

an application stored in the non-transitory memory that, when executed by the processor:

receives seismic data associated with a subsurface region and captured by one or more seismic receivers;

constructs a velocity model of the subsurface region based on the received seismic data;

performs a seismic migration of the received seismic data based on the constructed velocity model to obtain migrated seismic data;

computes polarized normal vectors associated with one or more subsurface reflectors of the subsurface region based on the migrated seismic data;

computes a velocity gradient associated with the subsurface region based on the constructed velocity model; and

generates a pseudo-reflectivity image of the subsurface region based on both the computed polarized normal vectors and the computed velocity gradient.

18. The system of claim 17, wherein:

the seismic migration is performed at a first frequency to obtain a migration stack image, and wherein the first frequency corresponds to a maximum frequency of the migration stack image; and

the pseudo-reflectivity image is generated at the first frequency, the first frequency corresponding to a maximum frequency of the pseudo-reflectivity image.

19. The system of claim 17, wherein the normal vectors each extend orthogonally with respect to one of the one or more subsurface reflectors.

20. The system of claim 17, wherein the normal vectors comprise polarized normal vectors each having computed polarity.

21. The system of claim 17, wherein the application, when executed by the processor:

combines the computed velocity gradient with the computed normal vectors to generate the pseudo-reflectivity image.