

CLAIMS

1. A computer-implemented method for inversion of seismic data to infer subsurface physical property parameters including P-wave velocity, S-wave velocity, and density, comprising extracting only PP mode from the seismic data, and inverting the PP mode data sequentially in two or more different offset ranges, each offset range inversion determining at least one physical property parameter, wherein in a second and subsequent inversions, parameters determined in a previous inversion are held fixed.
2. The method of claim 1, wherein a near offset range is sequentially first to be inverted, and said first inversion infers P-wave acoustic impedance I_P , using a computer programmed with an acoustic inversion algorithm.
3. The method of claim 2, wherein a mid-offset range is sequentially second to be inverted, and said second inversion infers S-wave acoustic impedance I_S , or P-wave velocity V_P divided by S-wave velocity V_S , with I_P fixed at its value from the first inversion, said second inversion using an elastic inversion algorithm.
4. The method of claim 3, wherein a far-offset range is sequentially third to be inverted and said third inversion infers density or V_P , using an elastic inversion algorithm, with I_P fixed at its value from the first inversion and V_P/V_S fixed at a value determined from the second inversion.
5. The method of claim 4, wherein V_P and V_S are computed from I_P and I_S using definition of acoustic impedance, and using density as inferred in the third inversion.
6. The method of claim 4, wherein V_P is inferred in the third inversion, and density is computed from the relationship $I_P = \rho V_P$ and I_P is as determined in the first inversion.
7. The method of claim 4, wherein one or both of the relationships $I_P = \rho V_P$ and $I_P = \rho V_P$ are used in performing the method.
8. The method of claim 4, further comprising repeating the sequential inversions at least one time to update the inferred physical property parameters.

9. The method of claim 4, wherein the acoustic and elastic inversion algorithms are full waveform inversion algorithms.

5 10. A computer-implemented method for inversion of seismic data to infer at least P-wave velocity, S-wave velocity, and density, comprising:

(a) taking only PP-mode data from the seismic data, and dividing the seismic data into a near-offset range, a mid-offset range, and a far offset range, which ranges may or may not overlap;

10 (b) inverting the near offset range for P-wave acoustic impedance I_P , using a computer programmed with an acoustic inversion algorithm;

(c) inverting the mid-offset range for S-wave acoustic impedance I_S , or for P-wave velocity V_P divided by S-wave velocity V_S , with I_P fixed at its value from (b), using an elastic inversion algorithm;

15 (d) inverting the far-offset range for density, using an elastic inversion algorithm, with I_P fixed at its value from (b) and V_P/V_S fixed at a value determined from the value of I_S from (c); and

(e) computing V_P and V_S from I_P and I_S using definition of acoustic impedance and density as determined in (d).

20

CLAIMS

1. A computer-implemented method for full waveform inversion of seismic data to infer subsurface physical property parameters including P-wave velocity, S-wave velocity, and density, comprising extracting only PP mode from the seismic data, and inverting, with a full waveform inversion algorithm, the PP mode data sequentially in two or more different offset ranges, each offset range full waveform inversion determining at least one physical property parameter, wherein in a second and subsequent full waveform inversions, parameters determined in a previous full waveform inversion are held fixed, and wherein all full waveform inversions are performed using a computer.
2. The method of claim 1, wherein a near offset range is sequentially first to be inverted, and said first full waveform inversion infers P-wave acoustic impedance I_P , using a computer programmed with an acoustic full waveform inversion algorithm.
3. The method of claim 2, wherein a mid-offset range is sequentially second to be inverted, and said second full waveform inversion infers S-wave acoustic impedance I_S , or P-wave velocity V_P divided by S-wave velocity V_S , with I_P fixed at its value from the first full waveform inversion, said second full waveform inversion using an elastic full waveform inversion algorithm.
4. The method of claim 3, wherein a far-offset range is sequentially third to be inverted and said third full waveform inversion infers density or V_P , using the elastic full waveform inversion algorithm, with I_P fixed at its value from the first full waveform inversion and V_P/V_S fixed at a value determined from the second full waveform inversion.
5. The method of claim 4, wherein V_P and V_S are computed from I_P and I_S using definition of acoustic impedance, and using density as inferred in the third full waveform inversion.
6. The method of claim 4, wherein V_P is inferred in the third full waveform inversion, and density is computed from the relationship $I_P = \rho V_P$ and I_P is as determined in the first full waveform inversion.

7. The method of claim 4, wherein one or both of the relationships $I_P = \rho V_P$ and $I_S = \rho V_S$ are used in performing the method.
8. The method of claim 4, further comprising repeating the sequential full wavefield inversions at least one time to update the inferred physical property parameters.
9. The method of claim 1, wherein at least some of the two or more different offset ranges overlap.
10. The method of claim 1, wherein the two or more different offset ranges do not overlap.