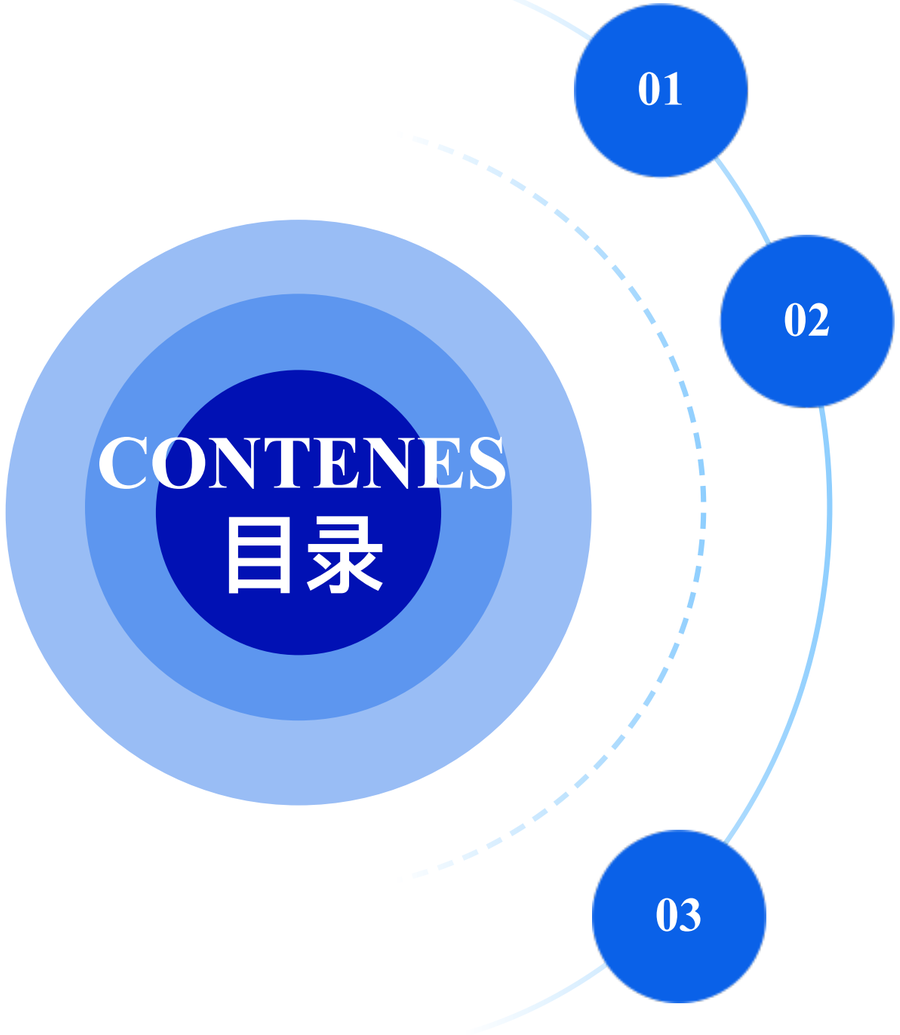
断层预测增强技

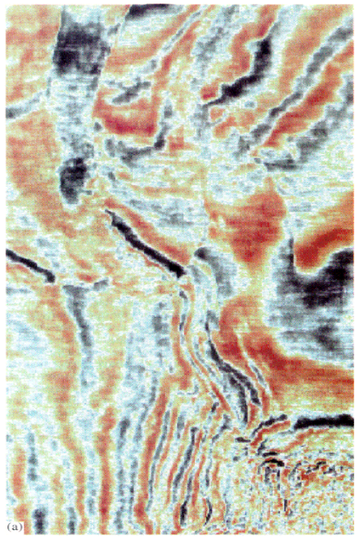
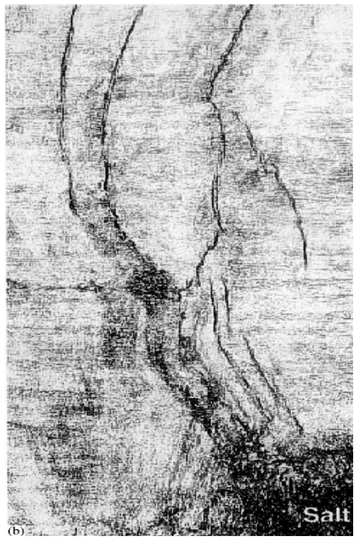
汇报人：袁世洪

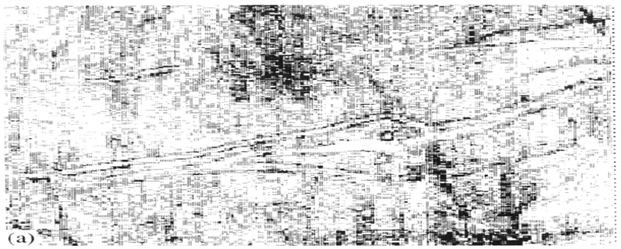
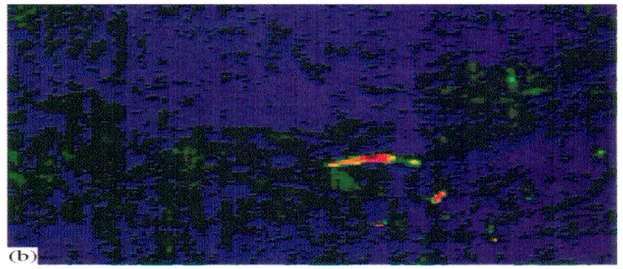
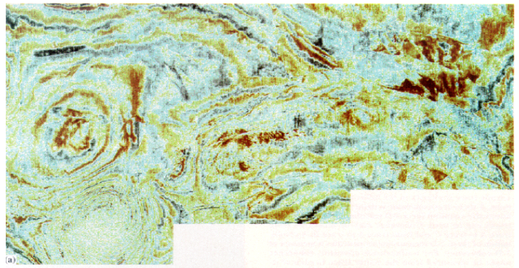
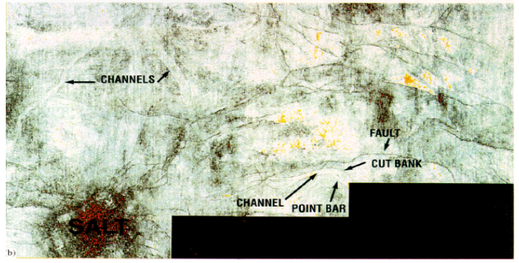
中国石油东方物探公司物探技术研究中心
中油油气勘探软件国家工程研究中心

2025年10月11日

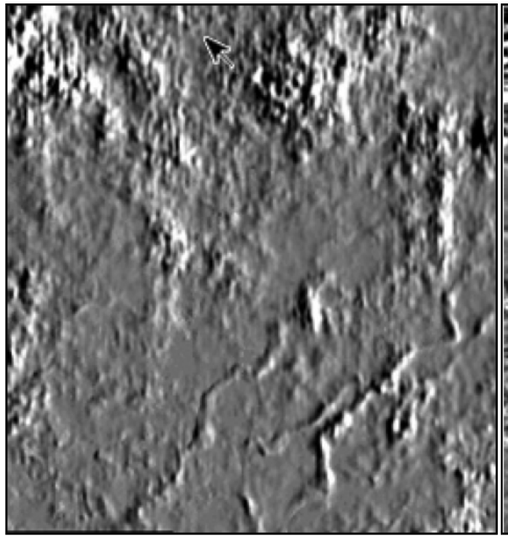
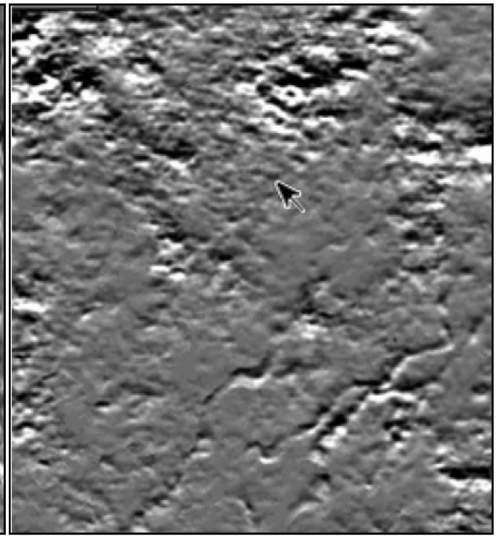


地震不连续性

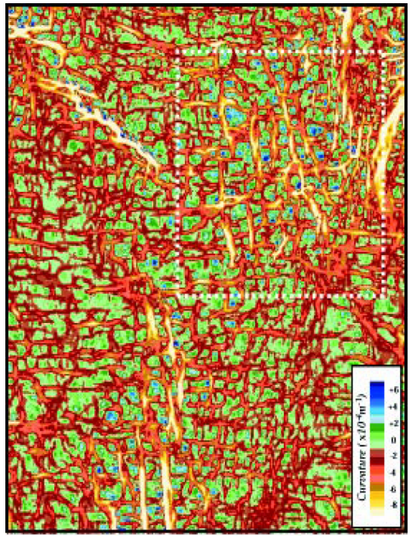
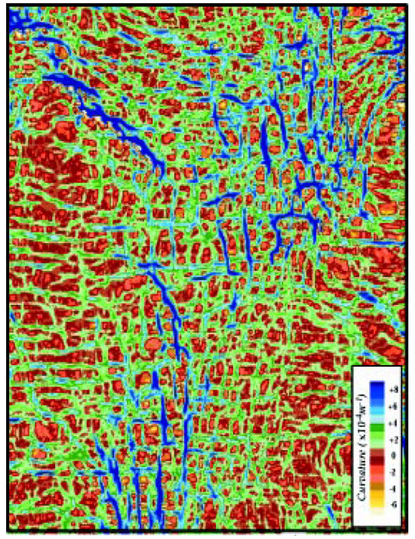



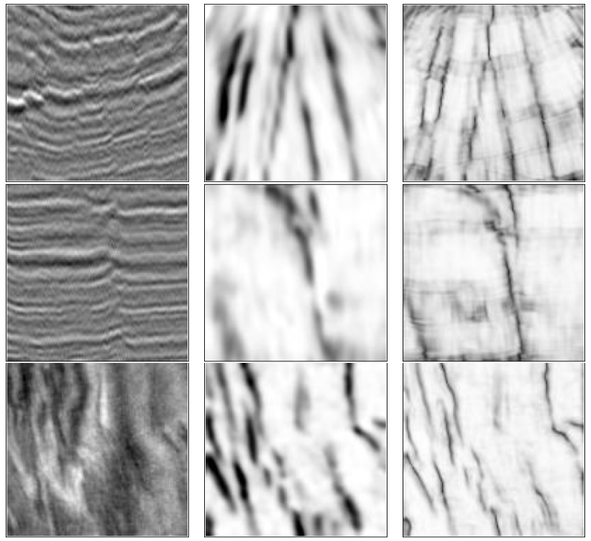
Coherence time slice

Gradient

Most negative and positve curvature



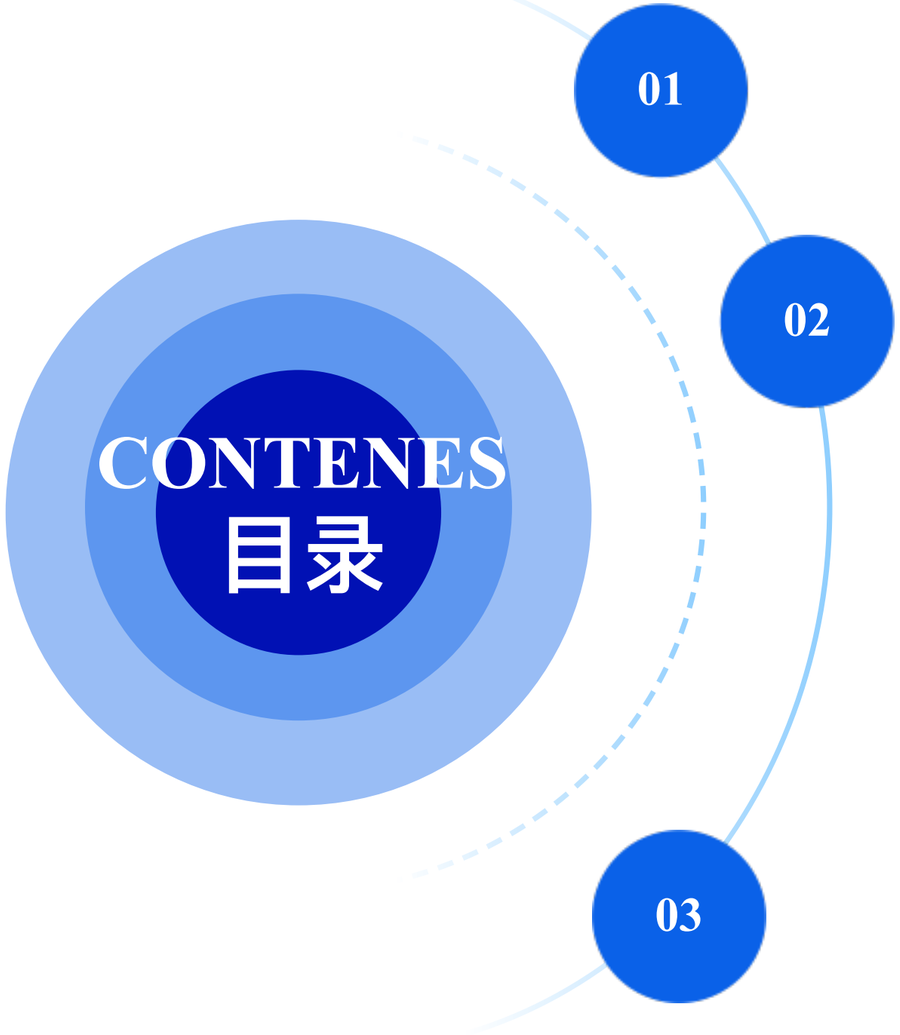
GST coherence C3

Bahorich, M. S., and S. L. Farmer, 1995

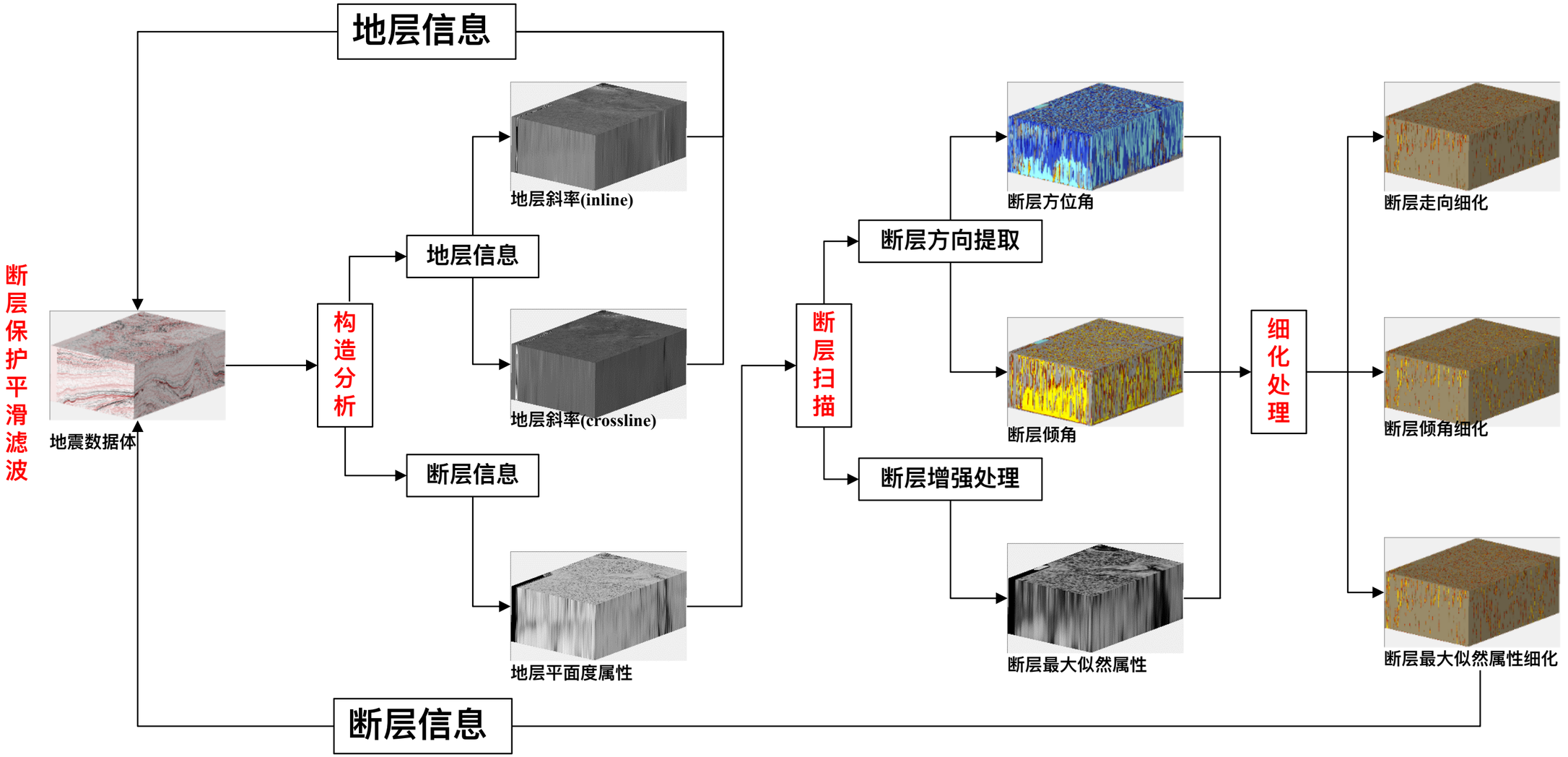
Marfurt, Seismic Attributes for Prospect Identification and Reservoir Characterization, P109

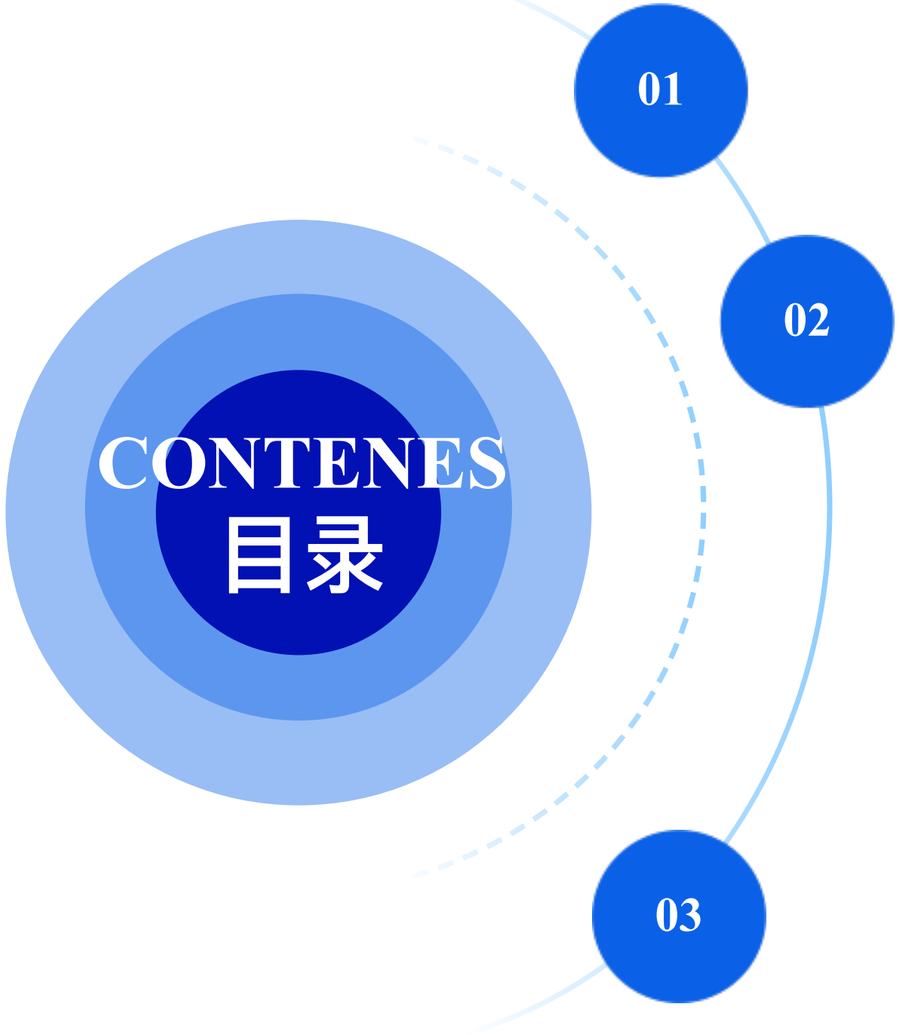
Roberts,2001

Bakker,2003



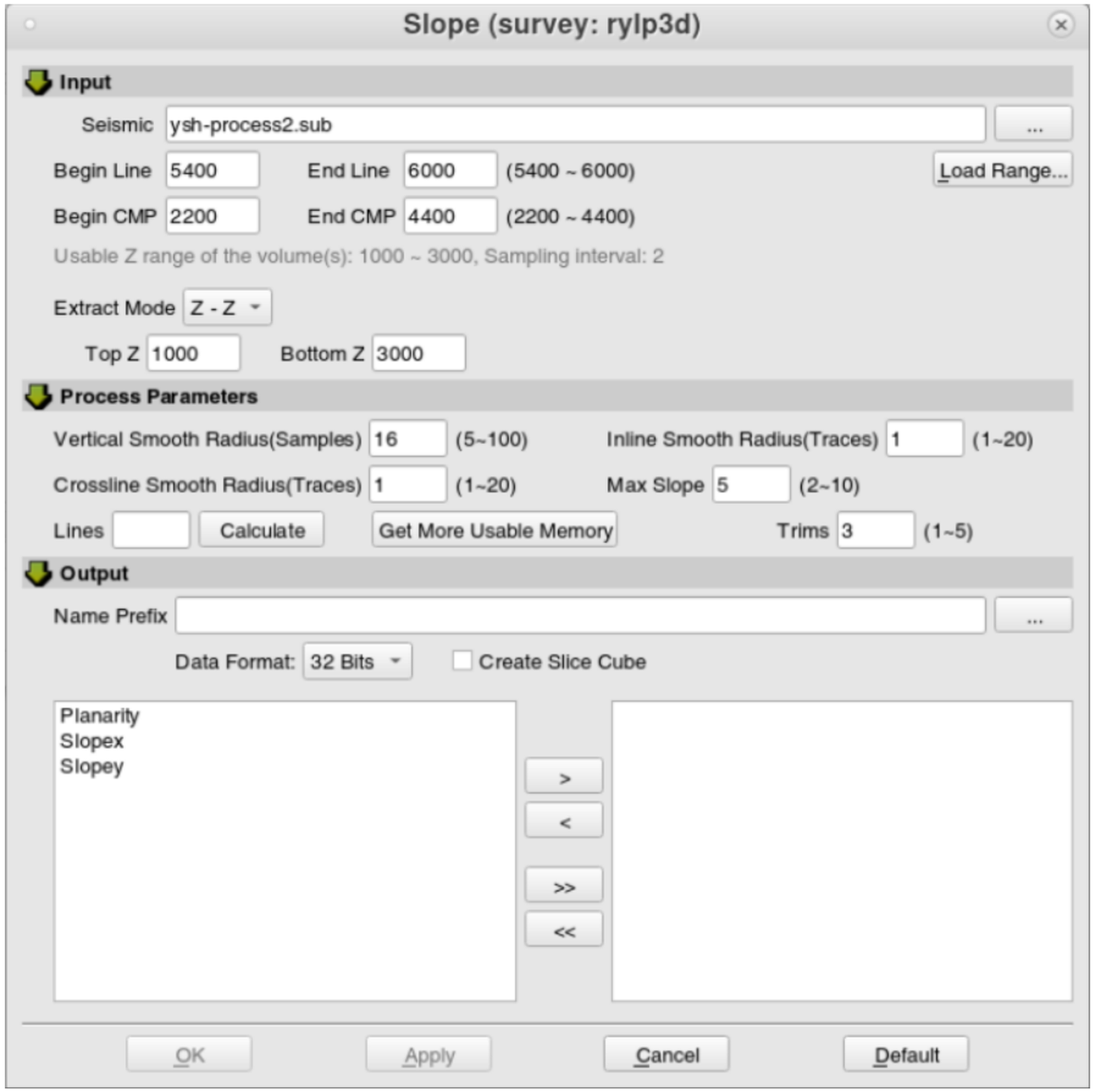
断层预测增强技术流程


地层信息
地层斜率(inline)
地层信息
断层保护平滑滤波
地震数据体
构造分析
地层斜率(crossline)
断层信息
地层平面度属性
断层信息
断层扫描
断层方向提取
断层方位角
断层倾角
断层增强处理
断层最大似然属性
细化处理
断层走向细化
断层倾角细化
断层最大似然属性细化



地层平面度及斜率

界面及主要参数



输入数据

① **Seismic Volume :** 地震数据体

计算参数

① **Sigma1 :** 平滑(半)时窗长度，样点数(纵向)；

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④ **Max Slope:** 最大斜率；

⑤ **Lines:** lines[20,50],Calculate估算当前可用内存m，m>=[200,500]；

⑥ Trims：分块计算后，数据拼接处理，要求数据重叠， trims决定重叠线的数目(1/2)；

输出数据

① **Planarity**：平面度属性；

② **Slopex**：Inline方向斜率；

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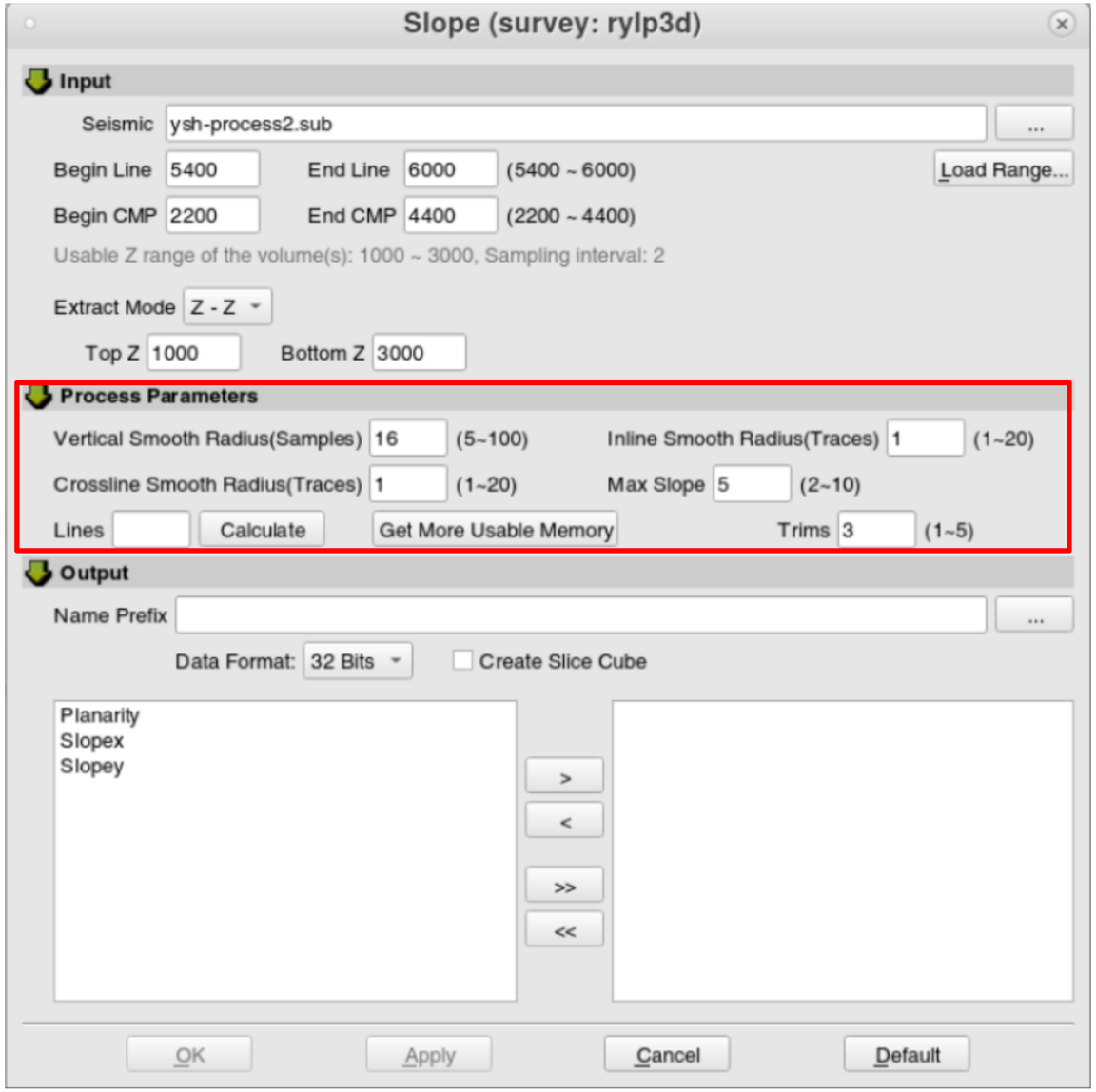
地层平面度及斜率

界面及主要参数



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地层平面度及斜率

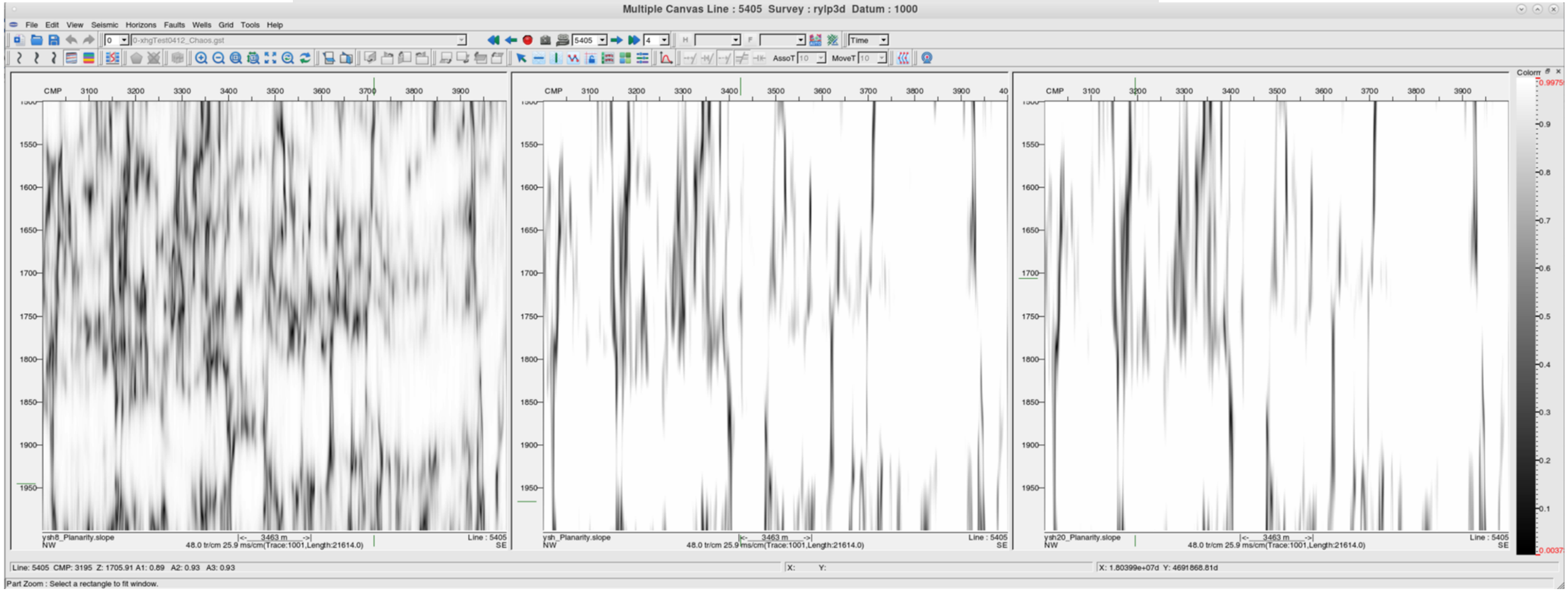
纵向滤波半径影响

Process Parameters

Vertical Smooth Radius(Samples) 16 (5~100)　Inline Smooth Radius(Traces) 1 (1~20)

Crossline Smooth Radius(Traces) 1 (1~20)　Max Slope 5 (2~10)

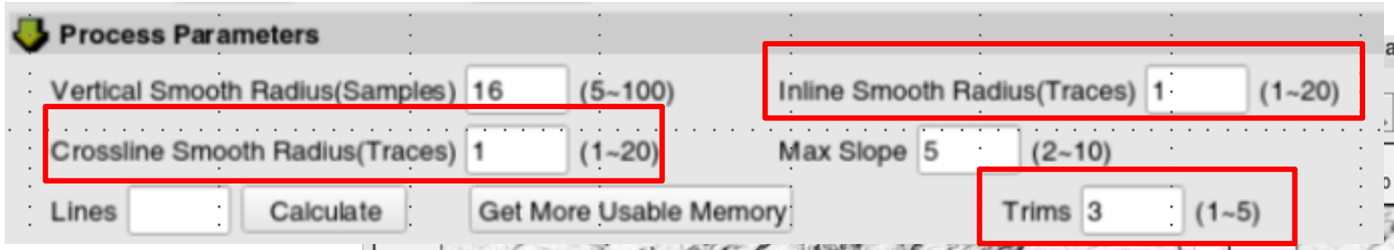
Lines　Calculate　Get More Usable Memory　Trims 3 (1~5)



8　16　20

地层平面度及斜率

横向滤波半径影响



1, 1, 3

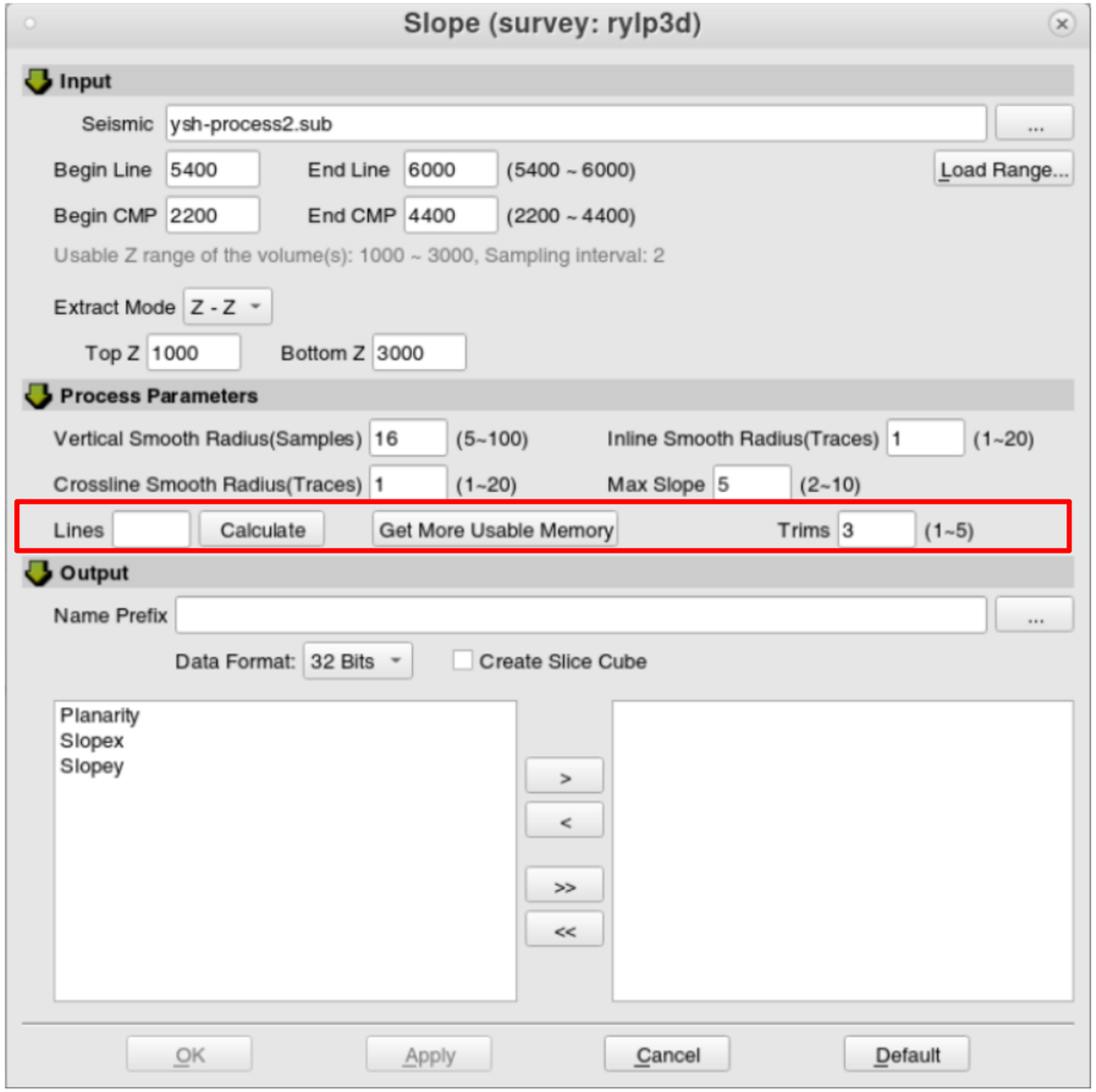
2, 2, 3

2, 2, 4

2, 2, 5

地层平面度及斜率

界面及主要参数



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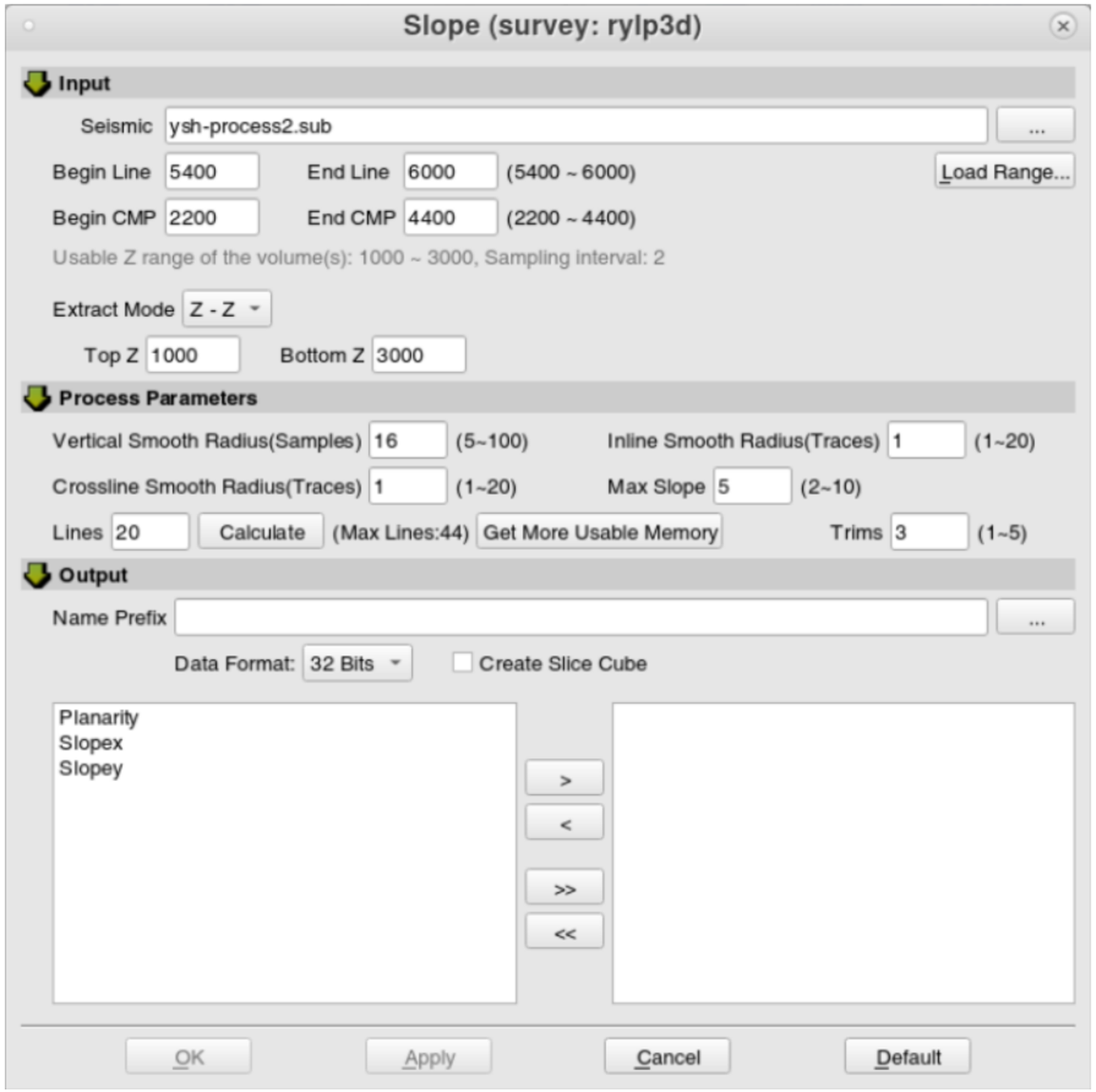
地层平面度及斜率

界面及主要参数



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地层平面度及斜率

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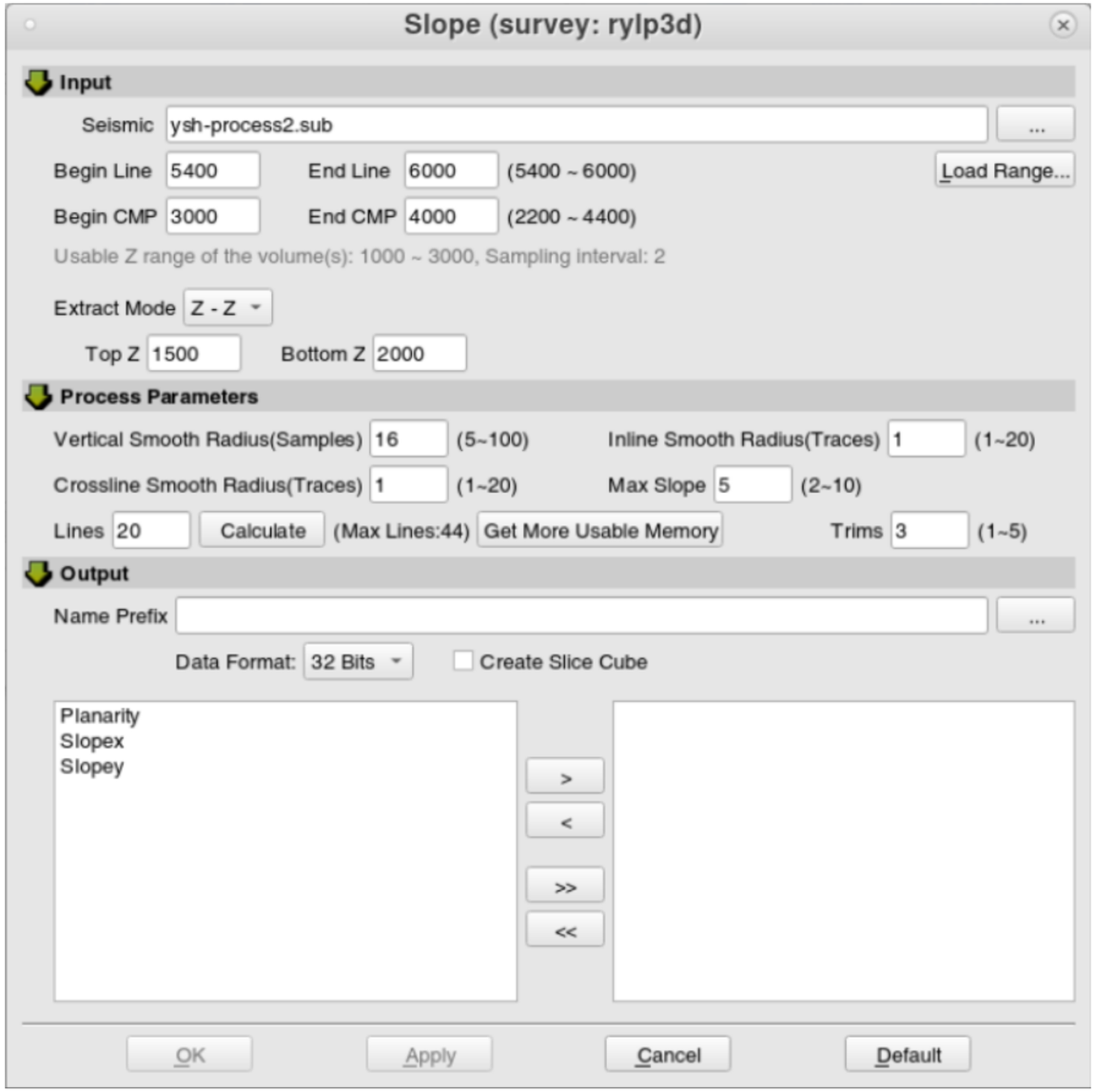

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地层平面度及斜率

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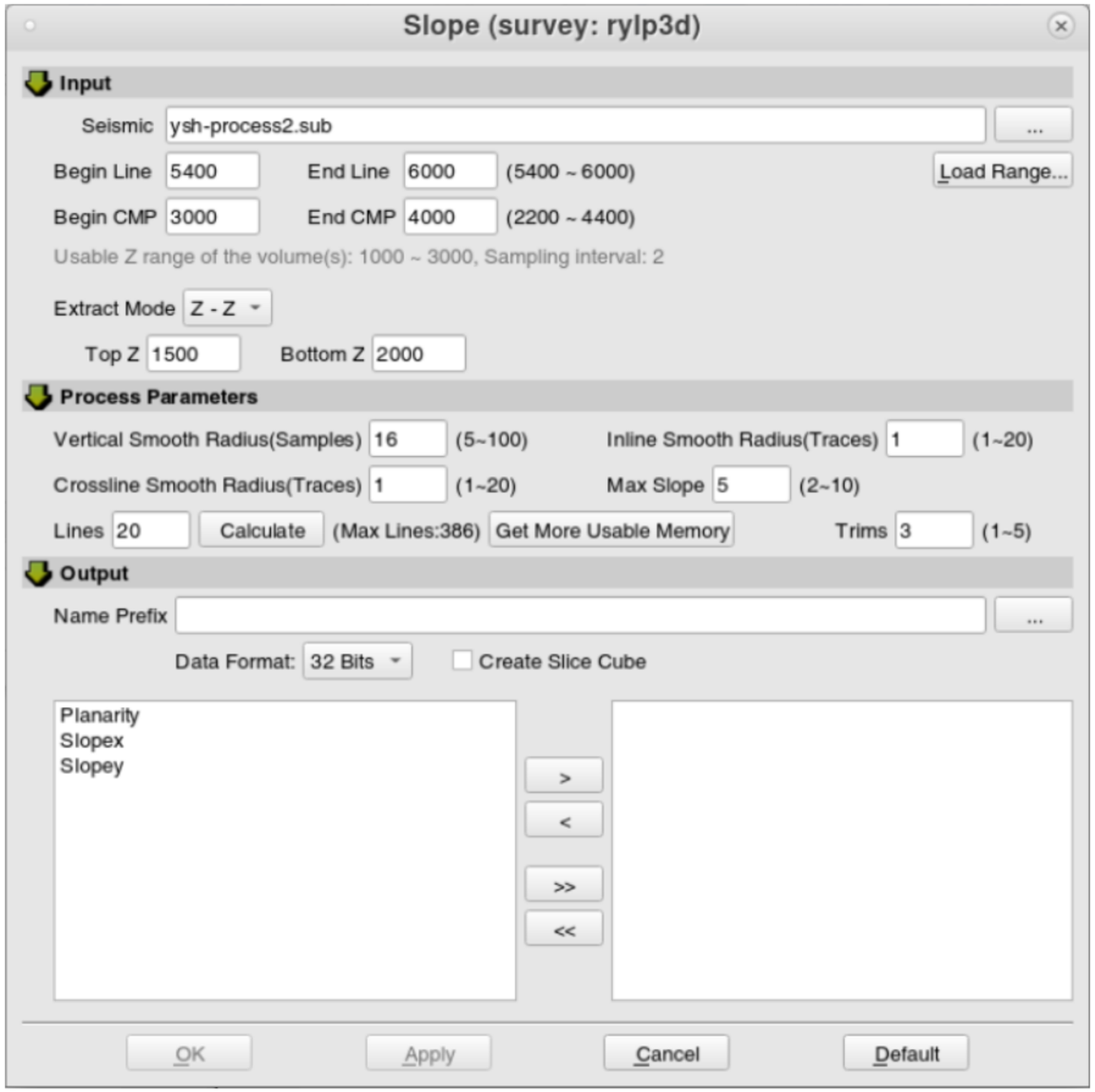

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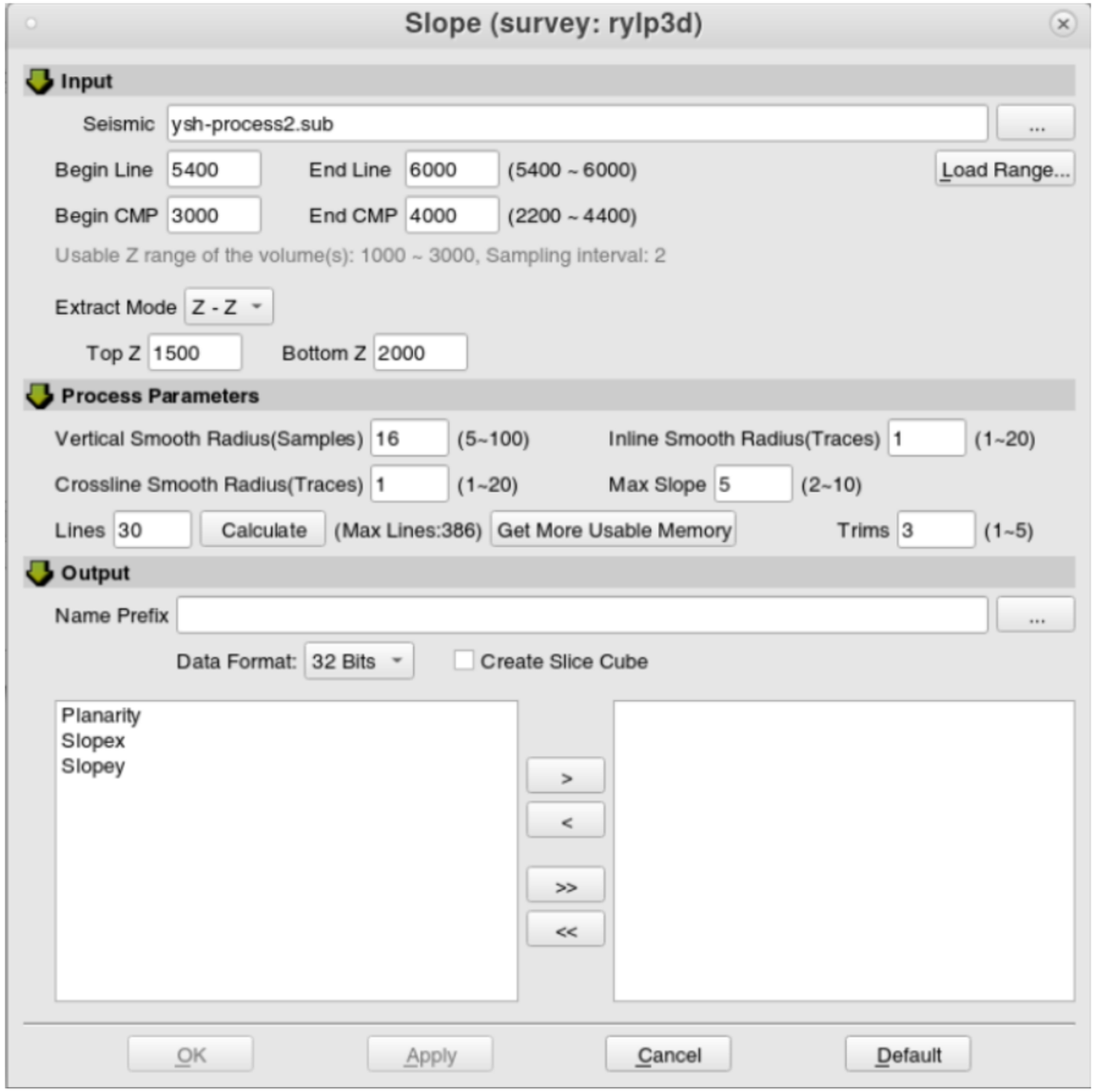
地层平面度及斜率

界面及主要参数



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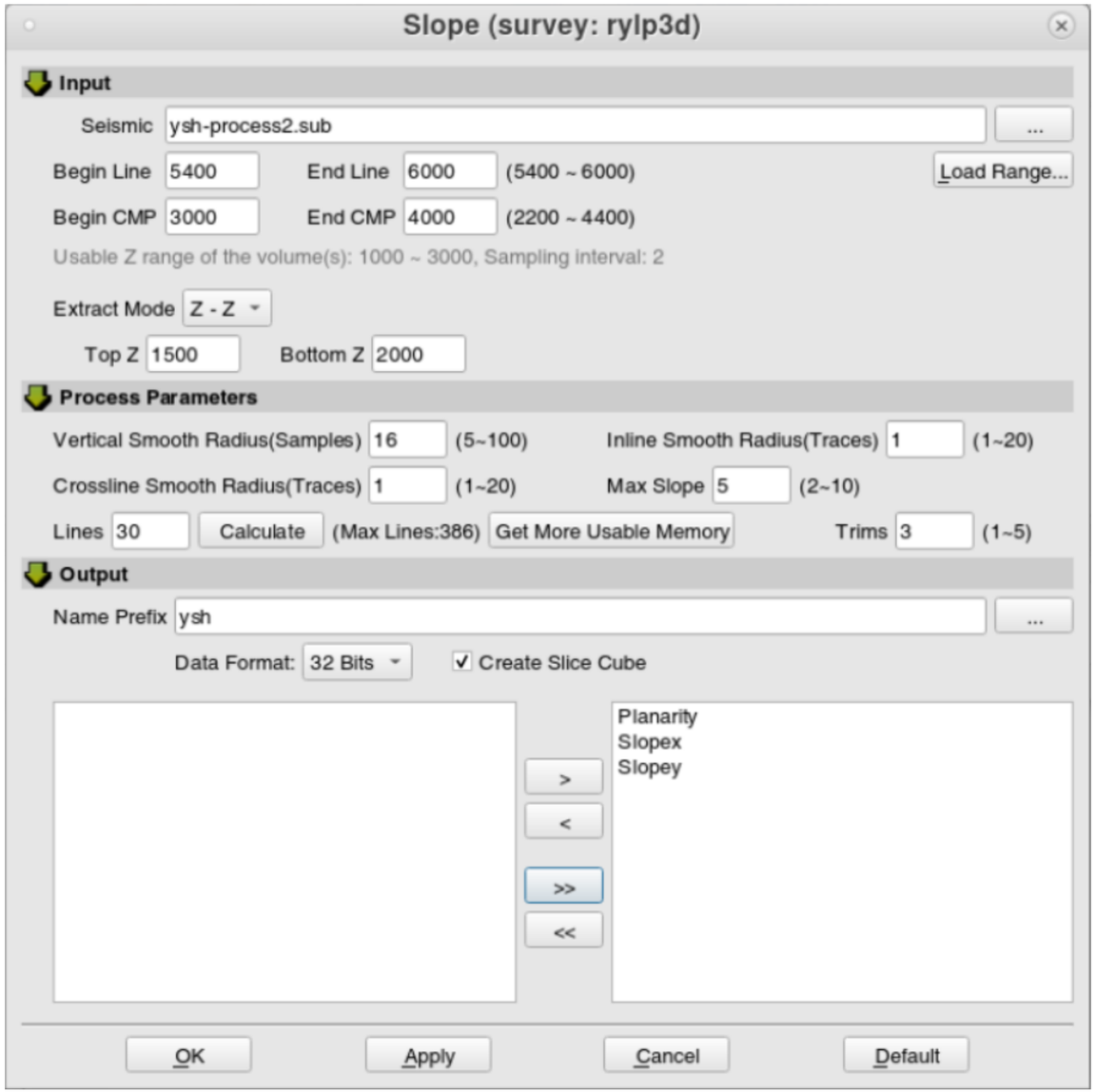
地层平面度及斜率

界面及主要参数



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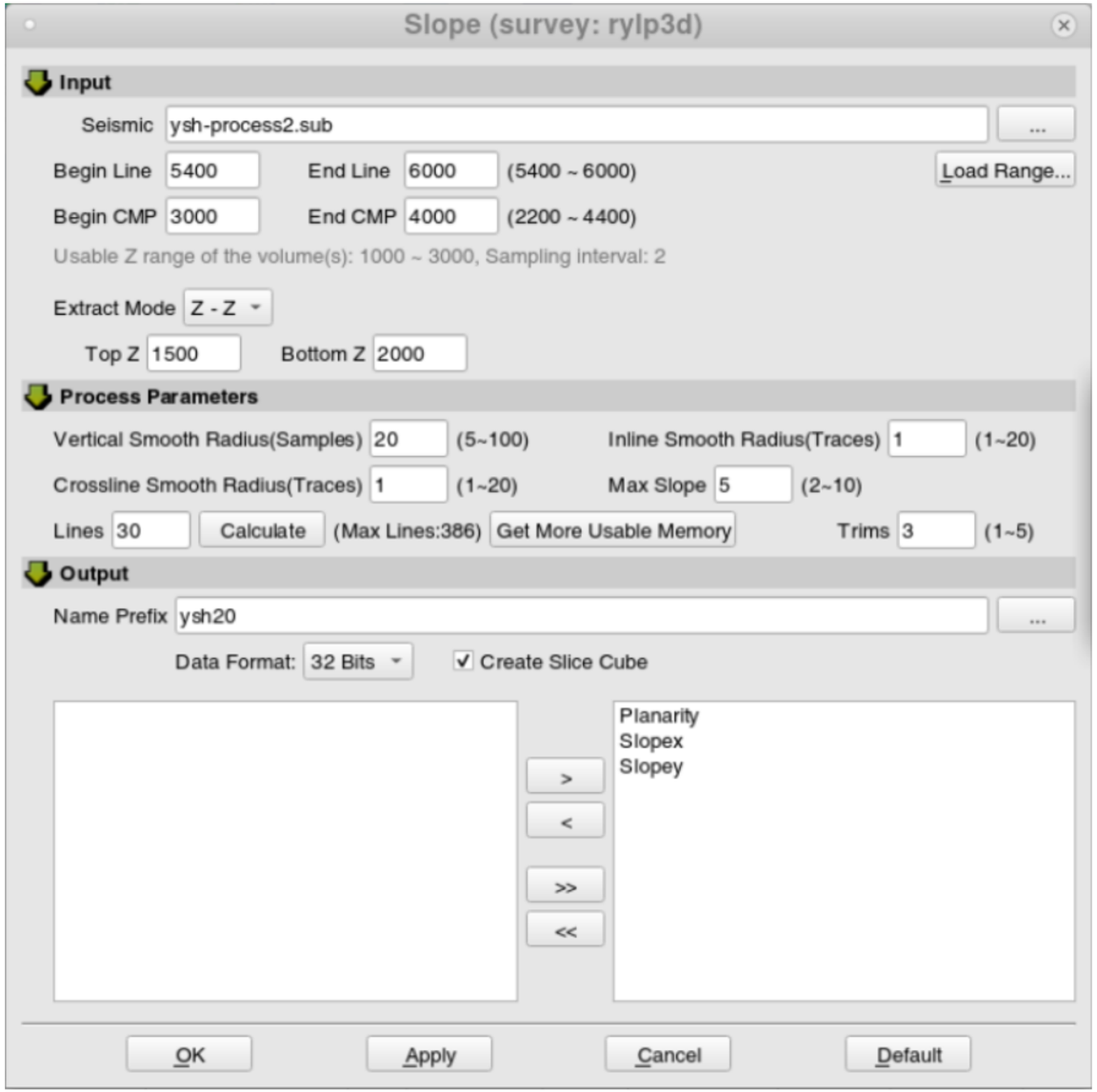
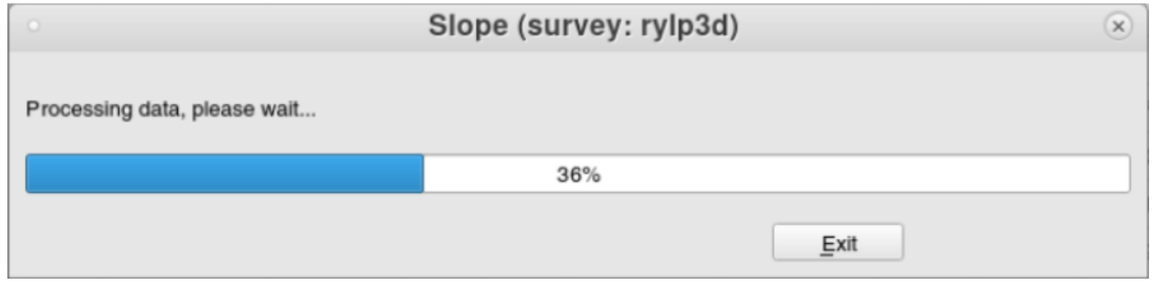
地层平面度及斜率

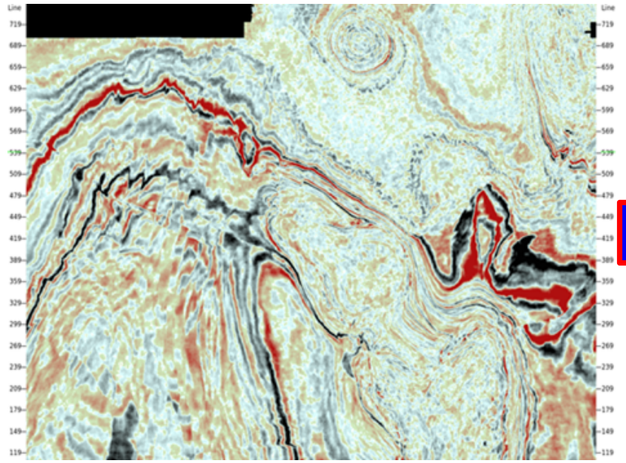
界面及主要参数



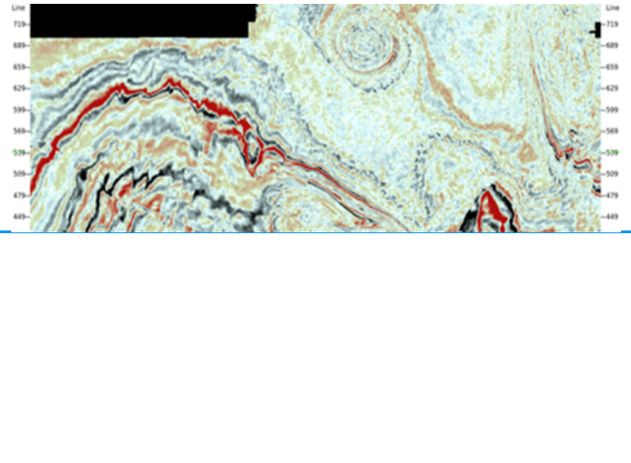


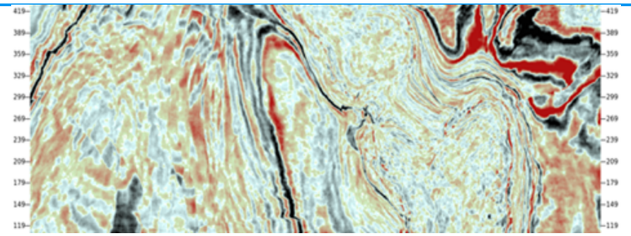
线方向分块及合并

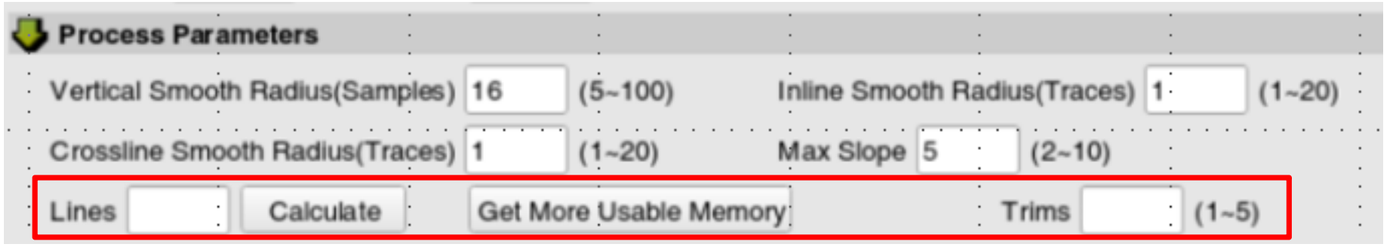
无重叠无切除

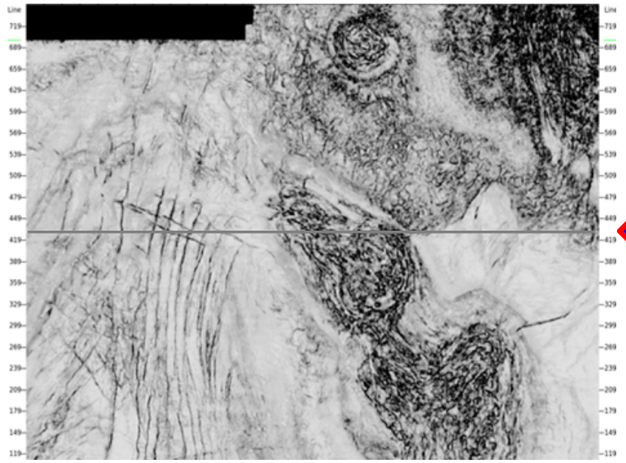


分块

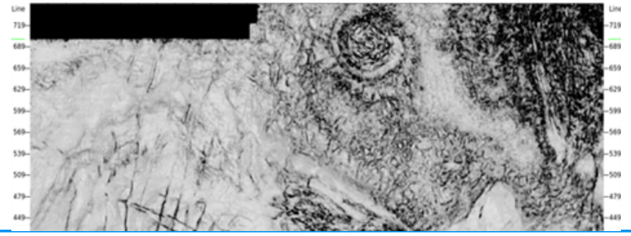


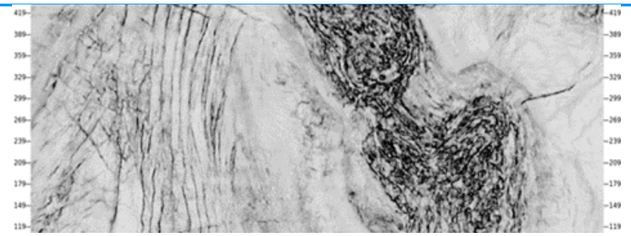






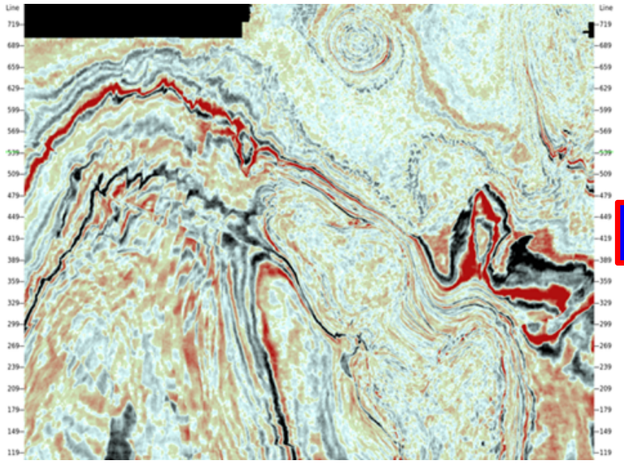
合并



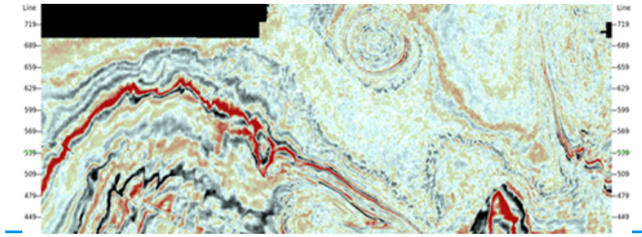


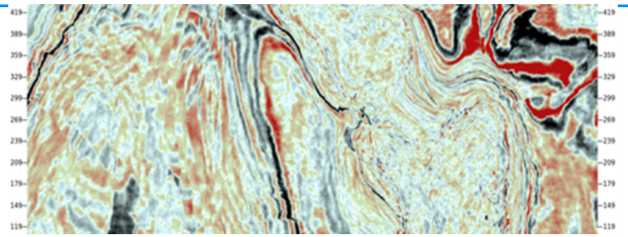
线方向分块及合并

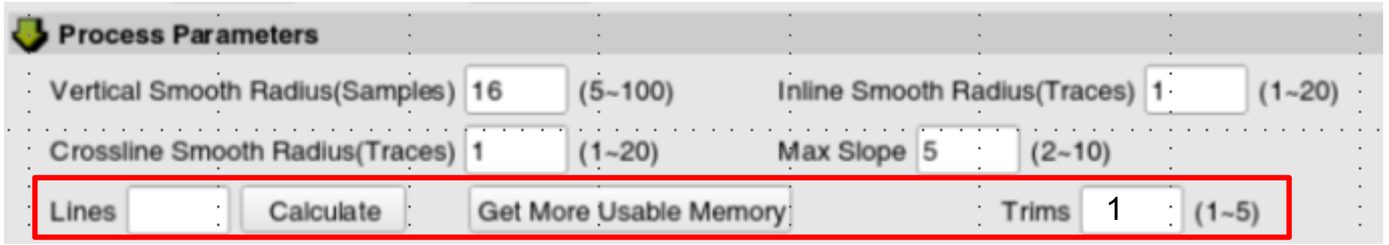
重叠2条线切除1条线

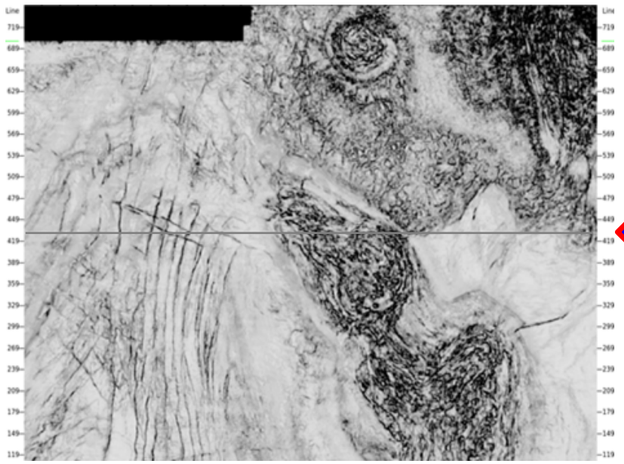


分块

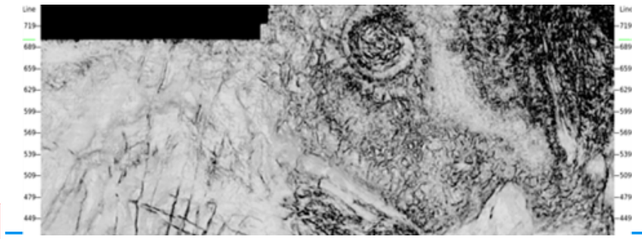


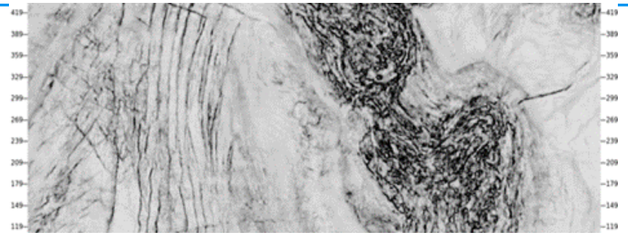






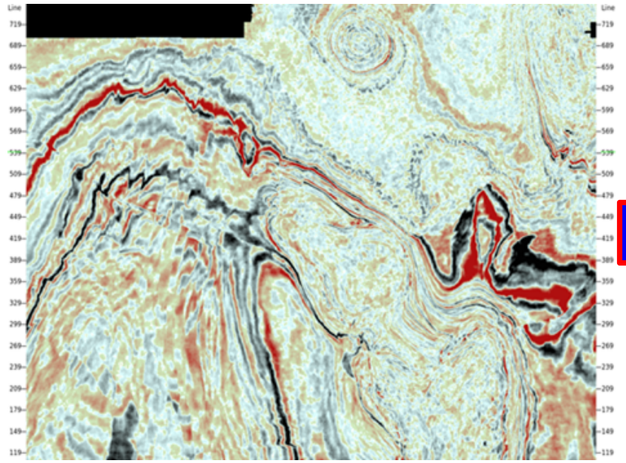
合并



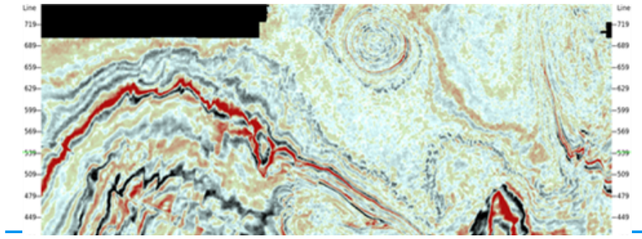


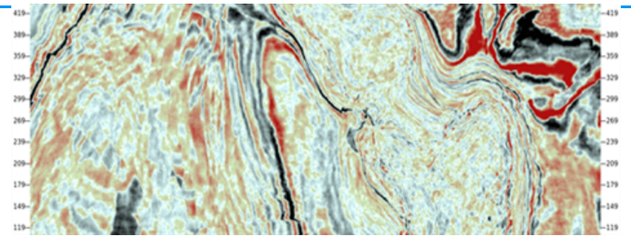
线方向分块及合并

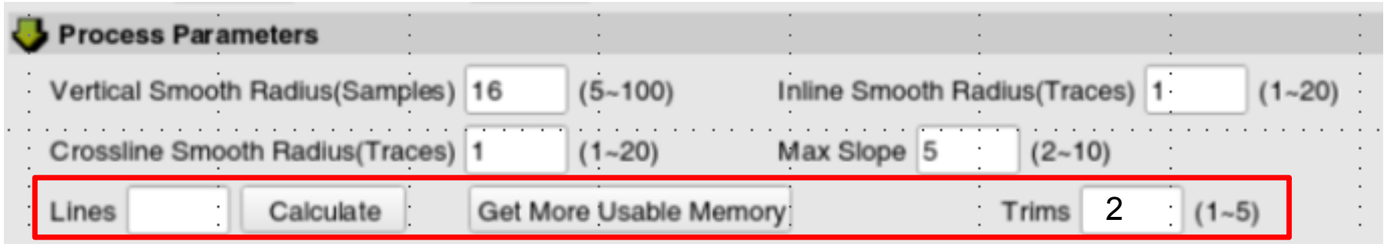
重叠4条线切除2条线

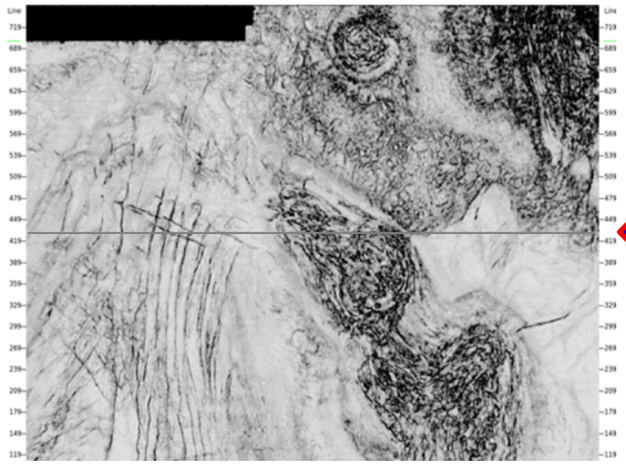


分块

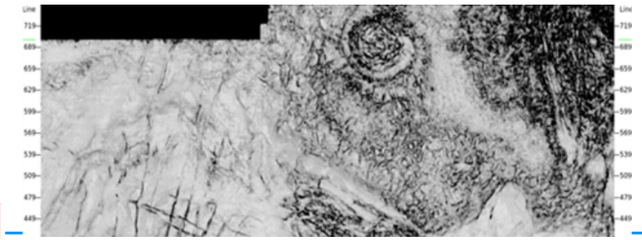


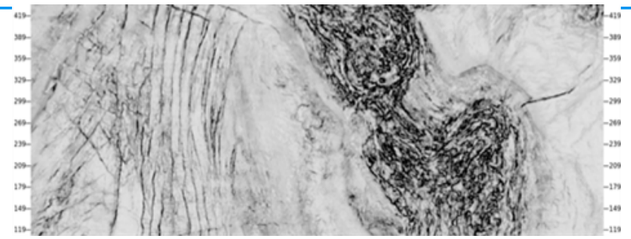






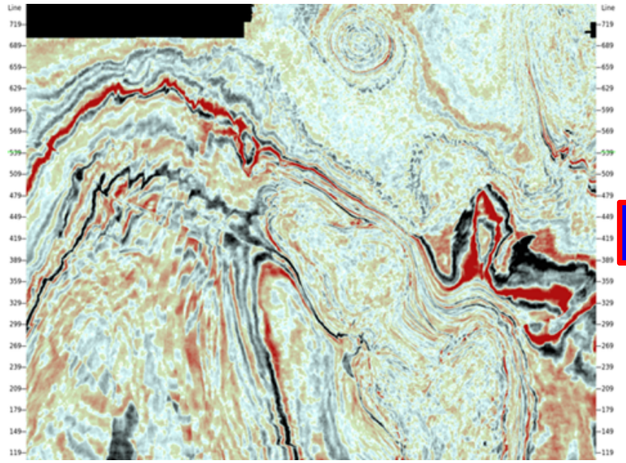
合并



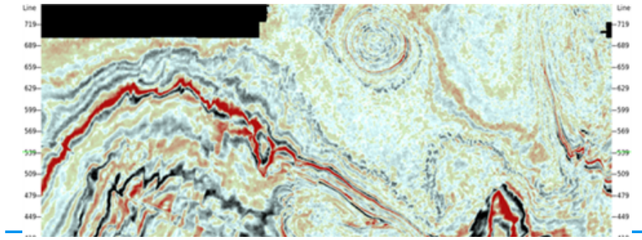


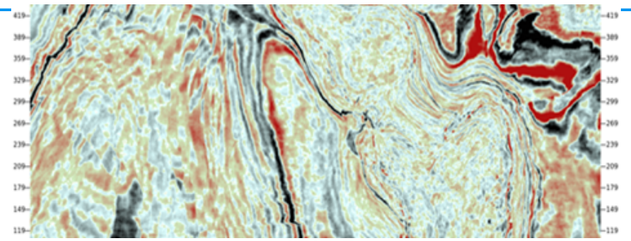
线方向分块及合并

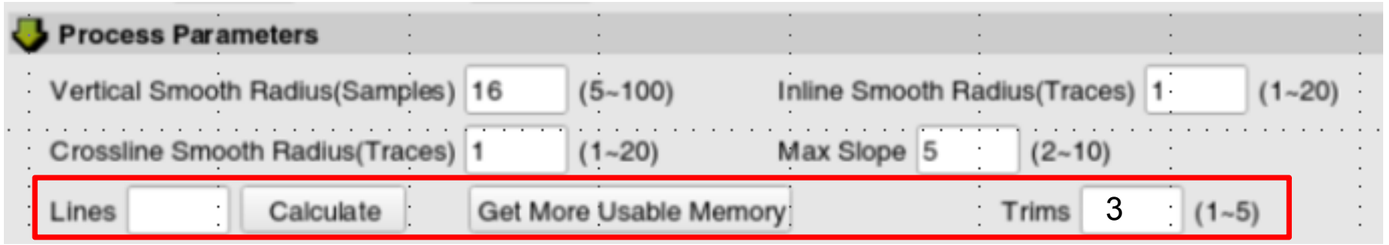
重叠6条线切除3条线

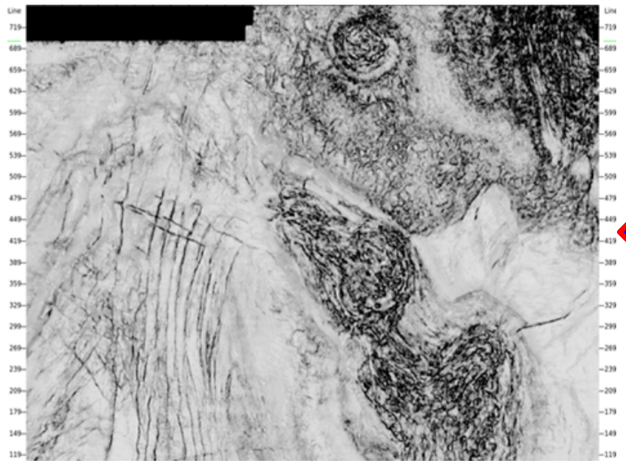


分块

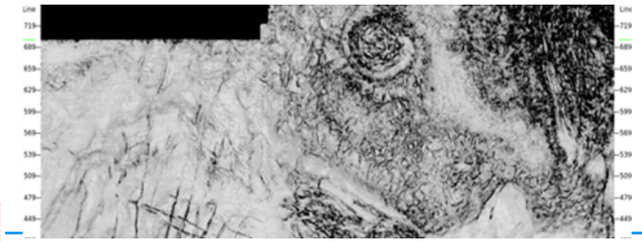


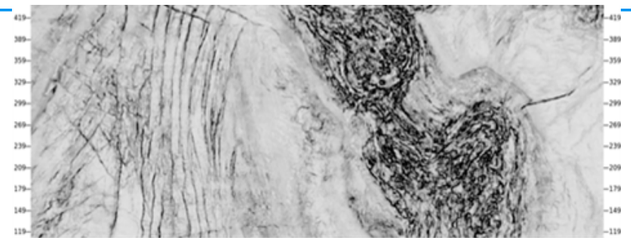


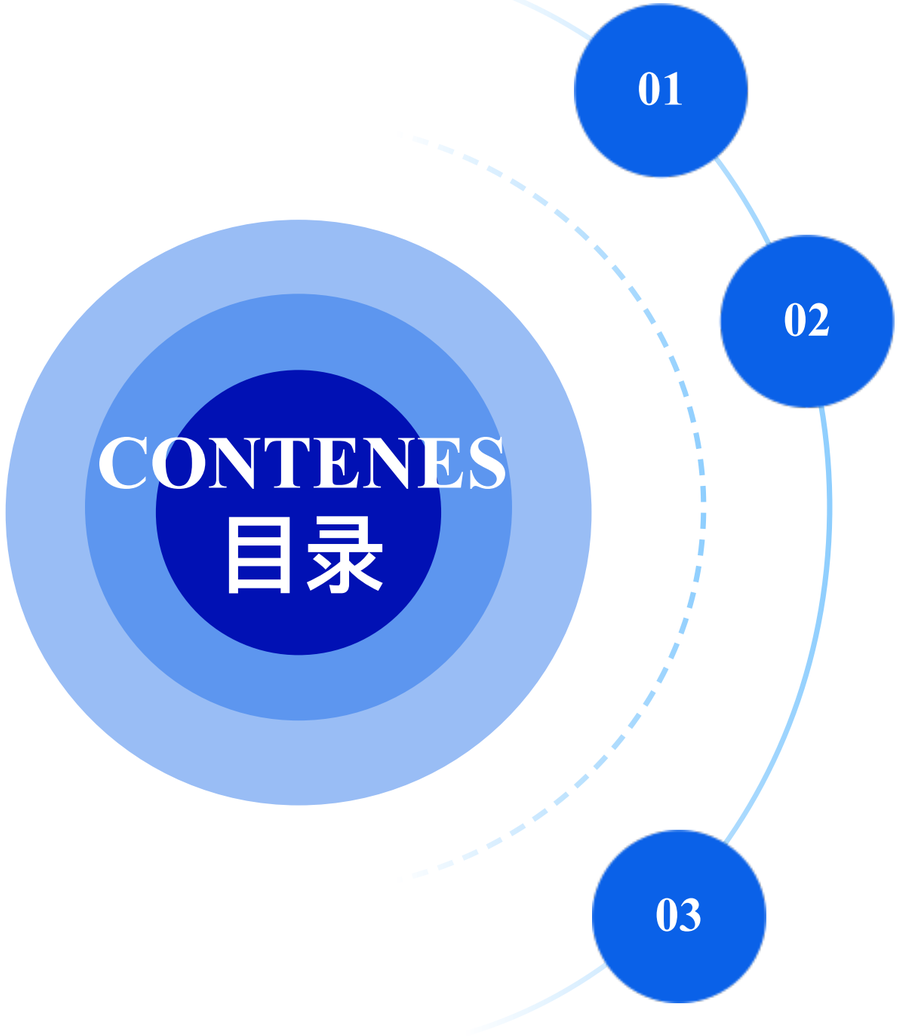




合并







研究背景

断层预测增强功能介绍

地层斜率与断层属性估算

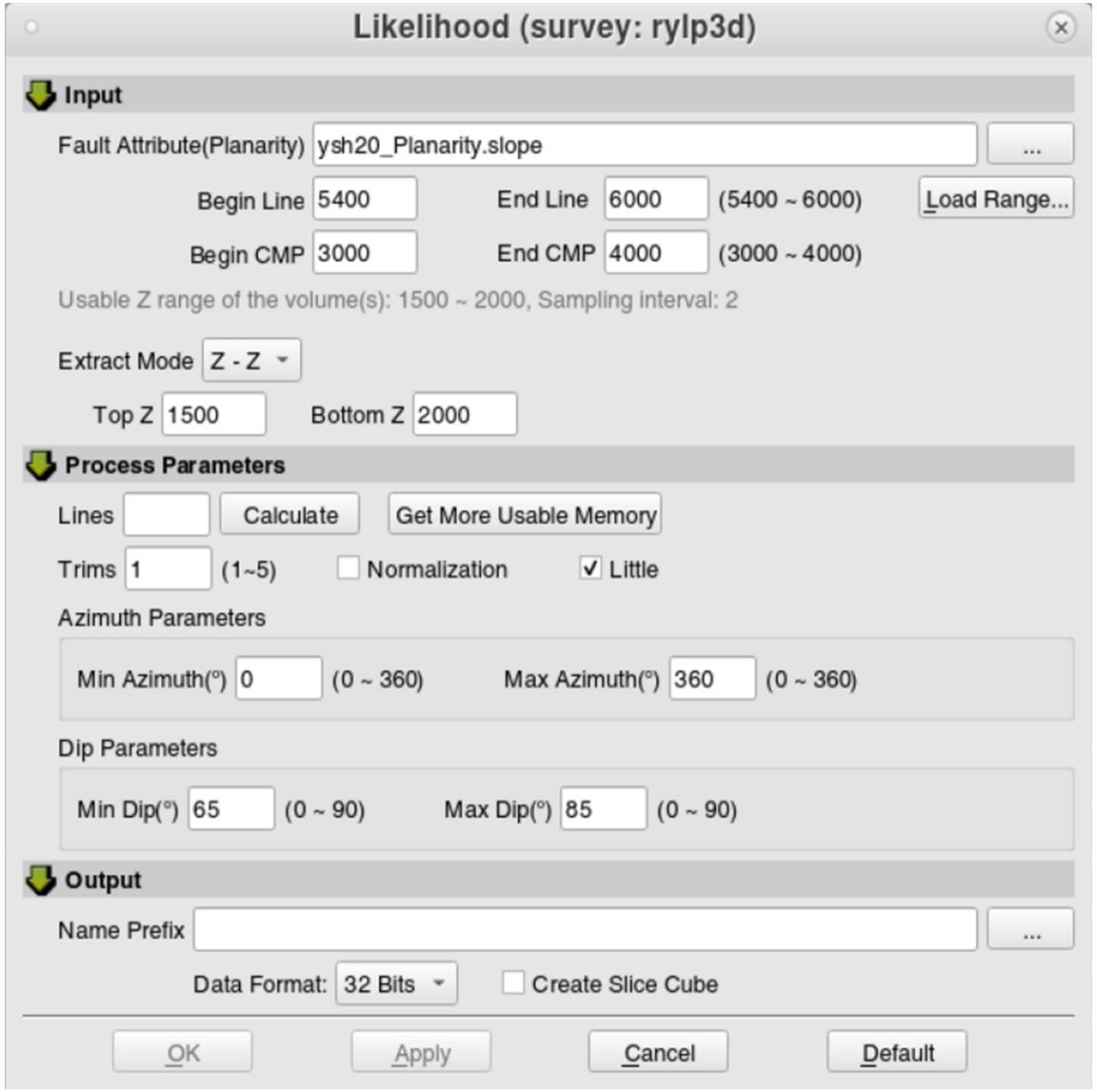
断层增强及细化

断层保护平滑滤波

注意事项及流程建议

断层增强及细化

界面及参数



输入数据

① **Fault Attribure :** 断层属性（平面度）数据；

计算参数

① **Lines :** lines[20,50],Calculate估算当前可用内存m，m>=10*lines[200,500]；

② **Normalization:**是否标准化；是否小值异常；

③ **Trims:** 与数据拼接处的重叠线数目相关(1/2)；

④ **Azimuth Parameters:** 断层扫描方位角范围。

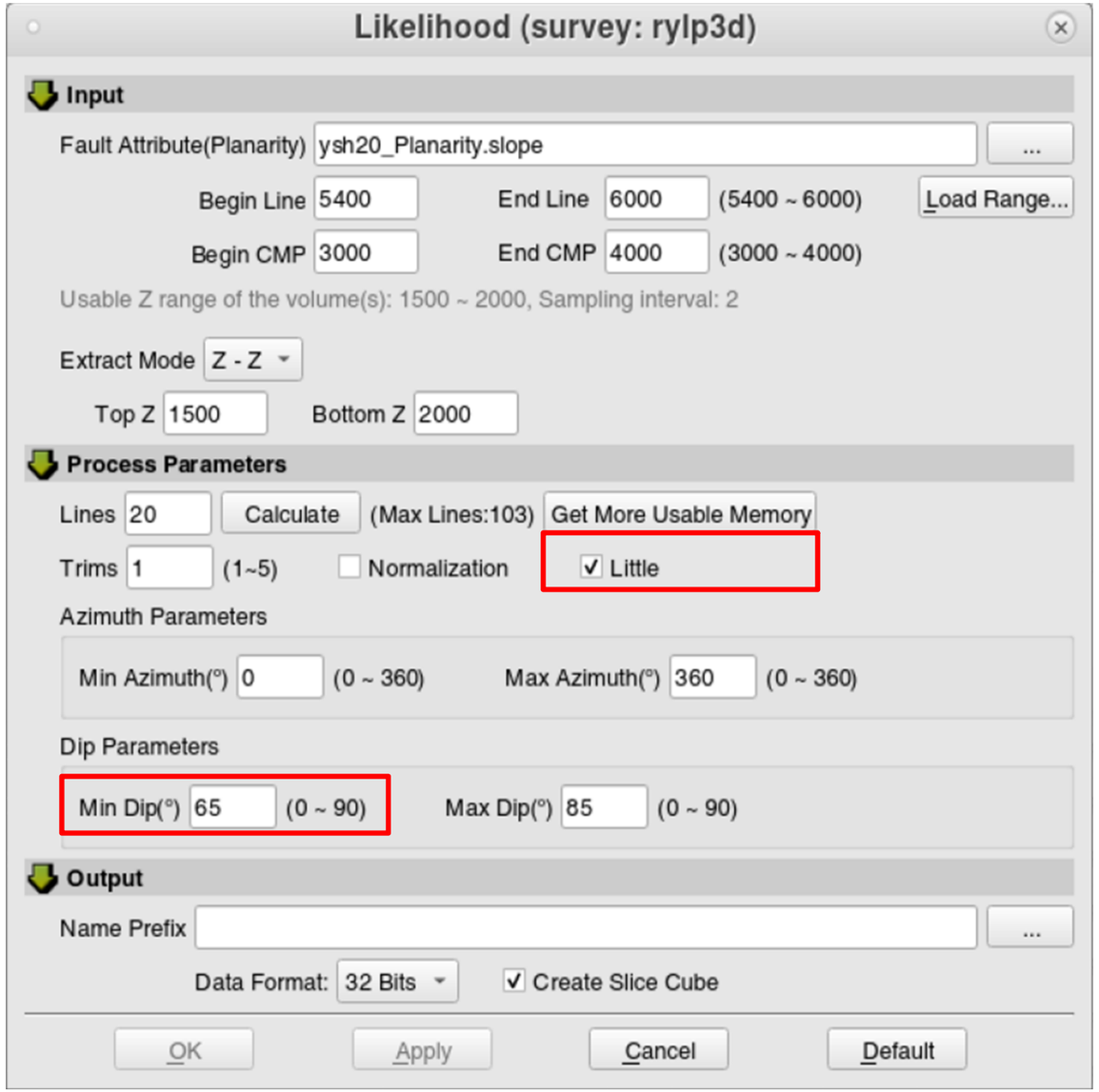
⑤ **Dip Parameters:** 断层扫描倾角范围。

输出数据

① 细化后的断层属性数据

断层增强及细化

界面及参数



输入数据

① **Fault Attribure :** 断层属性（平面度）数据；

计算参数

① **Lines :** lines[20,50],Calculate估算当前可用内存m，m>=10*lines[200,500]；

② **Normalization:**是否标准化；是否小值异常；

③ **Trims:** 与数据拼接处的重叠线数目相关(1/2)；

④ **Azimuth Parameters:** 断层扫描方位角范围。

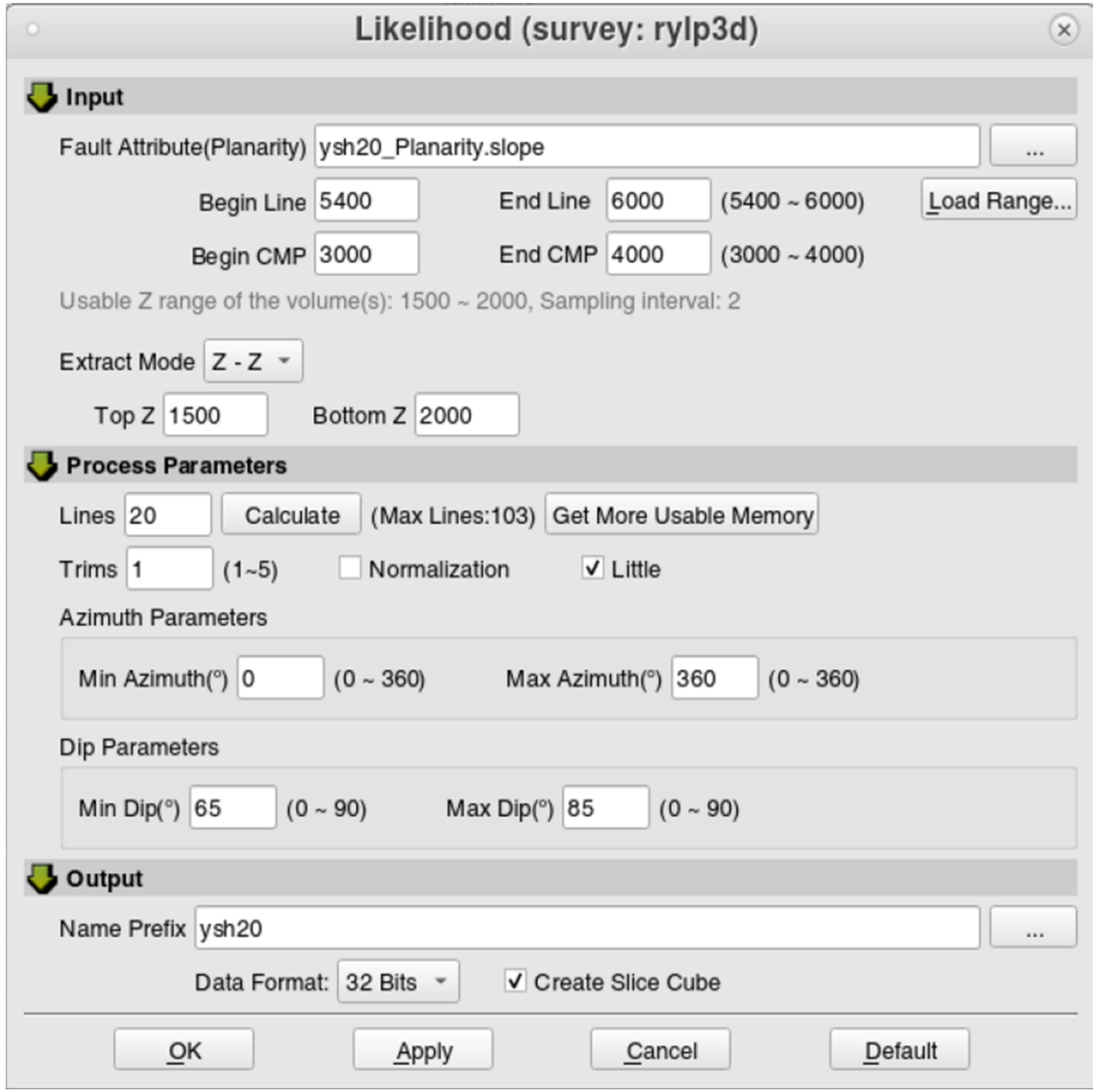
⑤ **Dip Parameters:** 断层扫描倾角范围。

输出数据

① 细化后的断层属性数据

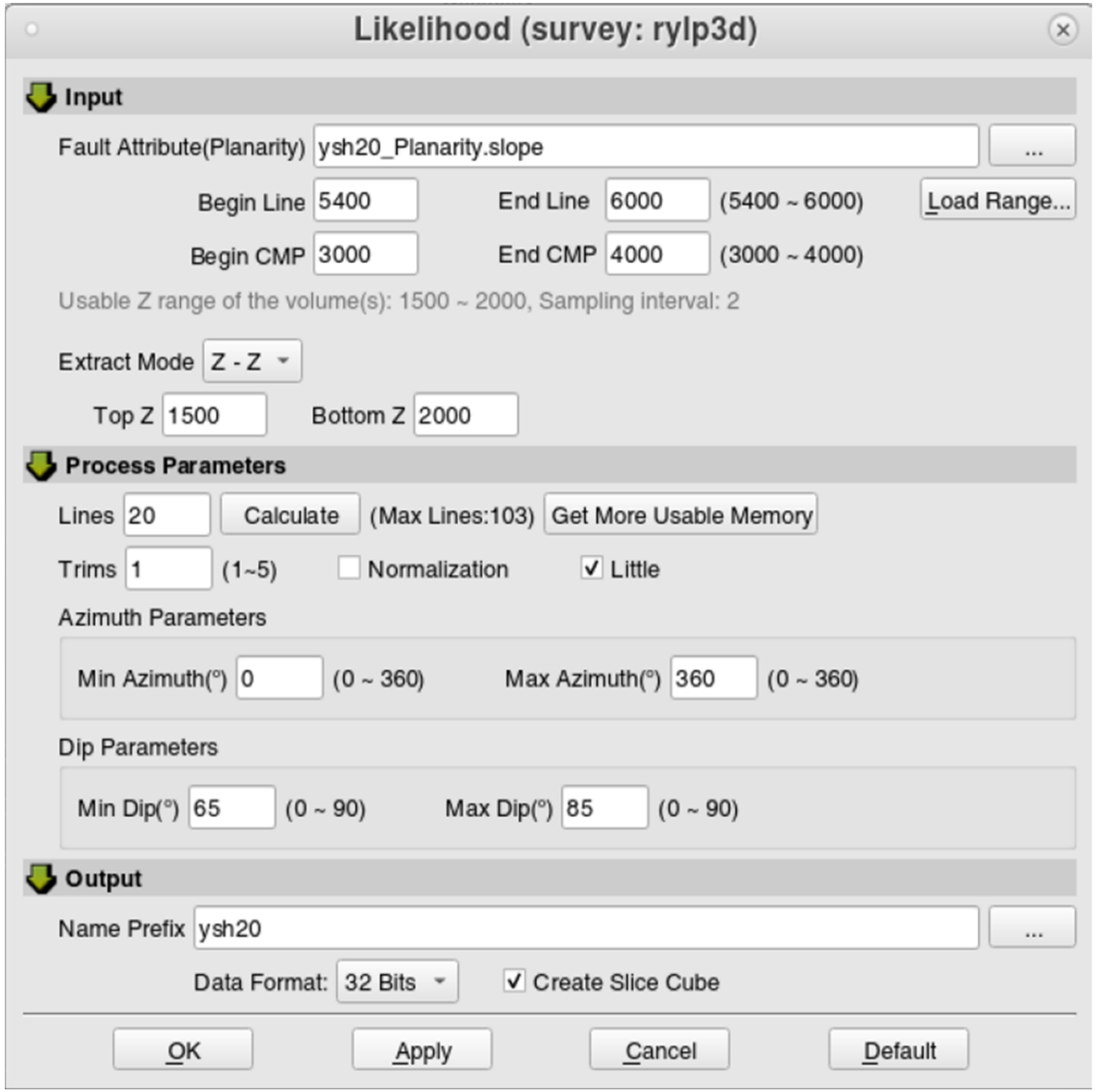
断层增强及细化

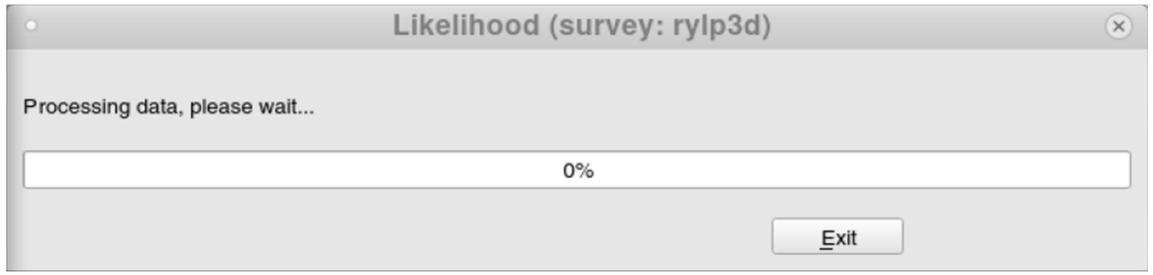
界面及参数



断层增强及细化

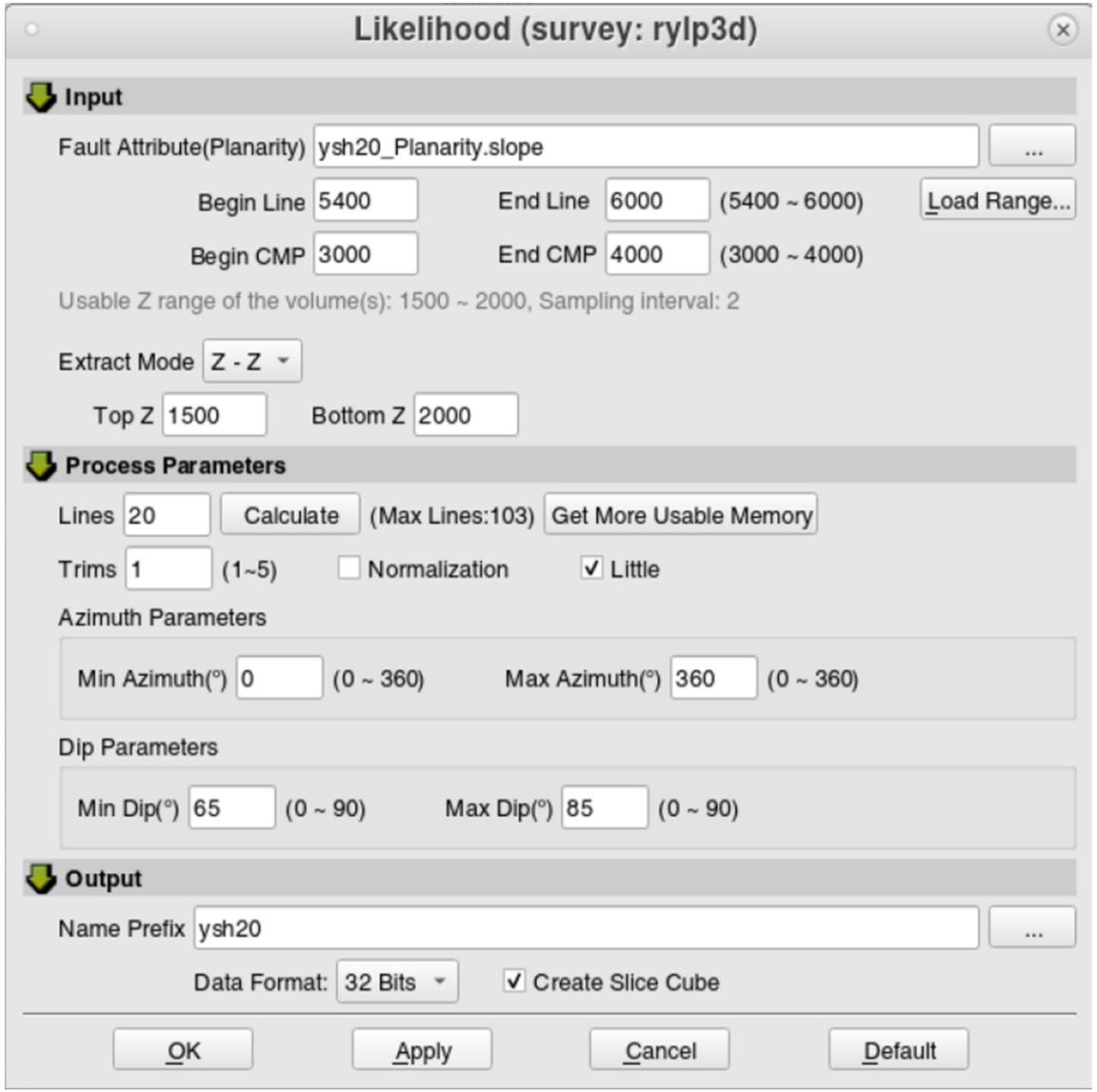
界面及参数

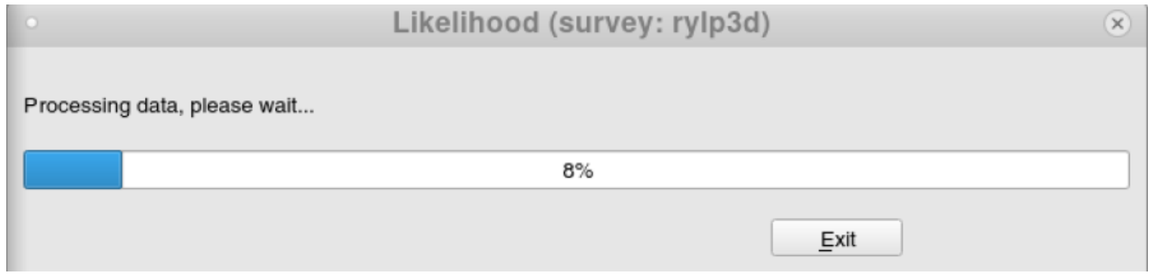




断层增强及细化

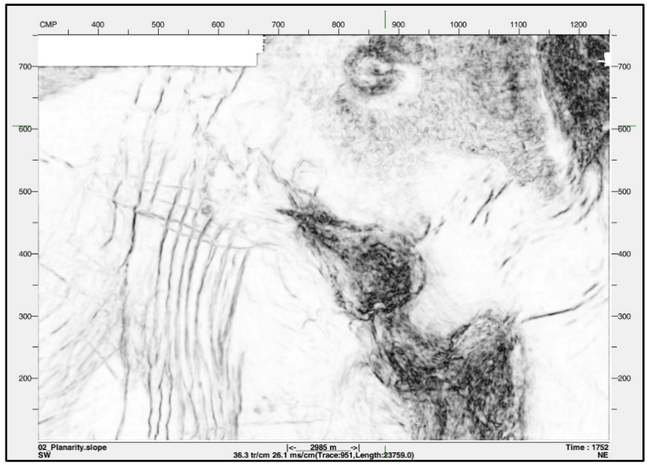
界面及参数

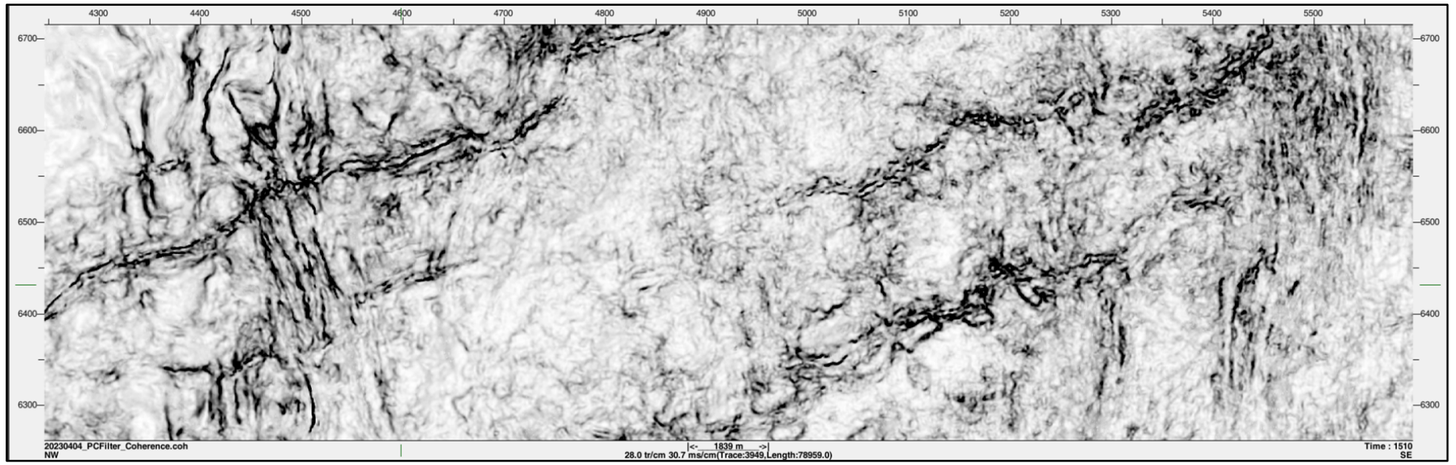


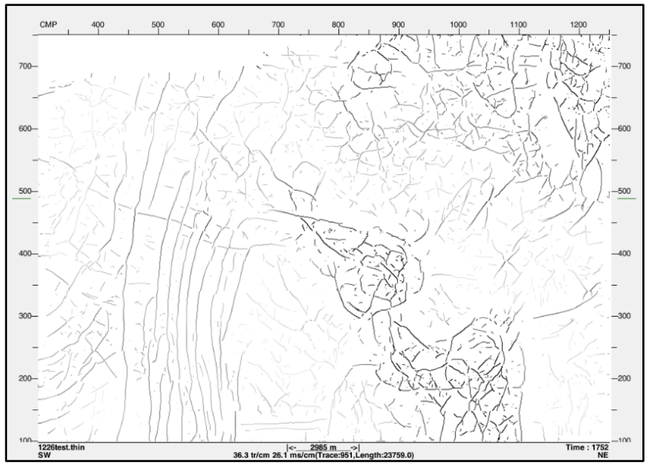


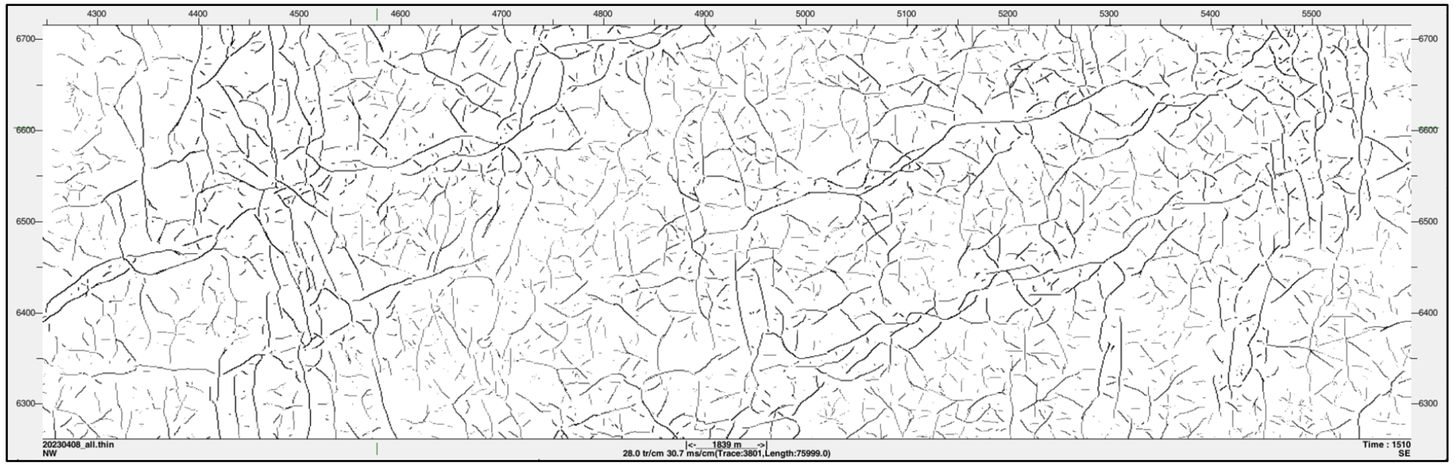
1.应用

断层属性

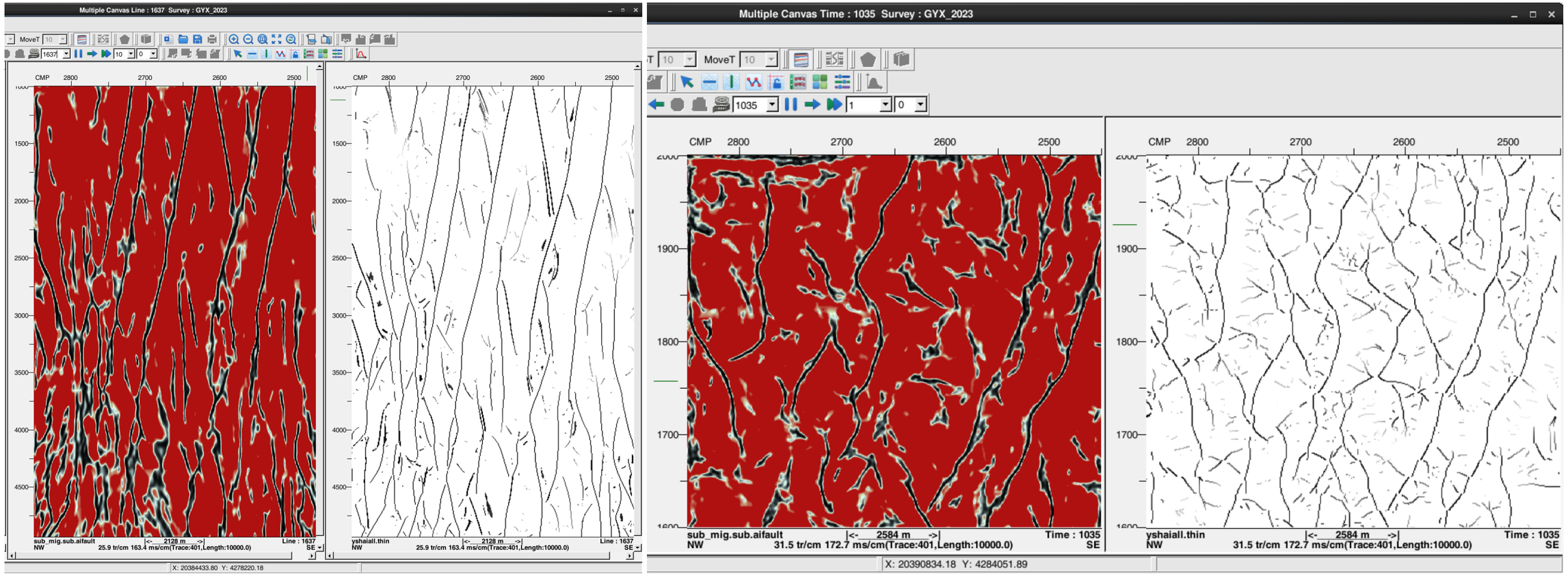

CMP
02_Planarity.slope
SW
36.3 tr/cm 26.1 ms/cm(Trace:951,Length:23759.0)
Time : 1752
NE


20230404_PCFilter_Coherence.coh
NW
28.0 tr/cm 30.7 ms/cm(Trace:3949,Length:78959.0)
Time : 1510
SE


CMP
1226test.thin
SW
36.3 tr/cm 26.1 ms/cm(Trace:951,Length:23759.0)
Time : 1752
NE

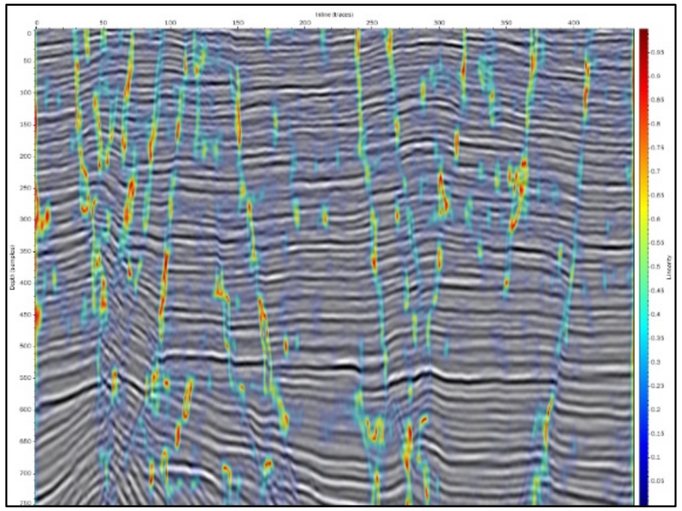

20230408_all.thin
NW
28.0 tr/cm 30.7 ms/cm(Trace:3801,Length:75999.0)
Time : 1510
SE

2.应用

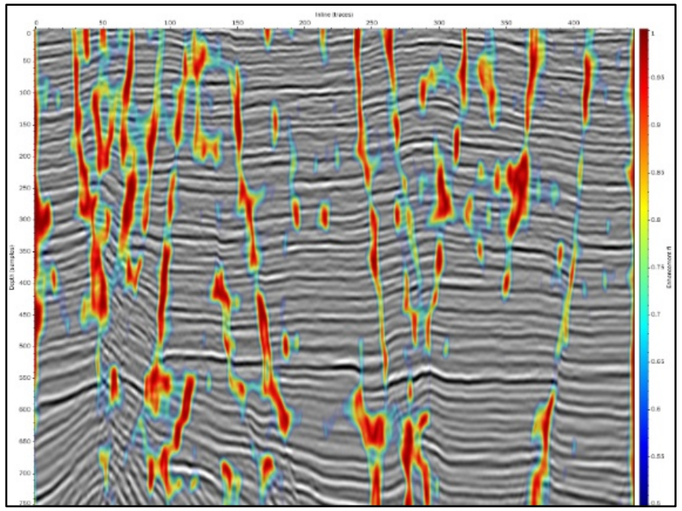

Multiple Canvas Line : 1637 Survey : GYX_2023
CMP 2800 2700 2600 2500
sub_mig.sub.aifault
NW
25.9 tr/cm 163.4 ms/cm(Trace:401,Length:10000.0)
SE
yshiall.thin
Multiple Canvas Time : 1035 Survey : GYX_2023
sub_mig.sub.aifault
NW
31.5 tr/cm 172.7 ms/cm(Trace:401,Length:10000.0)
SE
yshiall.thin
X: 20390834.18 Y: 4284051.89

3.应用

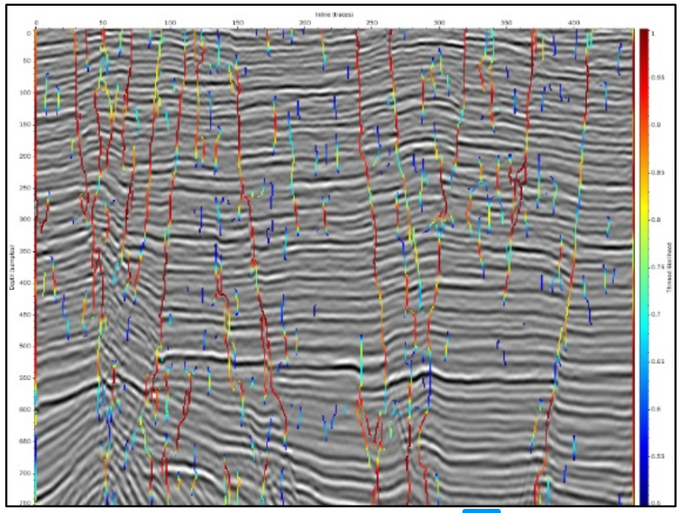
断层自动/半自动提取



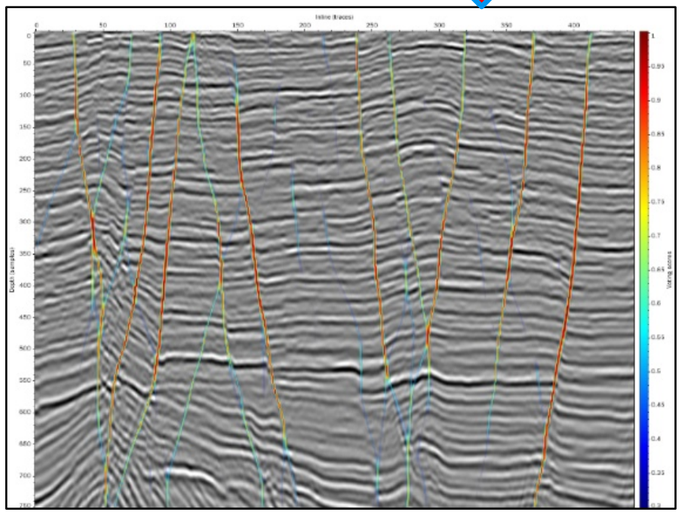
1)断层属性提取



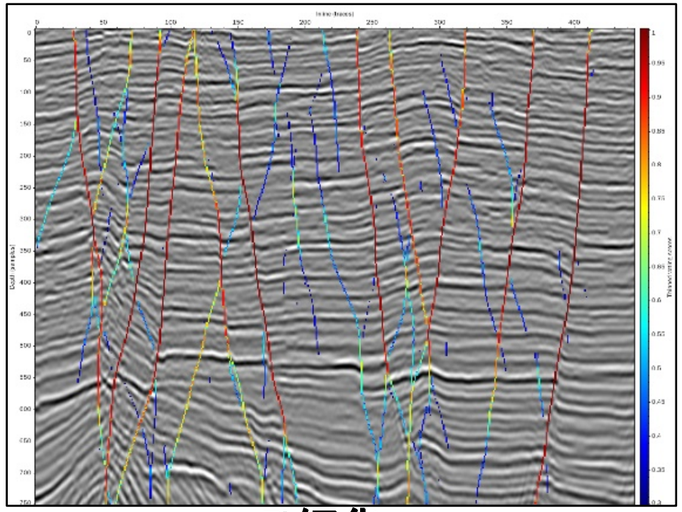
2)增强



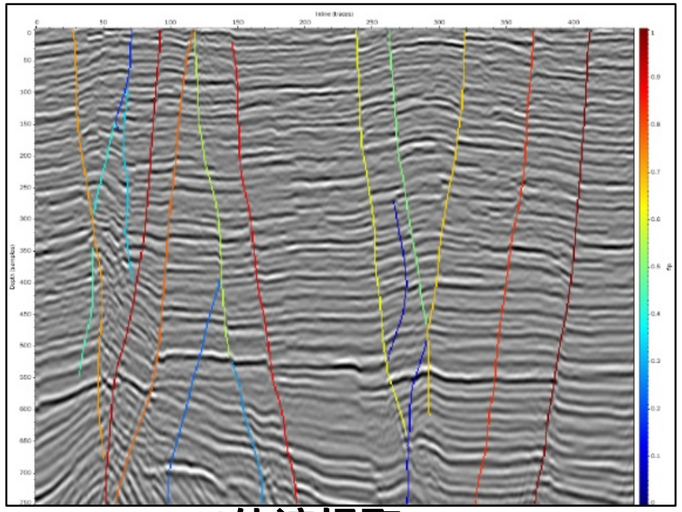
3)细化



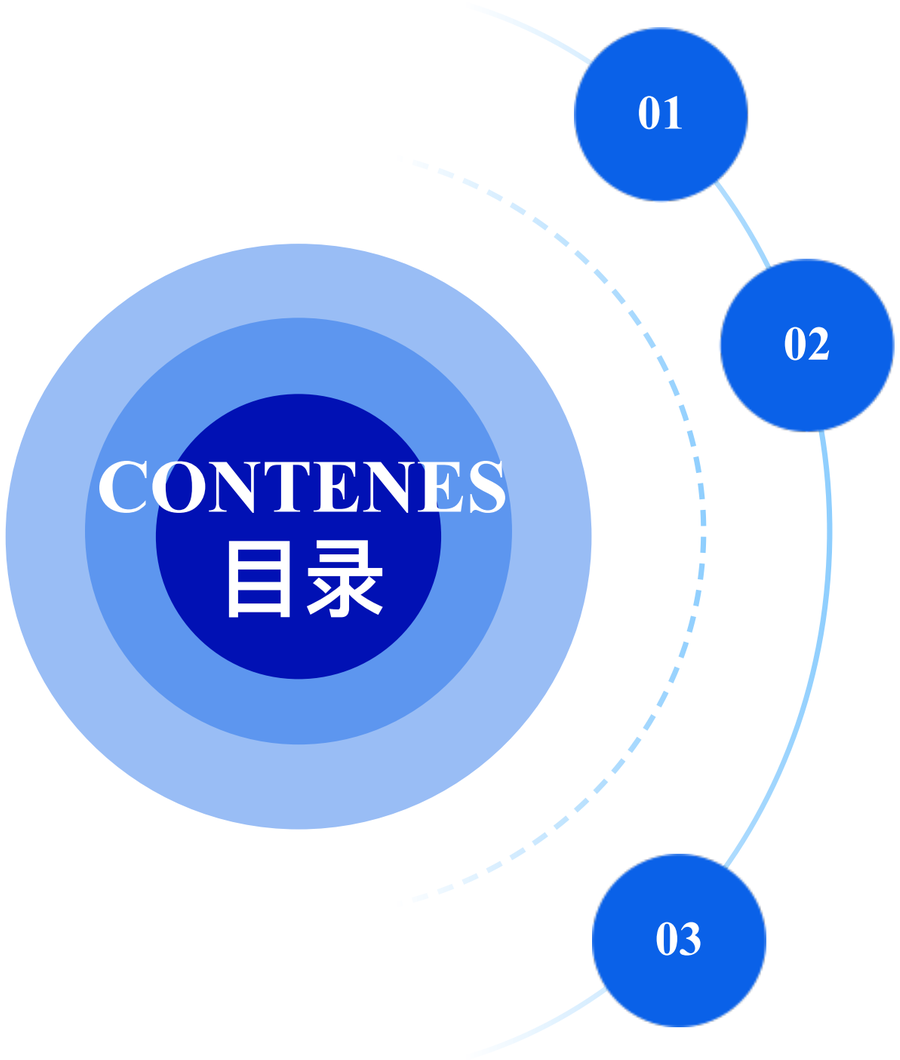
4)优化



5)细化

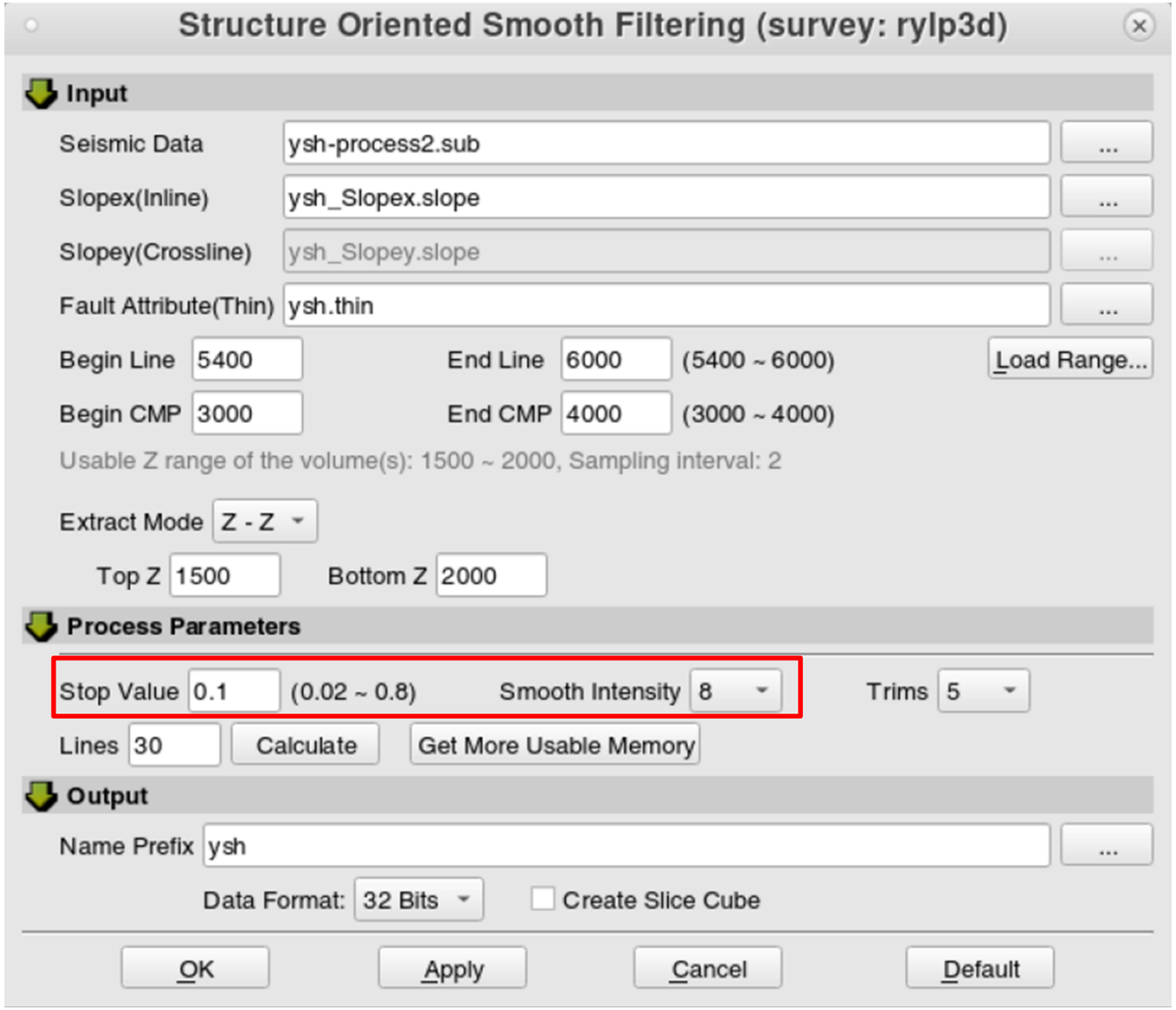


6)轨迹提取



断层保护平滑滤波

界面及参数



输入数据

① **Seismic Volume :** 地震数据体；

② **Slopex:**Inline方向斜率；

③ **Slopey:**Crossline方向斜率；

④ **Fault Attribute**(**Thin**):断层属性(细化)。

计算参数

① **Stop Value:** 平滑终止条件；

② **Smooth Intensity:** 平滑强度；

③ **Lines:** lines[20,50],Calculate估算当前可用内存m，m>=[200,500]；

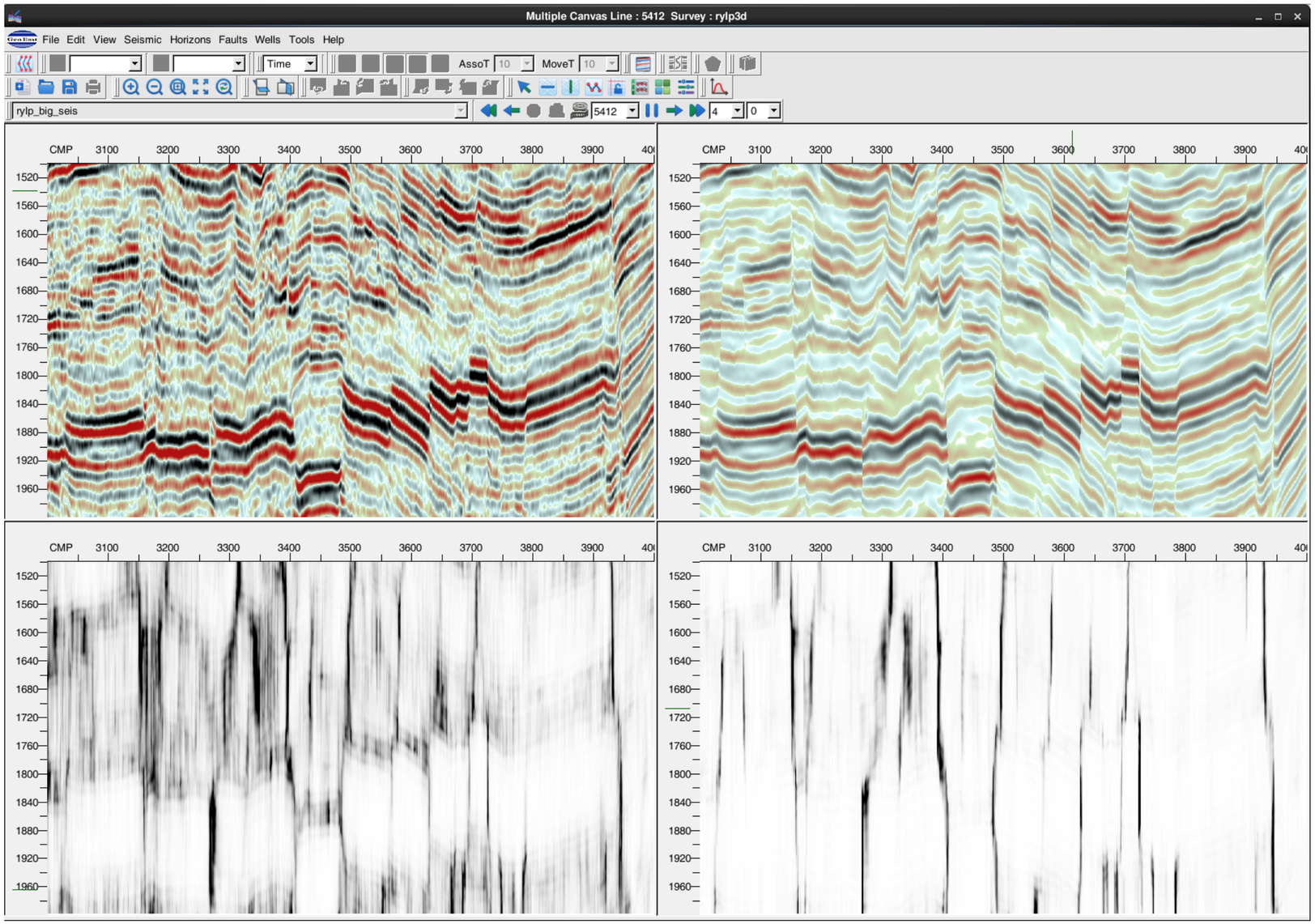
④ Trims：分块计算后，数据拼接处理，要求数据重叠， trims决定重叠线的数目(1/2)；

输出数据

① **滤波后的地震数据体**

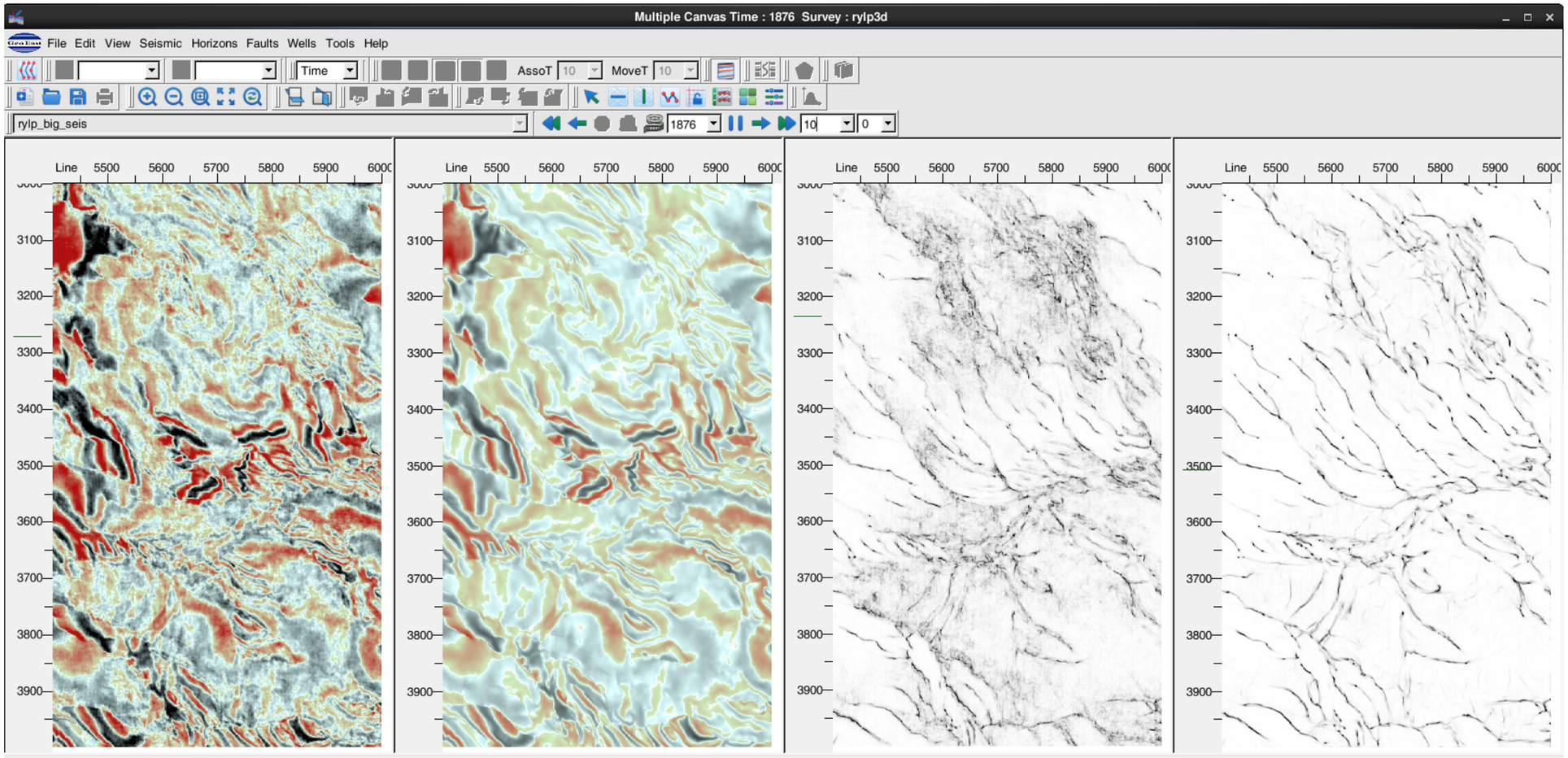
1.应用

断层属性提取

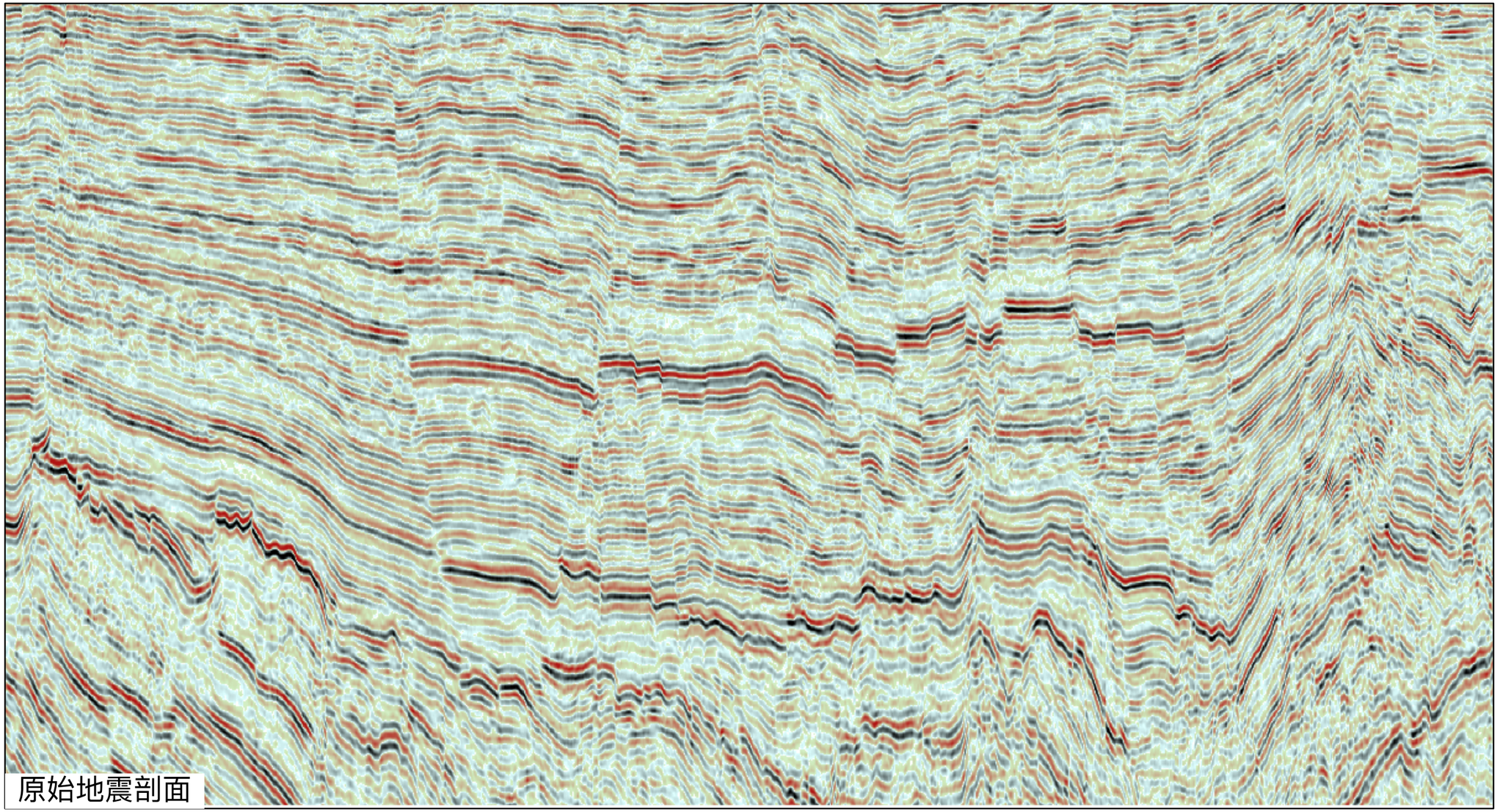

Multiple Canvas Line : 5412 Survey : rylp3d
File Edit View Seismic Horizons Faults Wells Tools Help
Time
AssoT 10
MoveT 10
rylp_big_seis
5412
CMP 3100 3200 3300 3400 3500 3600 3700 3800 3900
1520 1560 1600 1640 1680 1720 1760 1800 1840 1880 1920 1960

1.应用

断层属性提取


Multiple Canvas Time : 1876 Survey : rylp3d
File Edit View Seismic Horizons Faults Wells Tools Help
Time
AssoT 10
MoveT 10
rylp_big_seis
1876
10
0
Line 5500 5600 5700 5800 5900 6000
3100
3200
3300
3400
3500
3600
3700
3800
3900

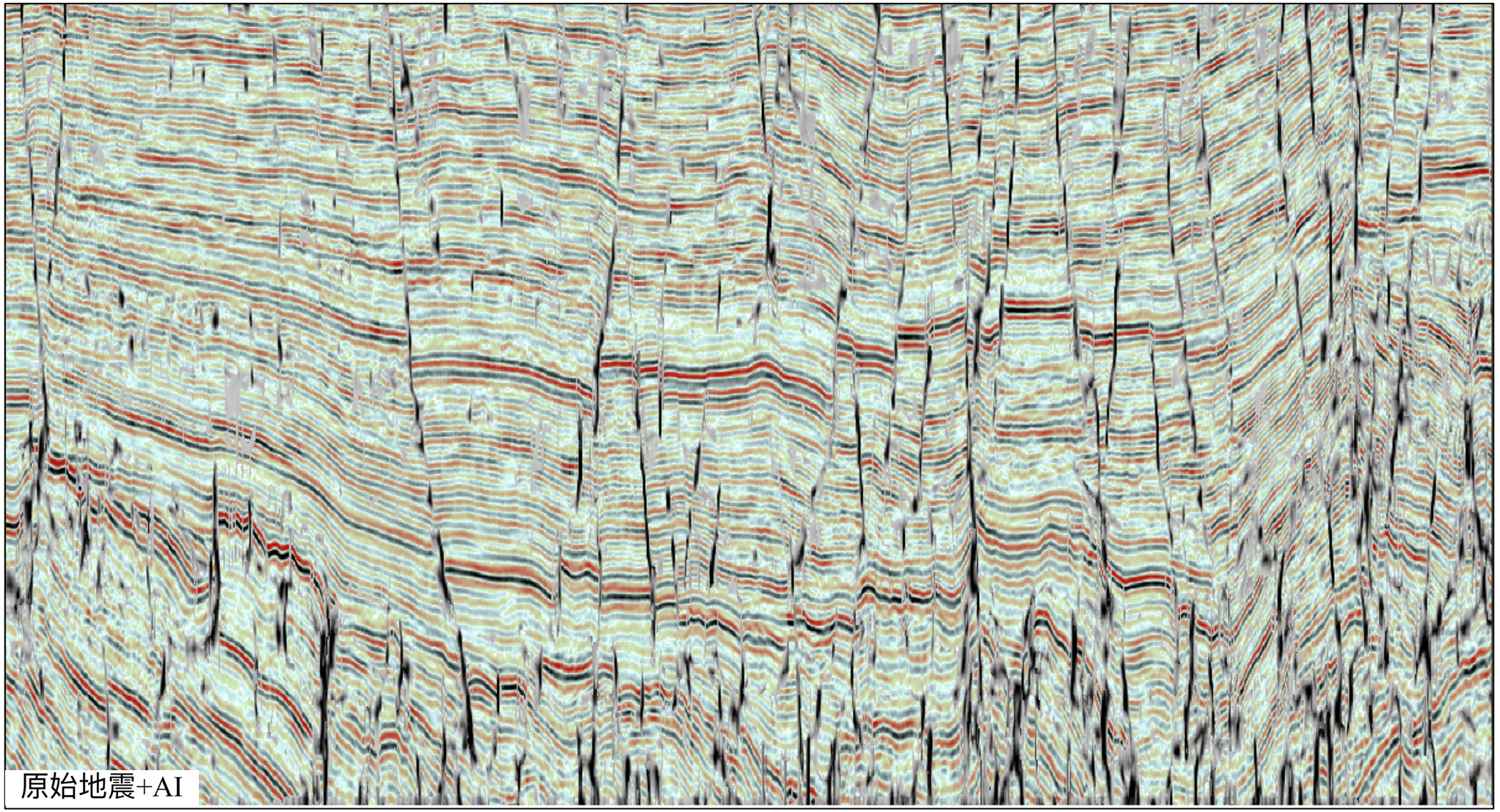
2.应用



原始地震剖面

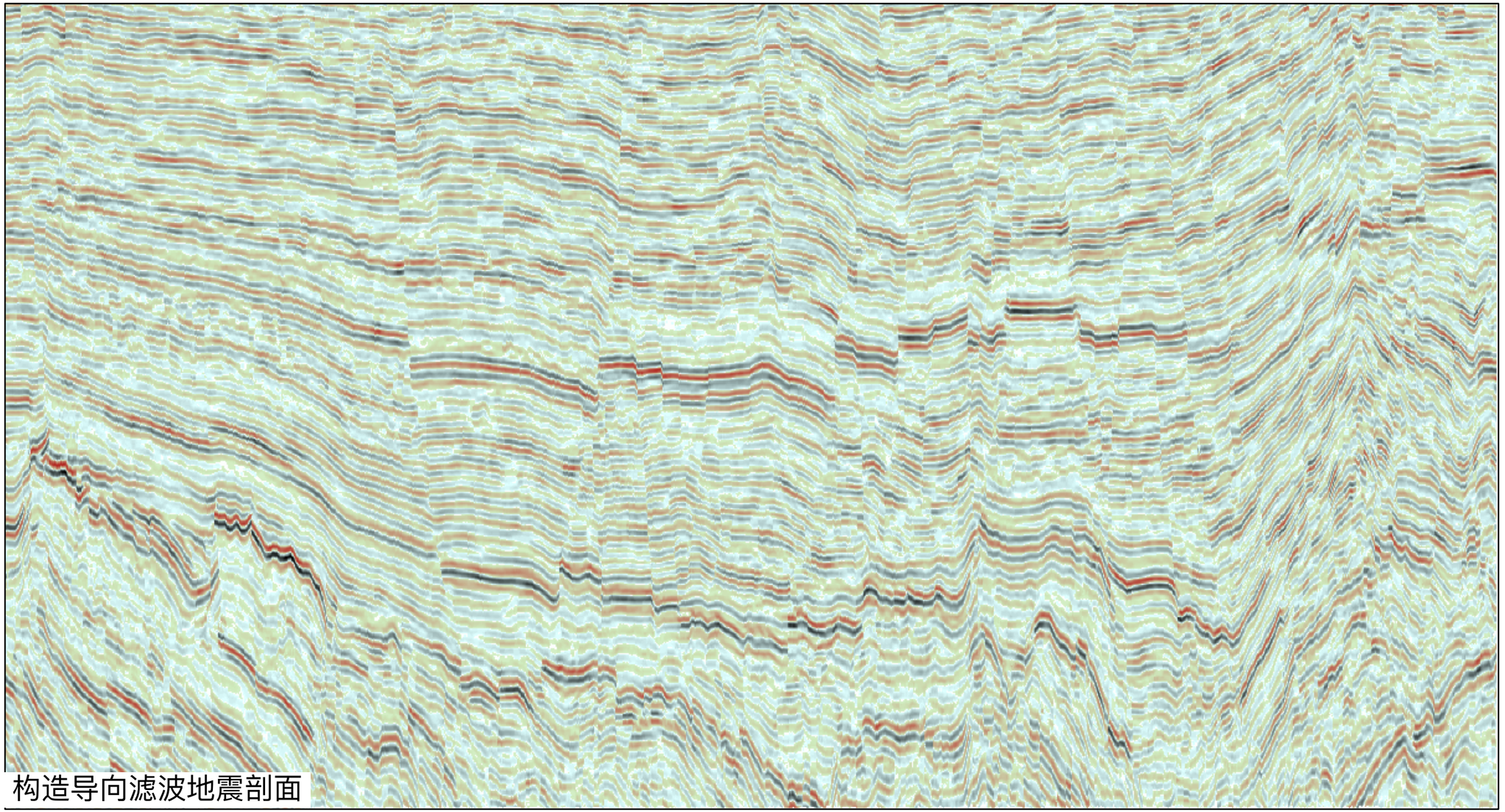
2.应用

AI断层识别



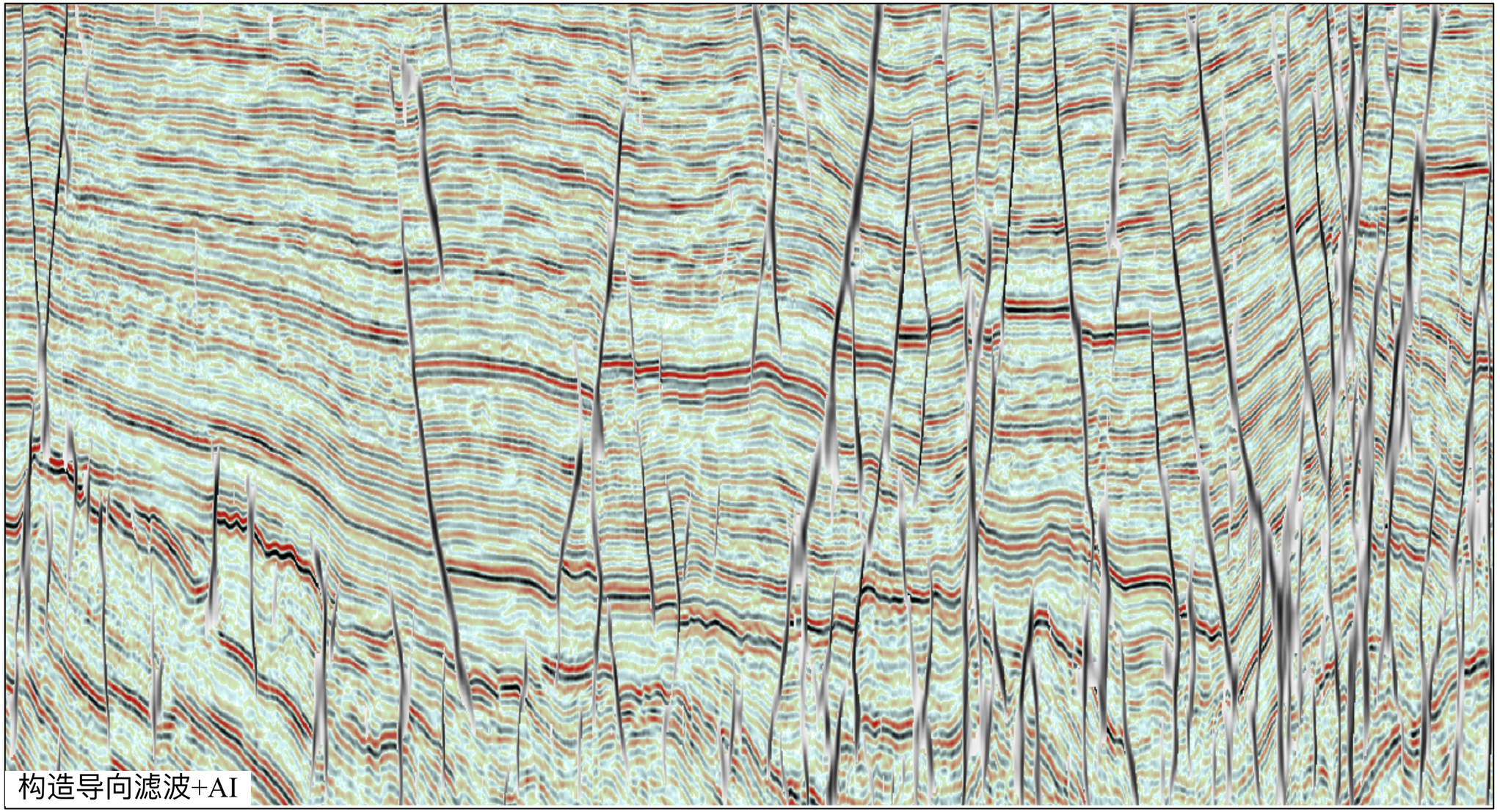
原始地震+AI

2.应用



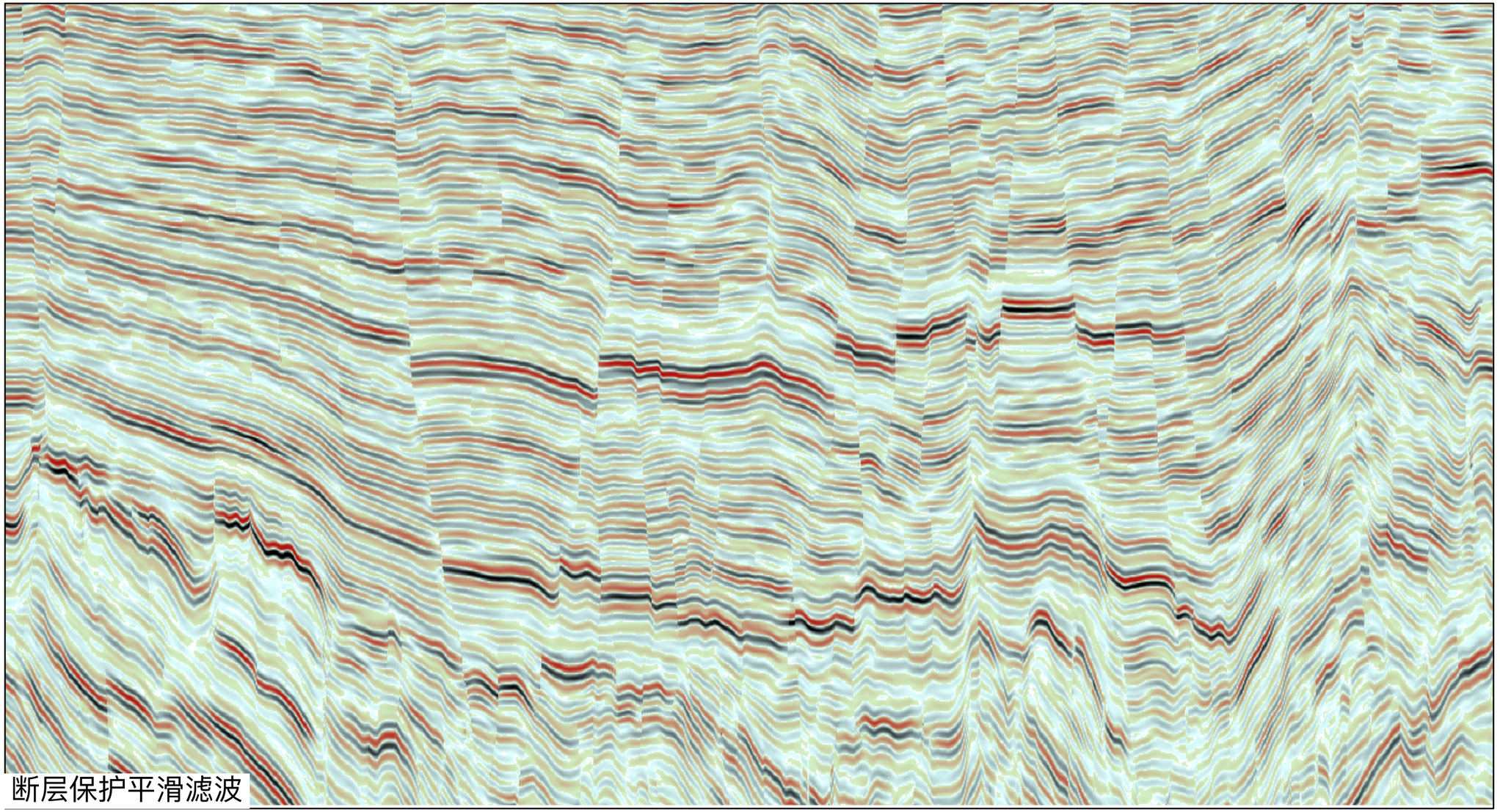
构造导向滤波地震剖面

2.应用



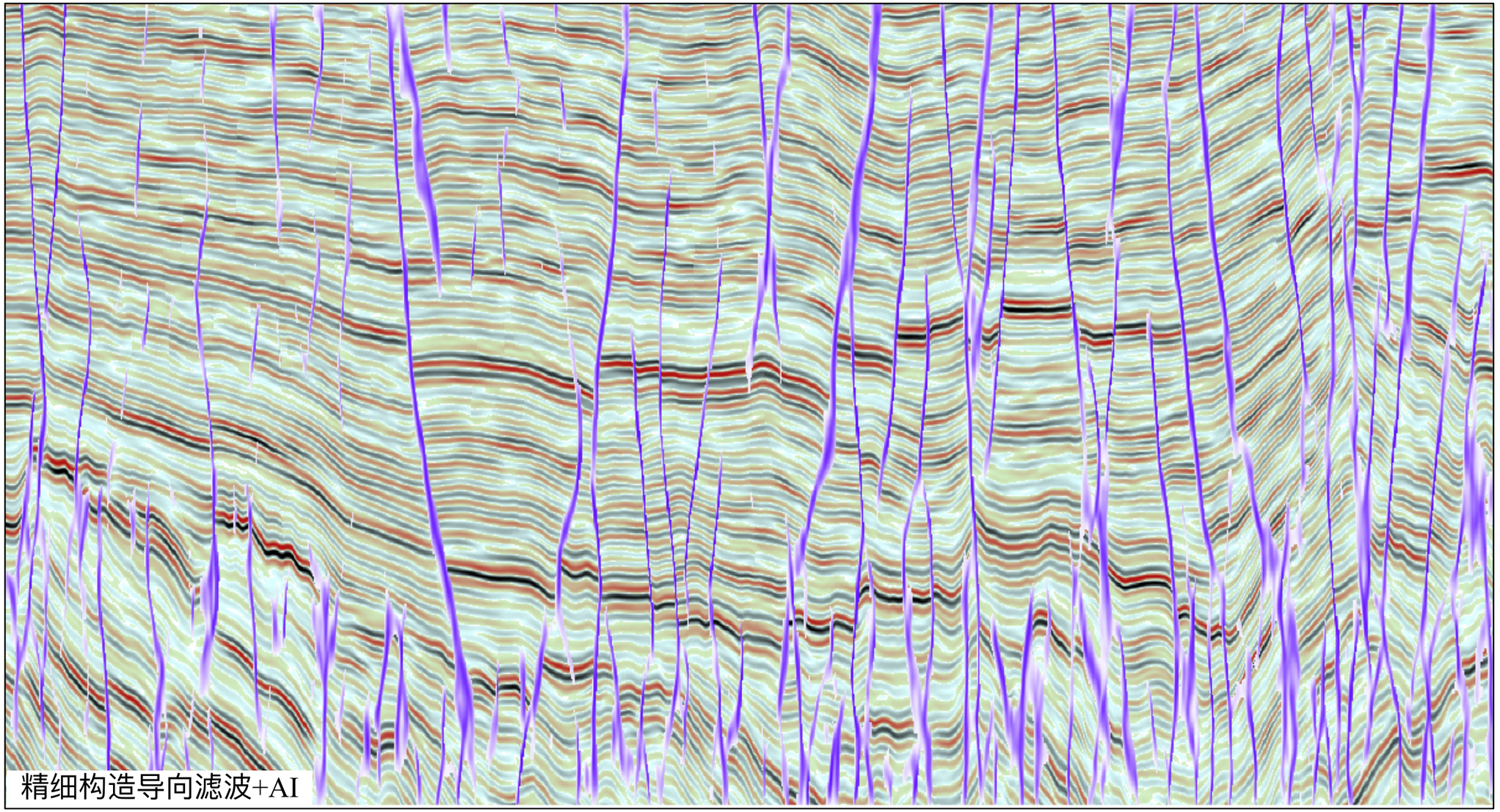
构造导向滤波+AI

2.应用



断层保护平滑滤波

2.应用



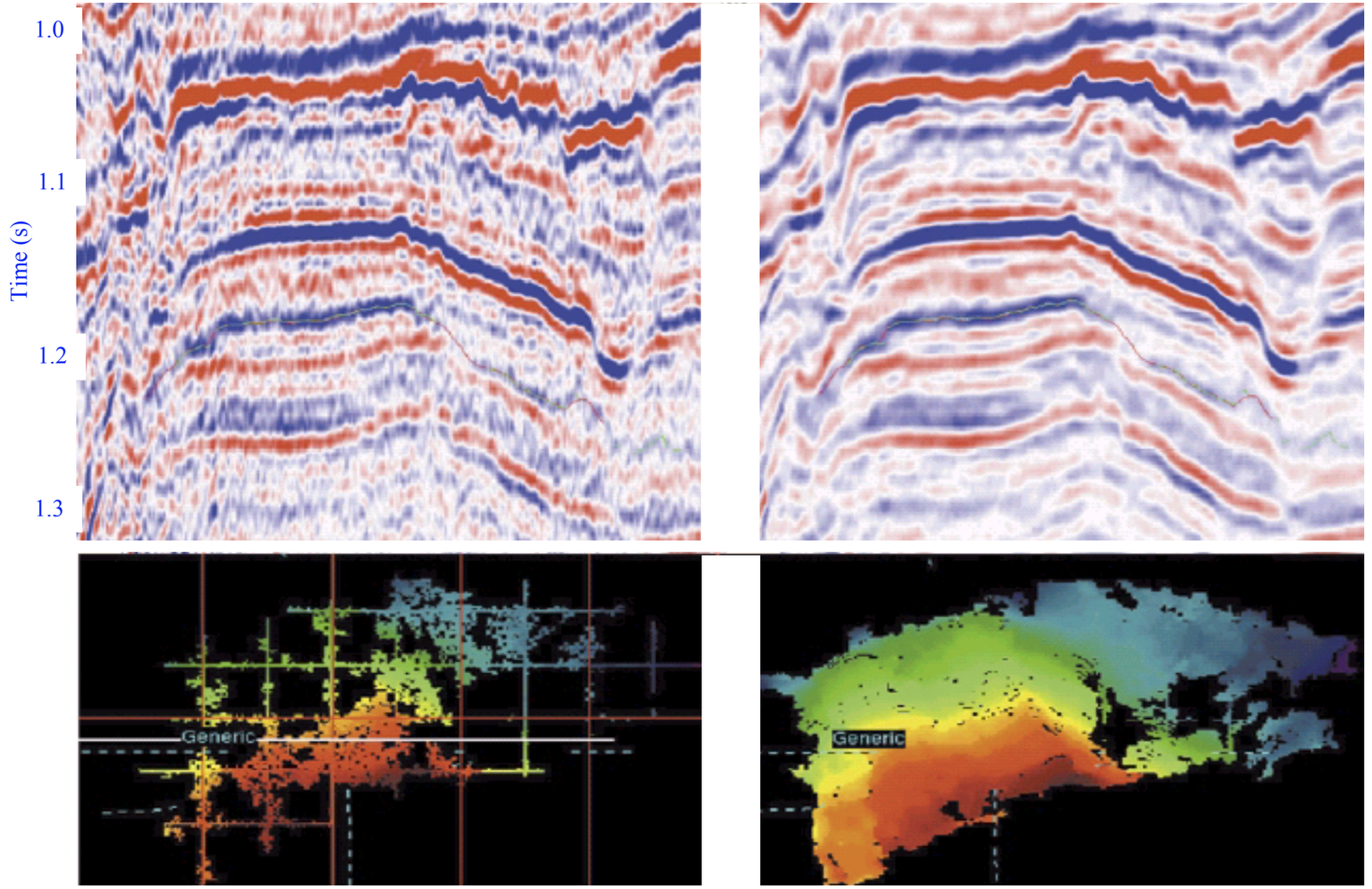
精细构造导向滤波+AI

3.应用

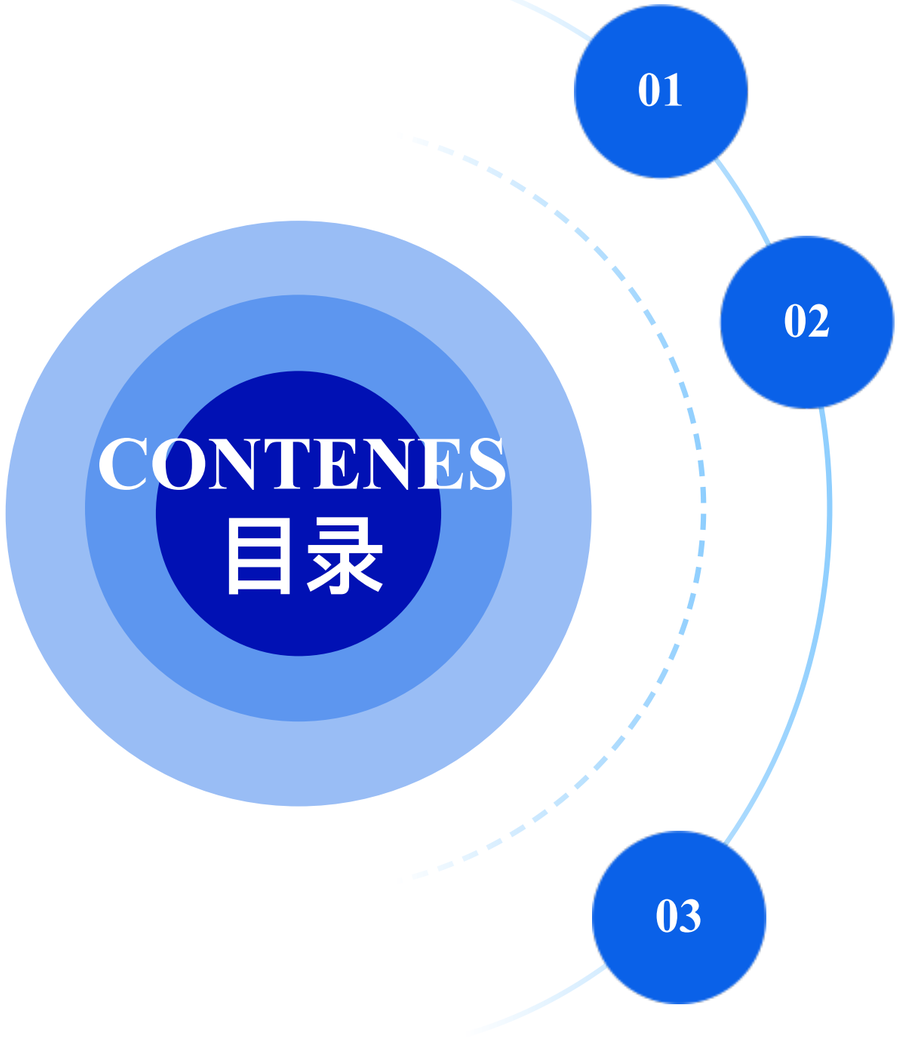
层位自动追踪

滤波前

滤波后



Hoecker and Fehmers, 2002



研究背景

断层预测增强功能介绍

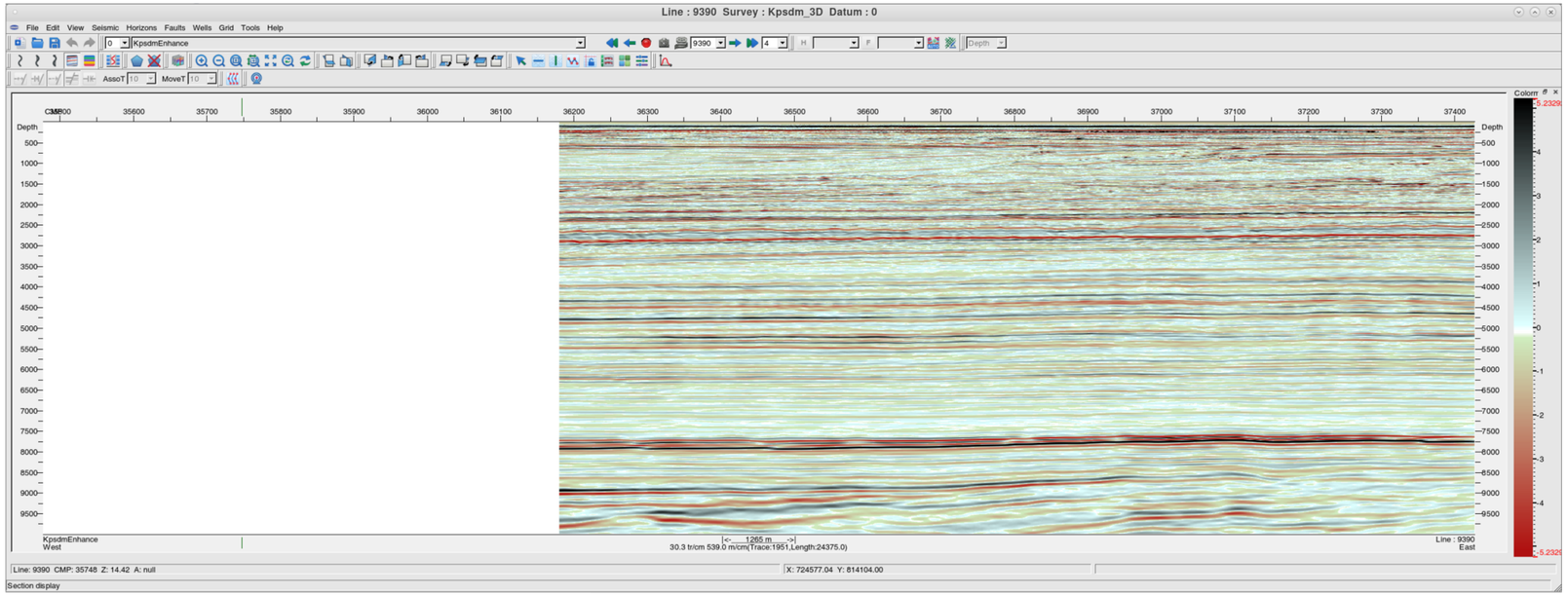
地层斜率与断层属性估算

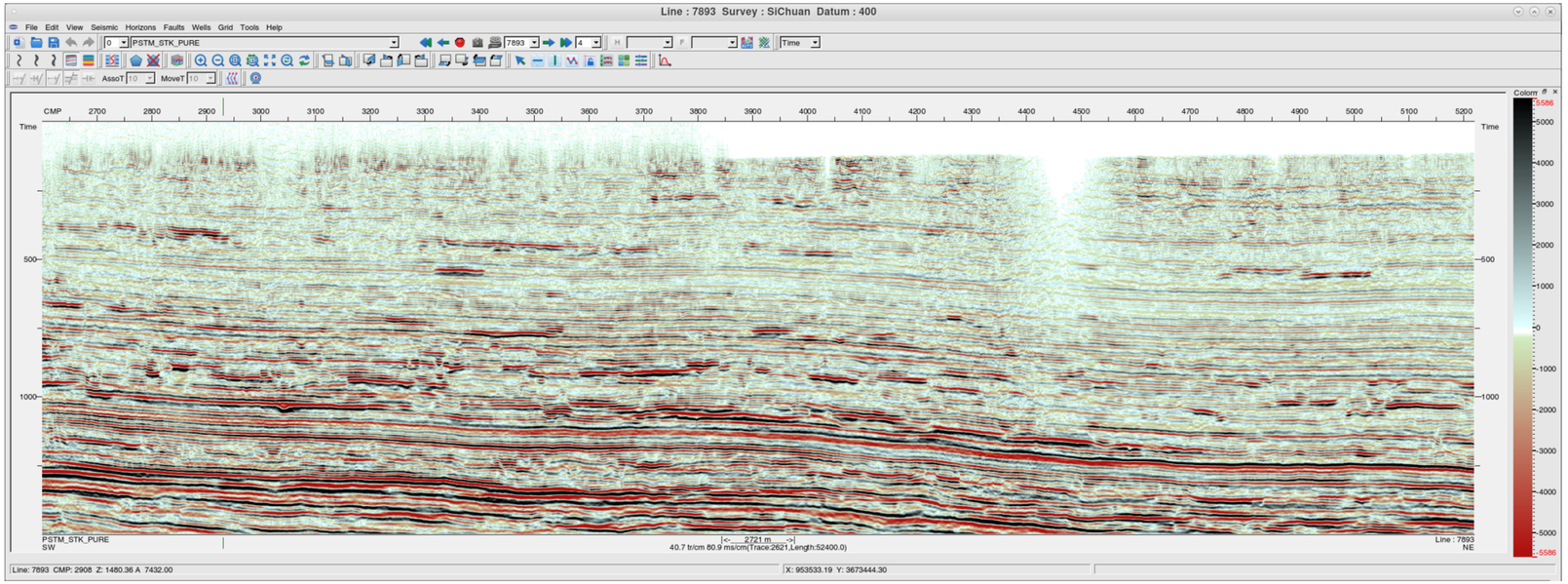
断层增强及细化

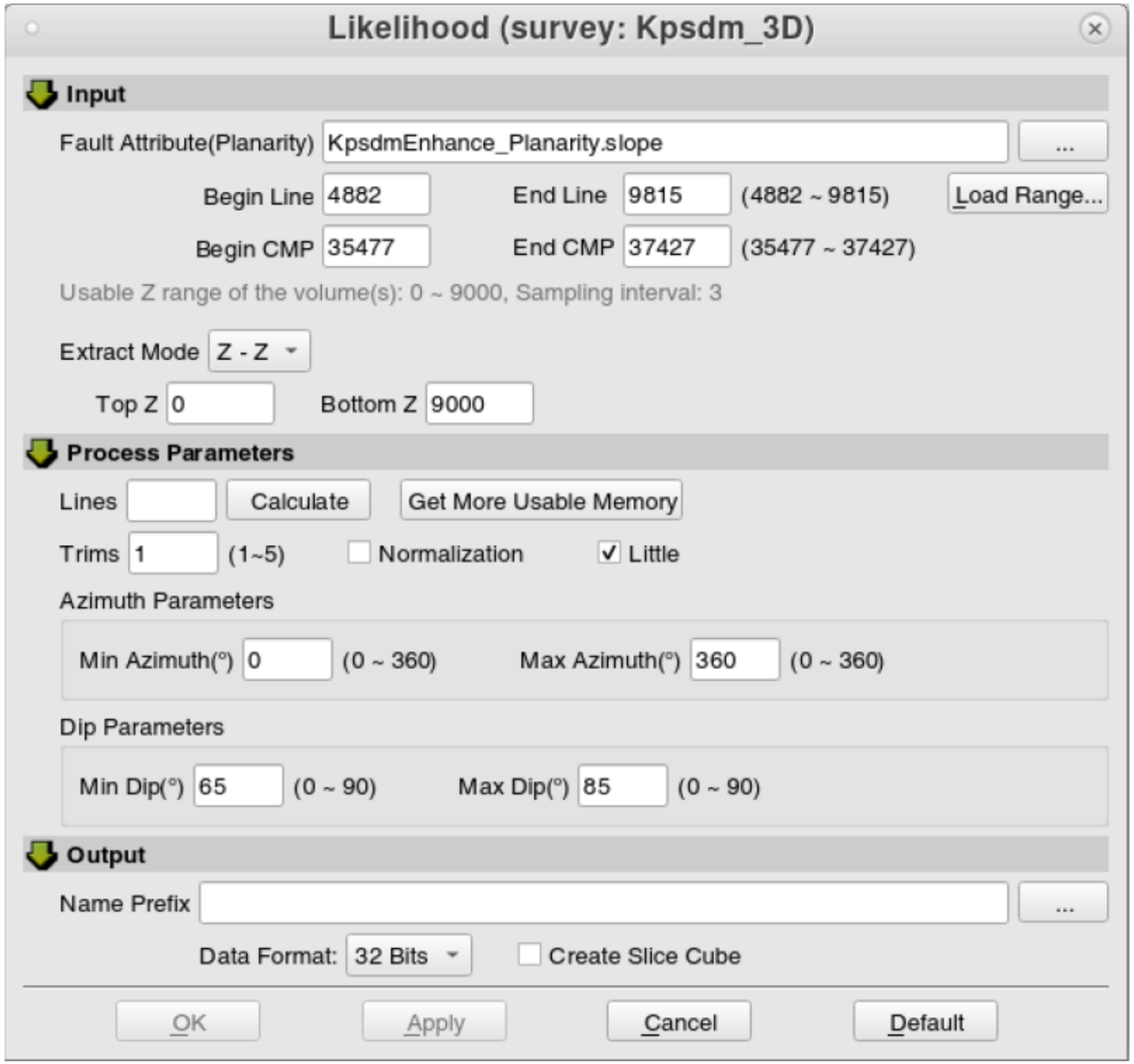
断层保护平滑滤波

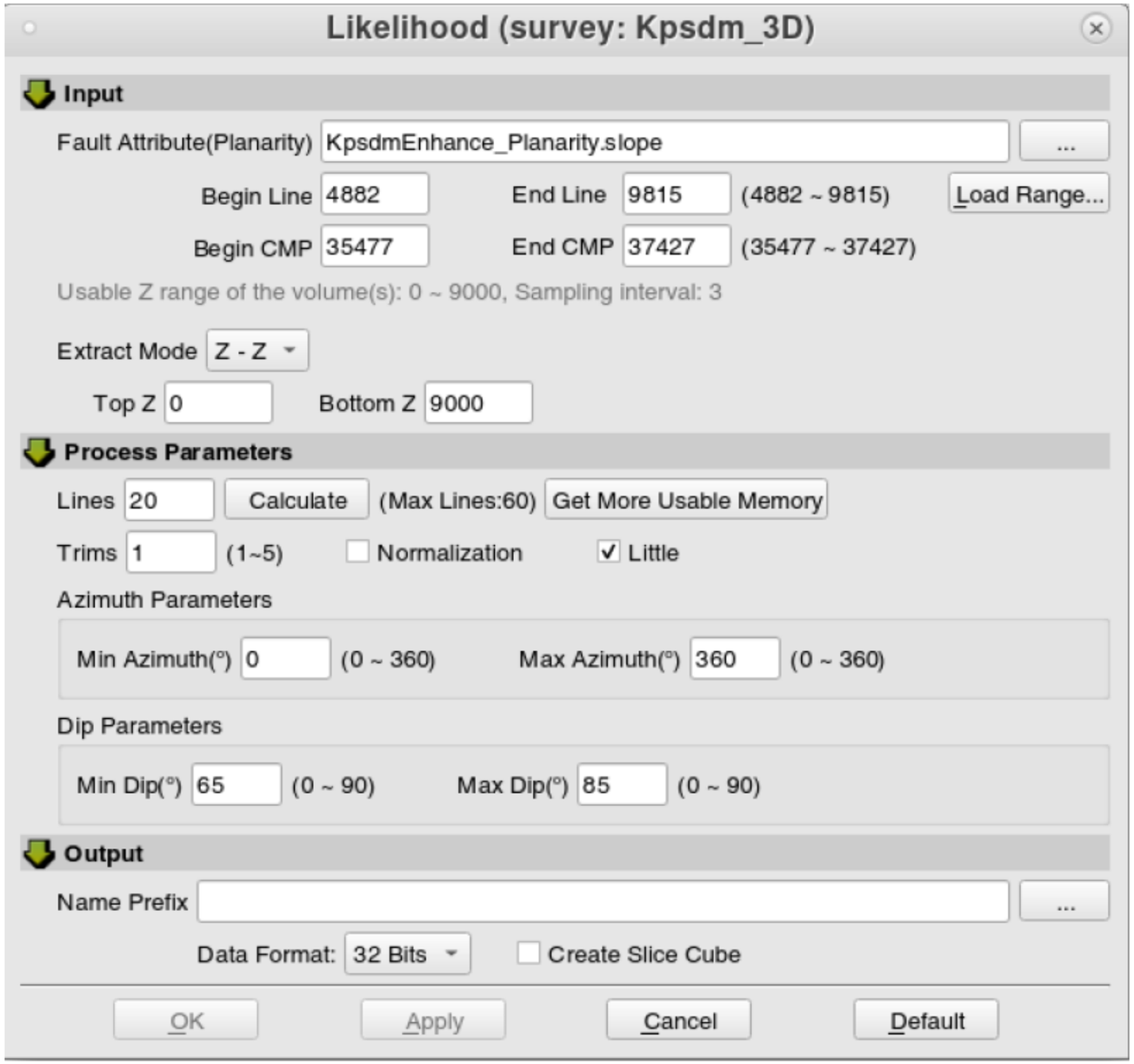
注意事项及流程建议

1.建议


Line : 9390 Survey : Kpsdm_3D Datum : 0
File Edit View Seismic Horizons Faults Wells Grid Tools Help
KpsdmEnhance
AssoT MoveT
CMP
Depth
KpsdmEnhance
West
Line : 9390
East
30.3 tr/cm 539.0 m/cm(Trace:1951,Length:24375.0)
Line: 9390 CMP: 35748 Z: 14.42 A: null
X: 724577.04 Y: 814104.00
Section display

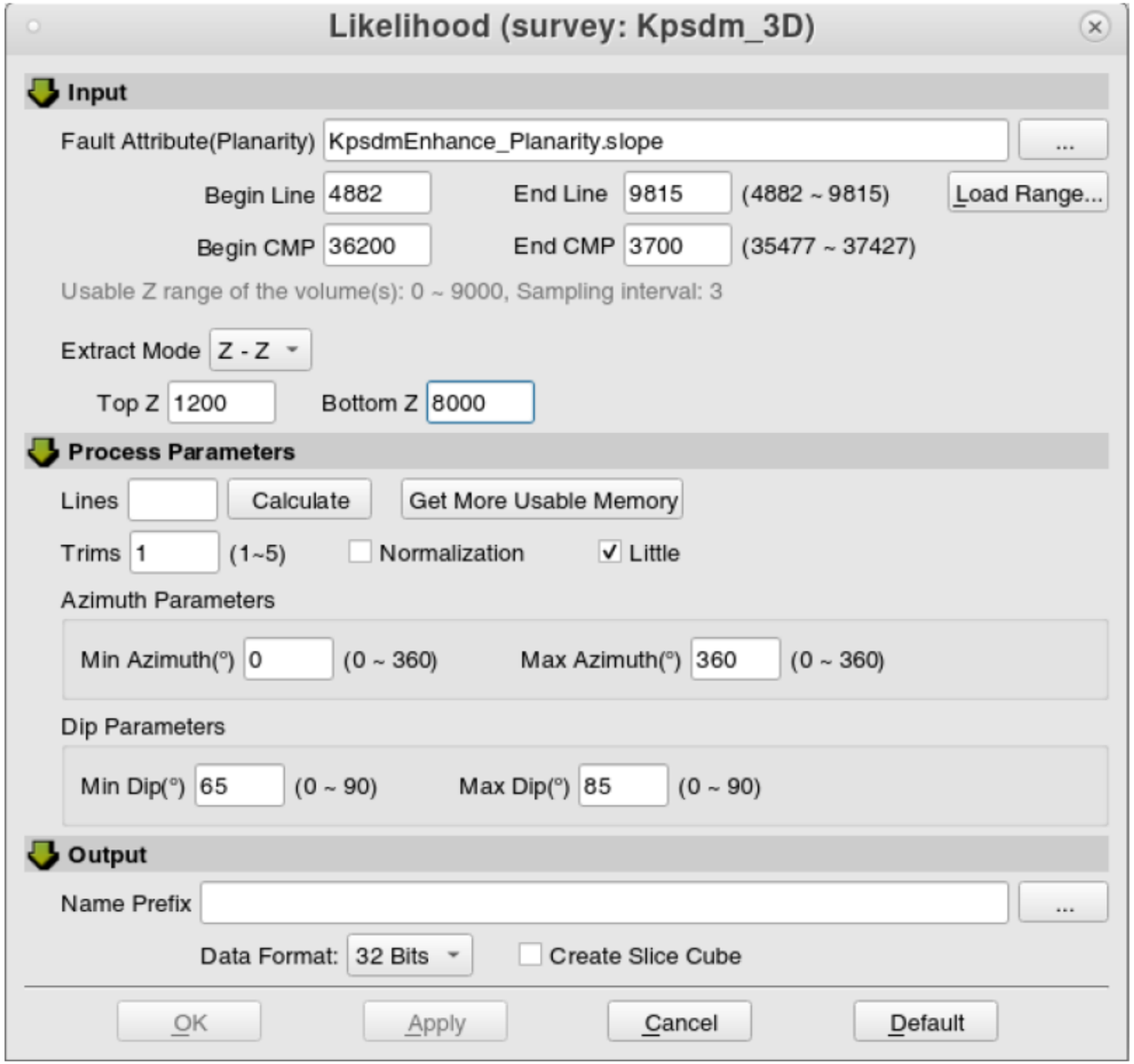

Line : 7893 Survey : SiChuan Datum : 400
File Edit View Seismic Horizons Faults Wells Grid Tools Help
PSTM_STK_PURE
AssoT MoveT
CMP
Time
PSTM_STK_PURE
SW
Line : 7893
NE
40.7 tr/cm 80.9 ms/cm(Trace:2621,Length:52400.0)
Line: 7893 CMP: 2908 Z: 1480.36 A 7432.00
X: 953533.19 Y: 3673444.30


Likelihood (survey: Kpsdm_3D)
Input
Fault Attribute(Planarity)
KpsdmEnhance_Planarity.slope
...
Begin Line
4882
End Line
9815
(4882 ~ 9815)
Load Range...
Begin CMP
35477
End CMP
37427
(35477 ~ 37427)
Usable Z range of the volume(s): 0 ~ 9000, Sampling interval: 3
Extract Mode
Z - Z
Top Z
0
Bottom Z
9000
Process Parameters
Lines
Calculate
Get More Usable Memory
Trims
1
(1~5)
Normalization
Little
Azimuth Parameters
Min Azimuth(°)
0
(0 ~ 360)
Max Azimuth(°)
360
(0 ~ 360)
Dip Parameters
Min Dip(°)
65
(0 ~ 90)
Max Dip(°)
85
(0 ~ 90)
Output
Name Prefix
...
Data Format:
32 Bits
Create Slice Cube
OK
Apply
Cancel
Default


Likelihood (survey: Kpsdm_3D)
Input
Fault Attribute(Planarity)
KpsdmEnhance_Planarity.slope
...
Begin Line
4882
End Line
9815
(4882 ~ 9815)
Load Range...
Begin CMP
35477
End CMP
37427
(35477 ~ 37427)
Usable Z range of the volume(s): 0 ~ 9000, Sampling interval: 3
Extract Mode
Z - Z
Top Z
0
Bottom Z
9000
Process Parameters
Lines
20
Calculate
(Max Lines:60)
Get More Usable Memory
Trims
1
(1~5)
Normalization
Little
Azimuth Parameters
Min Azimuth(°)
0
(0 ~ 360)
Max Azimuth(°)
360
(0 ~ 360)
Dip Parameters
Min Dip(°)
65
(0 ~ 90)
Max Dip(°)
85
(0 ~ 90)
Output
Name Prefix
...
Data Format:
32 Bits
Create Slice Cube
OK
Apply
Cancel
Default

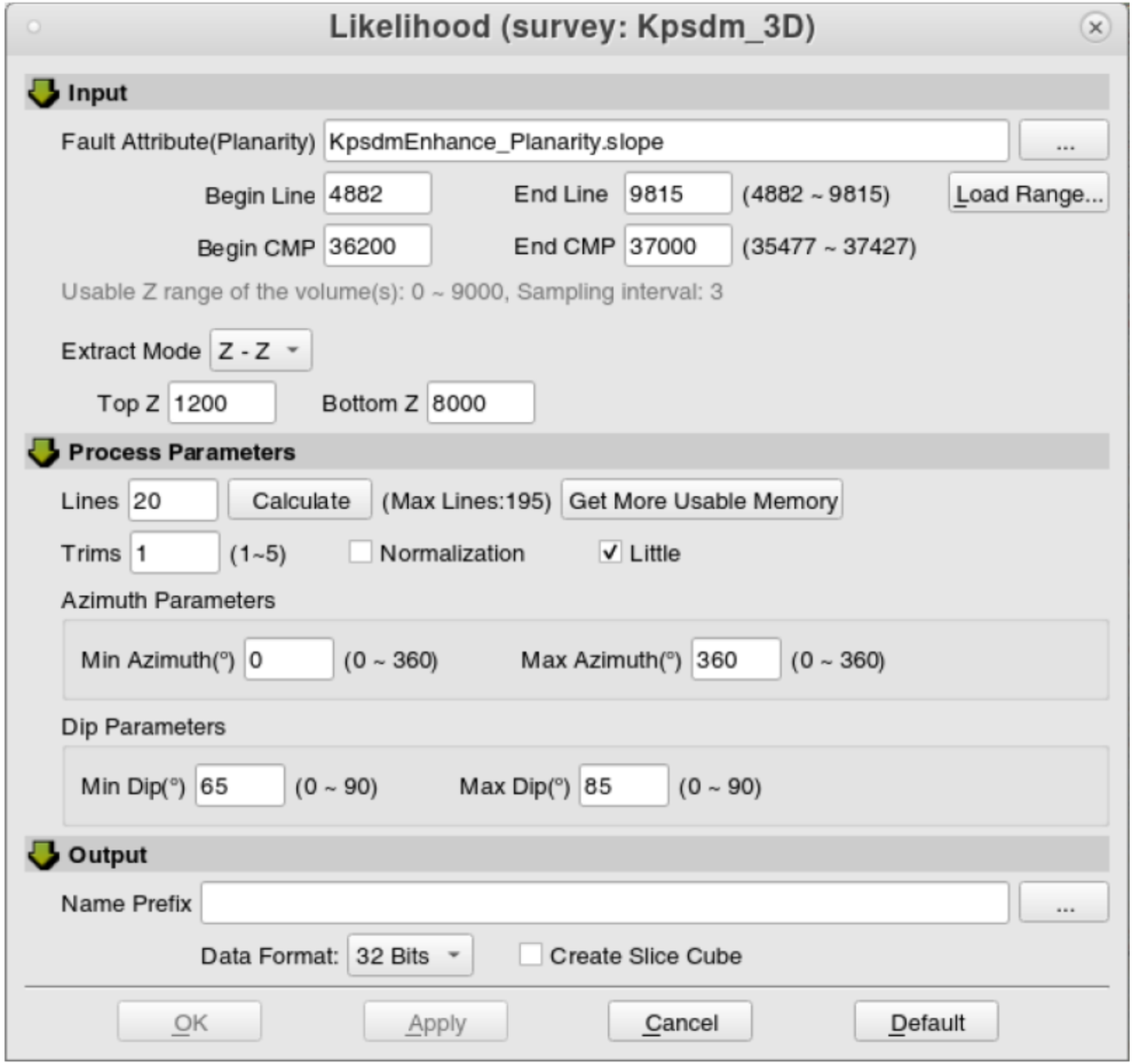
1.建议

范围确定


Likelihood (survey: Kpsdm_3D)
Input
Fault Attribute(Planarity)
KpsdmEnhance_Planarity.slope
...
Begin Line
4882
End Line
9815
(4882 ~ 9815)
Load Range...
Begin CMP
36200
End CMP
3700
(35477 ~ 37427)
Usable Z range of the volume(s): 0 ~ 9000, Sampling interval: 3
Extract Mode
Z - Z
Top Z
1200
Bottom Z
8000
Process Parameters
Lines
Calculate
Get More Usable Memory
Trims
1
(1~5)
Normalization
Little
Azimuth Parameters
Min Azimuth(°)
0
(0 ~ 360)
Max Azimuth(°)
360
(0 ~ 360)
Dip Parameters
Min Dip(°)
65
(0 ~ 90)
Max Dip(°)
85
(0 ~ 90)
Output
Name Prefix
...
Data Format:
32 Bits
Create Slice Cube
OK
Apply
Cancel
Default

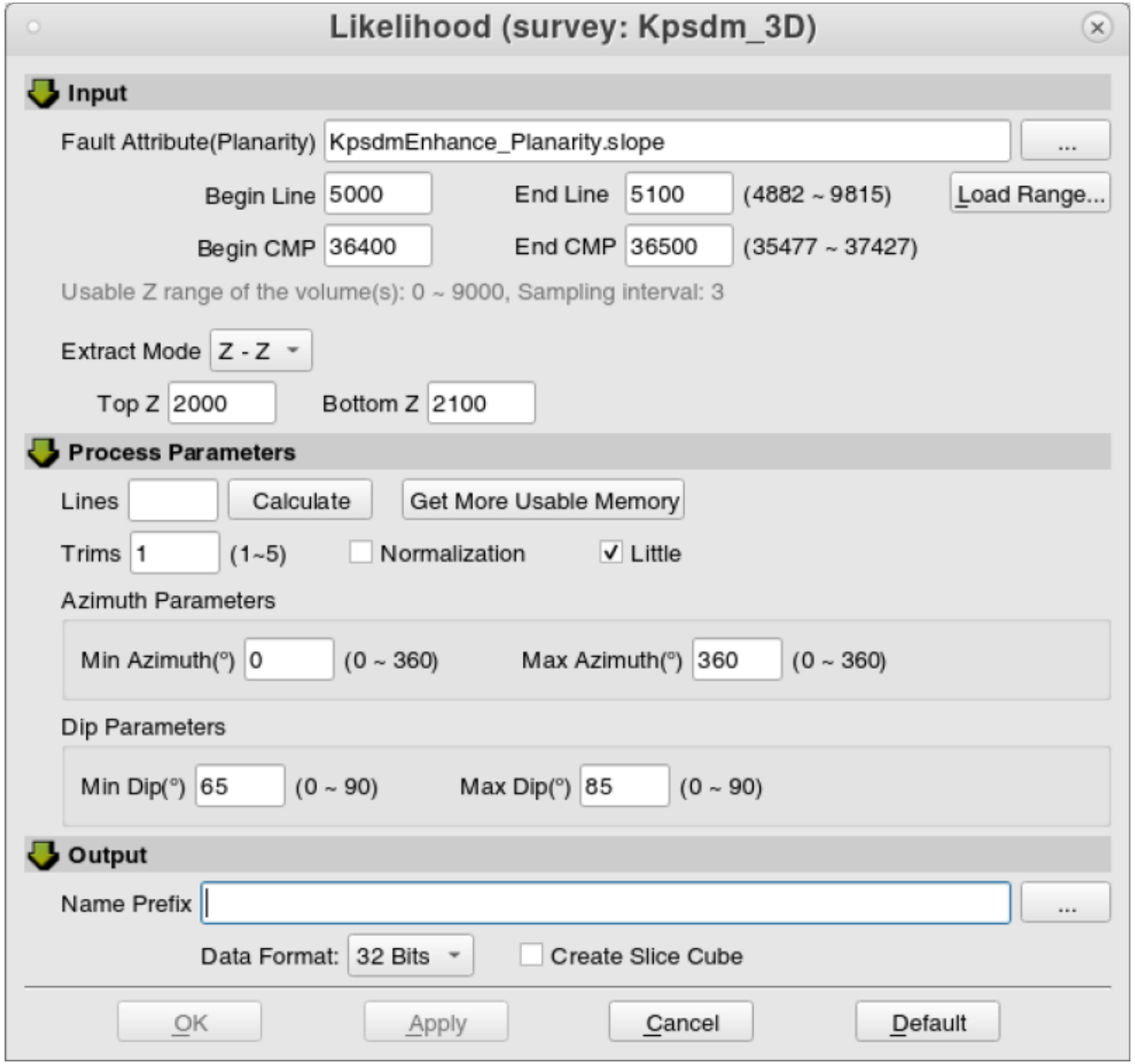
1.建议

范围确定


Likelihood (survey: Kpsdm_3D)
Input
Fault Attribute(Planarity)
KpsdmEnhance_Planarity.slope
...
Begin Line
4882
End Line
9815
(4882 ~ 9815)
Load Range...
Begin CMP
36200
End CMP
37000
(35477 ~ 37427)
Usable Z range of the volume(s): 0 ~ 9000, Sampling interval: 3
Extract Mode
Z - Z
Top Z
1200
Bottom Z
8000
Process Parameters
Lines
20
Calculate
(Max Lines:195)
Get More Usable Memory
Trims
1
(1~5)
Normalization
Little
Azimuth Parameters
Min Azimuth(°)
0
(0 ~ 360)
Max Azimuth(°)
360
(0 ~ 360)
Dip Parameters
Min Dip(°)
65
(0 ~ 90)
Max Dip(°)
85
(0 ~ 90)
Output
Name Prefix
...
Data Format:
32 Bits
Create Slice Cube
OK
Apply
Cancel
Default

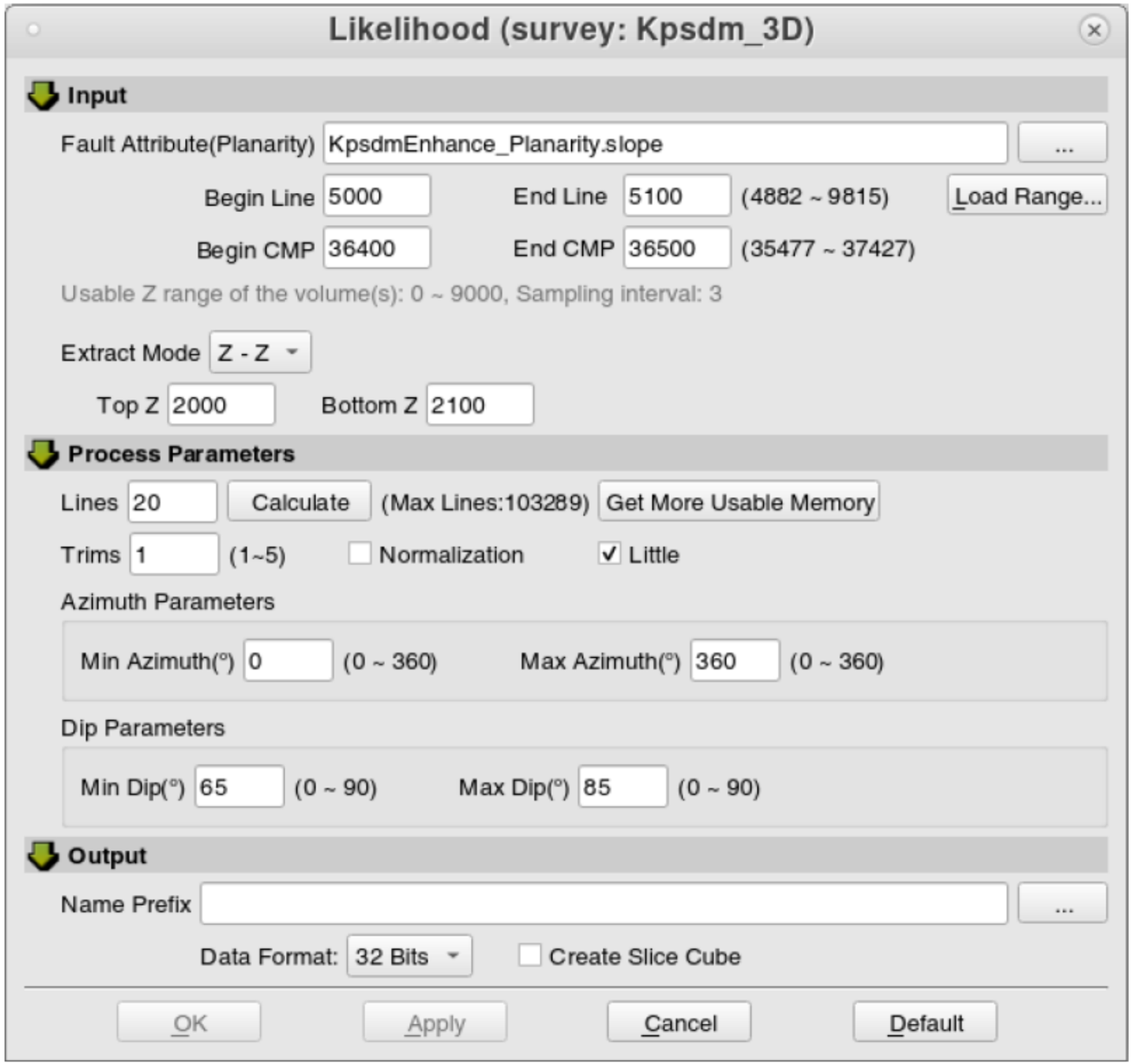
2.建议

参数确定


Likelihood (survey: Kpsdm_3D)
Input
Fault Attribute(Planarity)
KpsdmEnhance_Planarity.slope
...
Begin Line
5000
End Line
5100
(4882 ~ 9815)
Load Range...
Begin CMP
36400
End CMP
36500
(35477 ~ 37427)
Usable Z range of the volume(s): 0 ~ 9000, Sampling interval: 3
Extract Mode
Z - Z
Top Z
2000
Bottom Z
2100
Process Parameters
Lines
Calculate
Get More Usable Memory
Trims
1
(1~5)
Normalization
Little
Azimuth Parameters
Min Azimuth(°)
0
(0 ~ 360)
Max Azimuth(°)
360
(0 ~ 360)
Dip Parameters
Min Dip(°)
65
(0 ~ 90)
Max Dip(°)
85
(0 ~ 90)
Output
Name Prefix
...
Data Format:
32 Bits
Create Slice Cube
OK
Apply
Cancel
Default

2.建议

参数确定


Likelihood (survey: Kpsdm_3D)
Input
Fault Attribute(Planarity)
KpsdmEnhance_Planarity.slope
...
Begin Line
5000
End Line
5100
(4882 ~ 9815)
Load Range...
Begin CMP
36400
End CMP
36500
(35477 ~ 37427)
Usable Z range of the volume(s): 0 ~ 9000, Sampling interval: 3
Extract Mode
Z - Z
Top Z
2000
Bottom Z
2100
Process Parameters
Lines
20
Calculate
(Max Lines:103289)
Get More Usable Memory
Trims
1
(1~5)
Normalization
Little
Azimuth Parameters
Min Azimuth(°)
0
(0 ~ 360)
Max Azimuth(°)
360
(0 ~ 360)
Dip Parameters
Min Dip(°)
65
(0 ~ 90)
Max Dip(°)
85
(0 ~ 90)
Output
Name Prefix
...
Data Format:
32 Bits
Create Slice Cube
OK
Apply
Cancel
Default

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2025.10