CLAIMS

What is claimed is:

1. A method for performing azimuthal simultaneous elastic inversion of seismic data of a subterranean formation comprising:

determining a HTI stiffness matrix from seismic data, using parameterization means, for at least one azimuth and at least one angle of incidence from said seismic data, wherein the HTI stiffness matrix varies spatially with respect to one or more layers;

applying a Bond transformation to the HTI stiffness matrix to rotate ~~the~~ an isotropy symmetry plane such that it is referenced with respect to true North; and

calculating a reflectivity series for the at least one azimuth and angle of incidence using one or more reflection coefficients, wherein anisotropy media is incorporated.

2. The method of claim 1 wherein the parameterization is performed with a method selected from the group consisting of the linear slip deformation theory, the Hudson's penny-shaped crack theory, and Thomsen parameters.

3. The method of claim 1 wherein the one or more reflection coefficients is calculated using a linearized Zoeppritz equation, where the HTI stiffness matrix is expressed in terms of weak anisotropy parameters.

4. The method of claim 1 further comprising:

convolving a wavelet and the reflectivity series for the at least one azimuth and at least one angle of incidence to obtain one or more synthetic seismic traces for the at least one azimuth and at least one angle of incidence.

5. The method of claim 4 further comprising:

estimating elastic parameters by inverting the synthetic seismic traces.

6. The method of claim 1 wherein the inversion involves iteratively perturbation of an initial model containing the parameters P-wave velocity, Vp, S-wave velocity, Vs, and density, ρ.

7. The method of claim 6 where in the initial model further contains anisotropic parameters.

8. The method of claim 6 wherein the parameters are perturbed independently.

9. The method of claim 6 wherein the perturbation of the parameters is based on a defined relationship.

10. The method of claim 9 wherein the defined relationship is an empirical relationship linking two parameters.

11. The method of claim 10 wherein the empirical relationship is the Gardner's relationship linking the P-wave velocity, Vp and density, ρ.

12. The method of claim 6 further comprising perturbing ~~the~~ time-thickness of the microlayers so as to reduce ~~the~~ data misfit and enhance lateral coherence.

13. The method of claim 6 wherein the inversion uses simulated annealing to find a global solution which minimizes an objective function.

14. The method of claim 13 wherein the objective function contains a data misfit and a regularization term.

15. The method of claim 14 wherein the regularization term includes a three dimensional spatial continuity constraint to help attenuate the effects of random noise.

16. The method of claim 15 wherein ~~the~~ iteration is performed on all azimuthal-incidence angle stacks simultaneously such that data misfit is minimized and ~~avoid~~ penalties are avoided in the regularization term.

17. A method for performing azimuthal simultaneous elastic inversion comprising:

determining a reflectivity series for at least one seismic trace of seismic data obtained for a subterranean formation, wherein the reflectivity series includes anisotropy properties of said formation;

obtaining one or more synthetic seismic traces by convolving the reflectivity series with a source wavelet; and

inverting the one or more synthetic seismic traces to obtain elastic parameters estimates.

18. The method of claim 17 wherein said reflectivity series comprises Fourier coefficients characterizing azimuthal reflectivity at ~~a~~ an angle of incidence θ, wherein said reflectivity is determined at least by

$$R(\phi,\theta)=\frac{u_o}{2}+\sum_{n=1}^{N}\left(u_n(\theta)\cos(n\phi)+v_n(\theta)\sin(n\phi)\right)$$; and

wherein ϕ is an azimuth.

19. The method of claim 17 wherein said inverting step comprises constructing one or more misfit weighting functions that decouple fracture parameter estimation from density, P-wave background velocity estimation, and S-wave background velocity estimation.