Fault surfaces and fault throws from 3D seismic images

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3D seismic image

provided by
dGB Earth Sciences B.V.
Fault surfaces and throws

1 km

1.5 s

1.8

Vertical throw (ms)
3D seismic image

provided by
dGB Earth Sciences B.V.
(1) fault images

1.5 s

1.8 s

1 km

Fault likelihood

1

0.9

0.8

0.7

0.6

0.5
(2) fault surfaces

1.5 s

1.8

1 km

Fault likelihood

0.5

0.6

0.7

0.8

0.9

1
(3) fault throws

1.5 s

1.8

1 km

Vertical throw (ms)
Fault images
Seismic image
Structure-oriented semblance

\[
\text{semblance} = \frac{\langle \text{image} \rangle_s^2}{\langle \text{image}^2 \rangle_s}
\]

\[
\langle \cdot \rangle_s = \text{structure-oriented average}
\]
Structure-oriented semblance
Structure-oriented semblance

\[
\text{semblance} = \frac{\langle \text{image} \rangle_s^2}{\langle \text{image}^2 \rangle_s}
\]

\[
\langle \cdot \rangle_s = \text{structure-oriented average}
\]
Fault-oriented semblance

\[ \text{semblance} = \frac{\langle \langle \text{image} \rangle_s^2 \rangle_f}{\langle \langle \text{image}^2 \rangle_s \rangle_f} \]

\[ \langle \cdot \rangle_s = \text{structure-oriented average} \]

\[ \langle \cdot \rangle_f = \text{fault-oriented average} \]
Vertical faults?
Vertical faults?
Fault-oriented
Fault-oriented
Ridges in fault likelihood

1.5 s

1.8 s

1 km

Fault likelihood

1

0.9

0.8

0.7

0.6

0.5
Ridges in fault likelihood

1.5 s

1.8

1 km

Fault likelihood
Fault surfaces
Ridges in human brain MRI

Schultz et al., 2010
Ridges in fault likelihood

1.5 s

1.8

1 km

Fault likelihood

0.5

0.6

0.7

0.8

0.9

1
Image sampling cell

crossline

inline

time or depth

• image sample
Fault likelihoods

\[ f = \text{fault likelihood} \]

- image sample

\[ f_1 \quad f_2 \]
Fault orientations

\[ f_1, f_2 \]

\[ n_1, n_2 \]

\[ f = \text{fault likelihood} \]

\[ n = \text{fault normal} \]

- image sample
Fault-likelihood gradients

\[ f_1, f_2 \]

\[ g_1, g_2 \]

\[ n_1, n_2 \]

- image sample
- \( f \) = fault likelihood
- \( n \) = fault normal
- \( g \) = gradient = \( \nabla f \)
Ridge-edge intersection

- image sample
- ridge-edge intersection
One quad

- image sample
- ridge-edge intersection
- quad node
Three quads

- image sample
- ridge-edge intersection
- quad node
Four quads

- image sample
- ridge-edge intersection
- quad node
Fault surfaces

1.5 s

1.8

1 km

Fault likelihood
Quad meshes
Quad meshes
Three quads

- image sample
- ridge-edge intersection
- quad node
Fault surface
Fault surface

fault trace
Fault surface

fault curve

fault trace

Fault likelihood
Fault throws
Footwall image

Distance along fault strike (km)

Time (s)

Amplitude
Hanging-wall image

Distance along fault strike (km)

Time (s)

Amplitude
Hanging-wall image warped
Footwall image
Fault throw (vertical component)
Fault surfaces
Fault throws

1 km

1.5 s

1.8

Vertical throw (ms)
3D seismic image

-1 s

-1.3 s

1 km

Amplitude
Fault throws

-1 s

-1.3 s

1 km

Vertical throw (ms)
Fault throws
Fault throws
Fault throws
Fault throws
Fault throws