

CLAIMS

1. A computer-implemented method for determining rock and fluid parameters of a subsurface region from measured geophysical data, said method comprising:

generating, with a computer, a geophysical data volume by combining a plurality of
5 angle stacks obtained from the measured geophysical data and geophysical property data
obtained from a full wavefield or tomographic inversion of the measured geophysical data;

for each point of the geophysical data volume, determining, with a computer, a
petrophysical model that is a probability of a rock state based on initial values of the rock and
fluid parameters and the geophysical data volume;

10 iteratively determining, using a computer, updated values for the rock and fluid
parameters, wherein the iteratively determining includes determining a petrophysical
parameter estimate for the rock and fluid parameters from the petrophysical model as
constrained by the geophysical data volume and the initial values of the rock and fluid
parameters, minimizing a misfit between the geophysical data volume and synthetic data
15 generated from a forward modeling of the initial values of the rock and fluid parameters using
a cost function that includes the petrophysical parameter estimate of the rock and fluid
parameters, and repeating the iteratively determining until a predetermined stopping criteria is
satisfied and final values for the rock and fluid parameters are generated, and each subsequent
iteration of the iteratively determining replaces the initial values for the rock and fluid
20 parameters with the updated values for the rock and fluid parameters from a previous iteration;

determining, with a computer, uncertainty in the final values for the rock and fluid
parameters; and

exploring for or producing hydrocarbons using the final values for the rock and fluid
parameters and there uncertainty.

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2. The method of claim 1, wherein the rock and fluid parameters are porosity and V_{shale} .
3. The method of claim 1, wherein the geophysical property data obtained from the full
wavefield or tomographic inversion provides for a low frequency component of the rock and
30 fluid parameters that is lower in frequency than the angle stacks.

4. The method of claim 3, wherein each iteration of the iteratively determining learns the low frequency component by re-computing the petrophysical parameter estimate using the updated values for the rock and fluid parameters from the previous iteration.
- 5 5. The method of claim 1, wherein the determining the petrophysical model uses a Forward-Backward method.
6. The method of claim 5, wherein the Forward-Backward method includes a hidden Markov chain that is used in the determining of the petrophysical model.
- 10 7. The method of claim 1, wherein the determining the petrophysical model includes evaluating multiple scenarios that correspond to model structure differences due to geologic and geophysical variations.
- 15 8. The method of claim 1, wherein the forward modeling of the initial values of the rock and fluid parameters includes using a forwarded physics operator that is based on a rock physics model that links petrophysical properties to geophysical properties.
- 20 9. The method of claim 2, wherein the exploring for or producing hydrocarbons includes causing a well to be drilled based on the final values for the porosity and Vshale and their uncertainty.
10. The method of claim 1, wherein the geophysical data volume can have variable frequency data content with or without overlap.
- 25 11. The method of claim 1, wherein the geophysical property data is velocity, impedance, or density.
12. The method of claim 1, wherein the measured geophysical data is seismic data.

13. The method of claim 1, wherein the inversion is full wavefield inversion.
14. The method of claim 1, wherein the inversion is tomographic inversion.
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15. The method of claim 1, wherein the geophysical property data is resistivity and the measured geophysical data is controlled source electromagnetic data.
16. The method of claim 1, wherein the geophysical property data is density and the
- 10 measured geophysical data is gravity data.