Claims

1. A high-angle fracture prediction method, comprising the following steps of:

performing a log measurement to acquire logging data of a target region;

acquiring wide azimuth seismic data of the target region according to the logging data;

performing a first azimuthal anisotropy inversion on the wide azimuth seismic data of ~~a~~ the target region based on a constructed isotropic low-frequency model, to acquire a first anisotropy intensity;

performing P-wave fast and slow velocity anisotropy analysis on the wide azimuth seismic data of the target region, to acquire anisotropy of P-wave fast and slow velocity difference and a fast P-wave velocity direction;

fitting the first anisotropy intensity and the anisotropy of P-wave fast and slow velocity difference, to acquire a P-wave fast and slow velocity difference-based anisotropy intensity;

establishing an azimuthal P-wave anisotropic low-frequency model according to the P-wave fast and slow velocity difference-based anisotropy intensity and the fast P-wave velocity direction;

performing a second azimuthal anisotropy inversion on the wide azimuth seismic data of the target region based on the azimuthal P-wave anisotropic low-frequency model, to acquire a second anisotropy intensity and a second anisotropy direction; and

analyzing the second anisotropy intensity and the second anisotropy direction, to acquire a fracture prediction result;

wherein fitting the first anisotropy intensity and the anisotropy of P-wave fast and slow velocity difference in accordance with the following formula, to acquire the P-wave fast and slow velocity difference-based anisotropy intensity:

$$b_{1v} = -0.23 \times J - 0.005;$$

wherein, b_{1v} denotes P-wave fast and slow velocity difference-based anisotropy intensity; and J denotes anisotropy of the P-wave fast and slow velocity difference; and

wherein establishing the azimuthal P-wave anisotropic low-frequency model in accordance with the following formula, according to the P-wave fast and slow velocity difference-based anisotropy intensity and the fast P-wave velocity direction:

$$\left(\frac{V_p}{V_s}\right)_{01} \approx e^{2b_{1v}*\cos^2(\omega-\phi_v)} \bullet \left(\frac{V_p}{V_s}\right)_0;$$

wherein, V_p denotes a P-wave velocity, V_s denotes an S-wave velocity, b_{1v} denotes P-wave fast and slow velocity difference-based anisotropy intensity, ω denotes an azimuthal angle of the seismic data, ϕ_v denotes a direction perpendicular to the fast P-wave velocity, $\left(\frac{V_p}{V_s}\right)_{01}$ denotes the anisotropic low-frequency model of the azimuthal P-wave, and $\left(\frac{V_p}{V_s}\right)_0$ denotes an isotropic low-frequency model.

2. The high-angle fracture prediction method according to claim 1, wherein performing a first azimuthal anisotropy inversion on wide azimuth seismic data of a target region based on a constructed isotropic low-frequency model, to acquire a first anisotropy intensity comprises the following steps of:

the wide azimuth seismic data of the target region is divided and stacked in a manner of dividing the azimuthal angle at first and then dividing an offset, to form multiple partial angle stacked seismic data with different azimuths;

performing an azimuth anisotropy inversion on the multiple partial angle stacked seismic data of different azimuths based on the constructed isotropic low-frequency model, to acquire a divided azimuthal P-wave and S-wave velocity ratio; and

determining the first anisotropy intensity according to the divided azimuthal P-wave and S-wave velocity ratio.

3. The high-angle fracture prediction method according to claim 1, wherein performing P-wave fast and slow velocity anisotropy analysis on the wide azimuth seismic data of the target region, to acquire anisotropy of P-wave fast and slow velocity difference and a fast P-wave velocity direction comprises the following steps of:

processing the wide azimuth seismic data of the target region, to acquire a fast P-wave velocity, a slow P-wave velocity and a fast P-wave velocity direction; and

determining anisotropy of the P-wave fast and slow velocity difference based on the fast P-wave velocity and the slow P-wave velocity.

~~4. The high-angle fracture prediction method according to claim 3,wherein fitting the first anisotropy intensity and the anisotropy of P-wave fast and slow velocity difference in accordance with the following formula, to acquire the P-wave fast and slow velocity difference-based anisotropy intensity:~~

~~$b_{1v} = -0.23 \times J - 0.005$;~~

~~wherein, b_{1v} denotes P-wave fast and slow velocity difference based anisotropy intensity; and J denotes anisotropy of the P-wave fast and slow velocity difference.~~

~~5. The high-angle fracture prediction method according to claim 4, wherein establishing the azimuthal P-wave anisotropic low-frequency model in accordance with the following formula, according to the P-wave fast and slow velocity difference based anisotropy intensity and the fast P-wave velocity direction:~~

~~$$\left(\frac{V_p}{V_s}\right)_{01} \approx e^{2b_{1v}*\cos^2(\omega-\phi_v)} \left(\frac{V_p}{V_s}\right)_0$$;~~

~~wherein, V_p denotes a P-wave velocity, V_s denotes an S-wave velocity, b_{1v} denotes P-wave fast and slow velocity difference based anisotropy intensity, ω denotes an azimuthal angle of the seismic data, ϕ_v denotes a direction perpendicular to the fast P-wave velocity,~~ $\left(\frac{V_p}{V_s}\right)_{01}$ ~~denotes the anisotropic low-frequency model of the azimuthal P-wave, and~~ $\left(\frac{V_p}{V_s}\right)_0$ ~~denotes an isotropic low-frequency model.~~

~~6~~4. A computer device, comprising a memory, a processor and a computer program stored on the memory and executable by the processor, wherein when executing the computer program, the processor implements the following steps of:

performing a log measurement to acquire logging data of a target region;

acquiring wide azimuth seismic data of the target region according to the logging data;

performing a first azimuthal anisotropy inversion on the wide azimuth seismic data of ~~a~~ the target region based on a constructed isotropic low-frequency model, to acquire a first anisotropy intensity;

performing P-wave fast and slow velocity anisotropy analysis on the wide azimuth seismic data of the target region, to acquire anisotropy of P-wave fast and slow velocity difference and a fast P-wave velocity direction;

fitting the first anisotropy intensity and the anisotropy of P-wave fast and slow velocity difference, to acquire a P-wave fast and slow velocity difference-based anisotropy intensity;

establishing an azimuthal P-wave anisotropic low-frequency model according to the P-wave fast and slow velocity difference-based anisotropy intensity and the fast P-wave velocity direction;

performing a second azimuthal anisotropy inversion on the wide azimuth seismic data of the target region based on the azimuthal P-wave anisotropic low-frequency model, to acquire a second anisotropy intensity and a second anisotropy direction; and

analyzing the second anisotropy intensity and the second anisotropy direction, to acquire a fracture prediction result;

wherein when executing the computer program, the processor implements the following steps of:

fitting the first anisotropy intensity and the anisotropy of P-wave fast and slow velocity difference in accordance with the following formula, to acquire the P-wave fast and slow velocity difference-based anisotropy intensity:

$$b_{1v} = -0.23 \times J - 0.005;$$

wherein, b_{1v} denotes P-wave fast and slow velocity difference-based anisotropy intensity; and J denotes anisotropy of the P-wave fast and slow velocity difference; and

wherein when executing the computer program, the processor implements the following steps of:

establishing the azimuthal P-wave anisotropic low-frequency model in accordance with the following formula:

$$\left(\frac{V_p}{V_s}\right)_{01} \approx e^{2b_{1v}*\cos^2(\omega-\phi_v)} \bullet \left(\frac{V_p}{V_s}\right)_0;$$

wherein, V_p denotes a P-wave velocity, V_s denotes an S-wave velocity, b_{1v} denotes P-wave fast and slow velocity difference-based anisotropy intensity, ω denotes an azimuthal angle of the seismic data, ϕ_v denotes a direction perpendicular to the fast P-wave velocity, $\left(\frac{V_p}{V_s}\right)_{01}$ denotes the anisotropic low-frequency model of the azimuthal P-wave, and

$\left(\frac{V_p}{V_s}\right)_0$ denotes an isotropic low-frequency model.

~~7~~5. The computer device according to claim ~~6~~4, wherein when executing the computer program, the processor implements the following steps of:

the wide azimuth seismic data of the target region is divided and stacked in a manner of dividing the azimuthal angle at first and then dividing an offset, to form multiple partial angle stacked seismic data with different azimuths;

performing an azimuth anisotropy inversion on the multiple partial angle stacked seismic data of different azimuths based on the constructed isotropic low-frequency model, to acquire a divided azimuthal P-wave and S-wave velocity ratio; and

determining the first anisotropy intensity from the divided azimuthal P-wave and S-wave velocity ratio.

~~8~~6. The computer device according to claim ~~6~~4, wherein when executing the computer program, the processor implements the following steps of:

processing the wide azimuth seismic data of the target region, to acquire a fast P-wave velocity, a slow P-wave velocity and a fast P-wave velocity direction; and

determining anisotropy of the P-wave fast and slow velocity difference based on the fast P-wave velocity and the slow P-wave velocity.

~~9. The computer device according to claim 8, wherein when executing the computer program, the processor implements the following steps of:~~

~~fitting the first anisotropy intensity and the anisotropy of P-wave fast and slow velocity difference in accordance with the following formula, to acquire the P-wave fast and slow velocity difference-based anisotropy intensity:~~

$$b_{1v} = -0.23 \times J - 0.005;$$

~~wherein, b_{1v} denotes P-wave fast and slow velocity difference-based anisotropy intensity; and J denotes anisotropy of the P-wave fast and slow velocity difference.~~

~~10. The computer device according to claim 9, wherein when executing the computer program, the processor implements the following steps of:~~

~~establishing the azimuthal P-wave anisotropic low-frequency model in accordance with the following formula:~~

~~$$\left(\frac{V_p}{V_s}\right)_{01} \approx e^{2b_{1v}*\cos^2(\omega-\phi_v)} \left(\frac{V_p}{V_s}\right)_0 ;$$~~

~~wherein, V_p denotes a P-wave velocity, V_s denotes an S-wave velocity, b_{1v} denotes P-wave fast and slow velocity difference-based anisotropy intensity, ω denotes an azimuthal angle of the seismic data, ϕ_v denotes a direction perpendicular to the fast P-wave velocity, $\left(\frac{V_p}{V_s}\right)_{01}$ denotes the anisotropic low-frequency model of the azimuthal P-wave, and $\left(\frac{V_p}{V_s}\right)_0$ denotes an isotropic low-frequency model.~~

~~11~~7. A computer-readable storage medium, wherein the computer-readable storage medium stores a computer program for implementing the following steps of:

performing a log measurement to acquire logging data of a target region;

acquiring wide azimuth seismic data of the target region according to the logging data;

performing a first azimuthal anisotropy inversion on the wide azimuth seismic data of ~~a~~ the target region based on a constructed isotropic low-frequency model, to acquire a first anisotropy intensity and;

performing P-wave fast and slow velocity anisotropy analysis on the wide azimuth seismic data of the target region, to acquire anisotropy of P-wave fast and slow velocity difference and a fast P-wave velocity direction;

fitting the first anisotropy intensity and the anisotropy of P-wave fast and slow velocity difference, to acquire a P-wave fast and slow velocity difference-based anisotropy intensity;

establishing an azimuthal P-wave anisotropic low-frequency model according to the P-wave fast and slow velocity difference-based anisotropy intensity and the fast P-wave velocity direction;

performing a second azimuthal anisotropy inversion on the wide azimuth seismic data of the target region based on the azimuthal P-wave anisotropic low-frequency model, to acquire a second anisotropy intensity and a second anisotropy direction; and

analyzing the second anisotropy intensity and the second anisotropy direction, to acquire a fracture prediction result;

wherein the computer program for implementing the following steps of:

fitting the first anisotropy intensity and the anisotropy of P-wave fast and slow velocity difference in accordance with the following formula, to acquire the P-wave fast and slow velocity difference-based anisotropy intensity:

$$b_{1v} = -0.23 \times J - 0.005;$$

wherein, b_{1v} denotes P-wave fast and slow velocity difference-based anisotropy intensity; and J denotes anisotropy of the P-wave fast and slow velocity difference; and

wherein the computer program for implementing the following steps of:

establishing the azimuthal P-wave anisotropic low-frequency model in accordance with the following formula, according to the P-wave fast and slow velocity difference-based anisotropy intensity and the fast P-wave velocity direction:

$$\left(\frac{V_p}{V_s}\right)_{01} \approx e^{2b_{1v}*\cos^2(\omega-\phi_v)} \bullet \left(\frac{V_p}{V_s}\right)_0;$$

wherein, V_p denotes a P-wave velocity, V_s denotes an S-wave velocity, b_{1v} denotes P-wave fast and slow velocity difference-based anisotropy intensity, ω denotes an azimuthal angle of the seismic data, ϕ_v denotes a direction perpendicular to the fast P-wave velocity, $\left(\frac{V_p}{V_s}\right)_{01}$ denotes the anisotropic low-frequency model of the azimuthal P-wave, and $\left(\frac{V_p}{V_s}\right)_0$ denotes an isotropic low-frequency model.

~~12~~8. The computer-readable storage medium according to claim ~~11~~7, wherein the computer program for implementing the following steps of:

the wide azimuth seismic data of the target region is divided and stacked in a manner of dividing the azimuthal angle at first and then dividing an offset, to form multiple partial angle stacked seismic data with different azimuths;

performing an azimuth anisotropy inversion on the multiple partial angle stacked seismic data of different azimuths based on the constructed isotropic low-frequency model, to acquire adivided azimuthal P-wave and S-wave velocity ratio; and

determining the first anisotropy intensity according to the divided azimuthal P-wave and

S-wave velocity ratio.

~~13~~9. The computer-readable storage medium according to claim ~~11~~7, wherein the computer program for implementing the following steps of:

processing the wide azimuth seismic data of the target region, to acquire a fast P-wave velocity, a slow P-wave velocity and a fast P-wave velocity direction; and

determining anisotropy of the P-wave fast and slow velocity difference based on the fast P-wave velocity and the slow P-wave velocity.

~~14. The computer-readable storage medium according to claim 13,wherein the computer program for implementing the following steps of:~~

~~fitting the first anisotropy intensity and the anisotropy of P-wave fast and slow velocity difference in accordance with the following formula, to acquire the P-wave fast and slow velocity difference-based anisotropy intensity:~~

$$b_{1v} = -0.23 \times J - 0.005;$$

~~wherein, b_{1v} denotes P-wave fast and slow velocity difference-based anisotropy intensity; and J denotes anisotropy of the P-wave fast and slow velocity difference.~~

~~15. The computer-readable storage medium according to claim 14, wherein the computer program for implementing the following steps of:~~

~~establishing the azimuthal P-wave anisotropic low-frequency model in accordance with the following formula, according to the P-wave fast and slow velocity difference-based anisotropy intensity and the fast P-wave velocity direction:~~

$$\left(\frac{V_p}{V_s}\right)_{01} = e^{2b_{1v}*\cos^2(\omega-\phi_v)} \left(\frac{V_p}{V_s}\right)_0;$$

~~wherein, V_p denotes a P-wave velocity, V_s denotes an S-wave velocity, b_{1v} denotes P-wave fast and slow velocity difference-based anisotropy intensity, ω denotes an azimuthal angle of the seismic data, ϕ_v denotes a direction perpendicular to the fast P-wave velocity,~~

$\left(\frac{V_p}{V_s}\right)_{01}$ ~~denotes the anisotropic low-frequency model of the azimuthal P-wave, and~~

$\left(\frac{V_p}{V_s}\right)_0$ ~~denotes an isotropic low-frequency model.~~