Interpretation of 3D multicomponent seismic data for investigating natural fractures in the Horn River Basin, northeast British Columbia

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UNIVERSITY OF CALGARY

CREWES

The Objective:

- To interpret wide-azimuth multicomponent 3D data in the HRB area and to map the shale gas units and attempt to predict fracture density and orientation.

The Methodology:

1. Curvature analysis
2. P-wave azimuthal anisotropy(AVAZ)
3. Shear-wave splitting

Outline:

- Shale gas definition and characterization
- Location map
- Geological background
- Seismic interpretation
- Curvature analysis & results
- Conclusion
- Future work
- Acknowledgements

Shale Gas Definition & Characterization

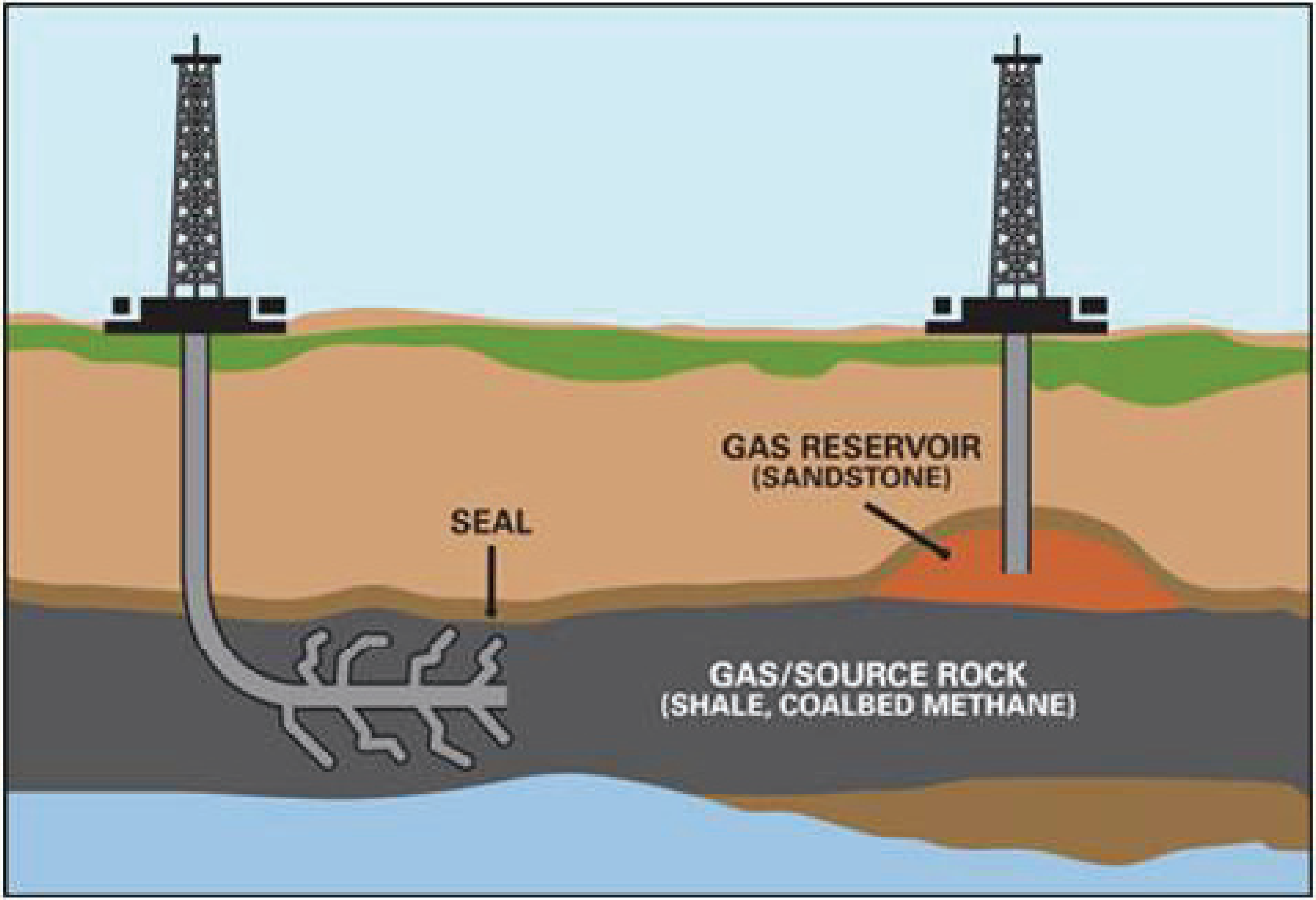
- The best definition is " Organic-rich, and fine-grained shale"(Bustin, 2006).

1) Maturity of the organic matter
2) Type of gas generated and stored in the reservoir
3) TOC content of the strata
4) Mineralogy

Formation	# of Core Wells	Average Thickness (m)	Average TOC (wt%)	Average Porosity (%)	Mineralogy	Average Gas Capacity at 11 MPa (cc/g)
Exshaw	4	5-10	5.0	4.4	Quartz, Kolinite, Illite	1.3
Besa River	2	450-500	4.3	4.6	Quartz, Kolinite, Illite	0.8
Fort Simpson	3	475-525	0.4	3.3	Quartz, Kolinite, Illite	0.3
Muskwa	8	15-25	3.1	3.2	Quartz, Kolinite, Illite	0.7

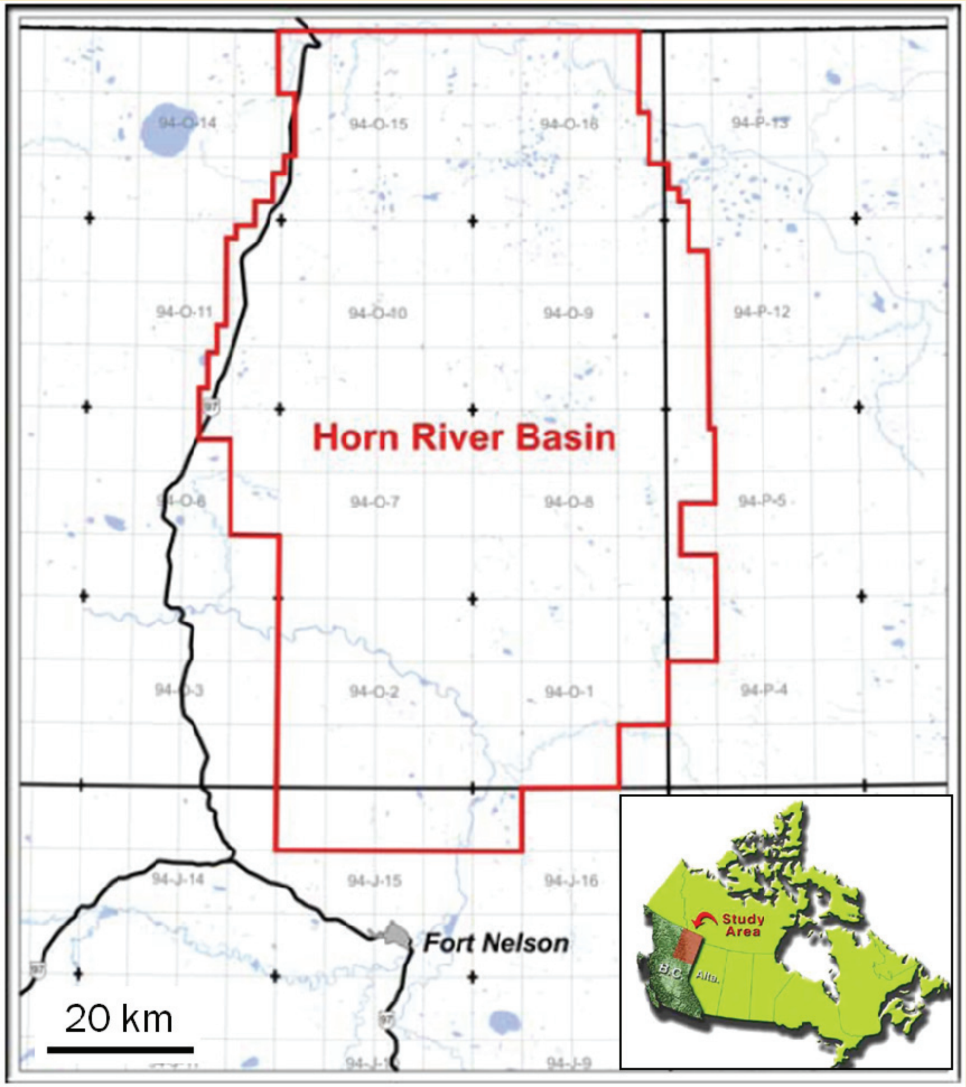
Table 1. Summary data for each formation analyzed.
(British Columbia Ministry of Energy and Mines, 2006)

Horizontal Drilling & Hydraulic Fracturing



Source:http://www.intragaz.com/en/geophysics_drilling.html

Horn River Basin Map



Source:http://www.northernrockies.org/Departments/Leg_Admin/Bulletin_Board/HRB%20Symposium/HRB%20FAQ2.pdf

Stratigraphy

HRB Area

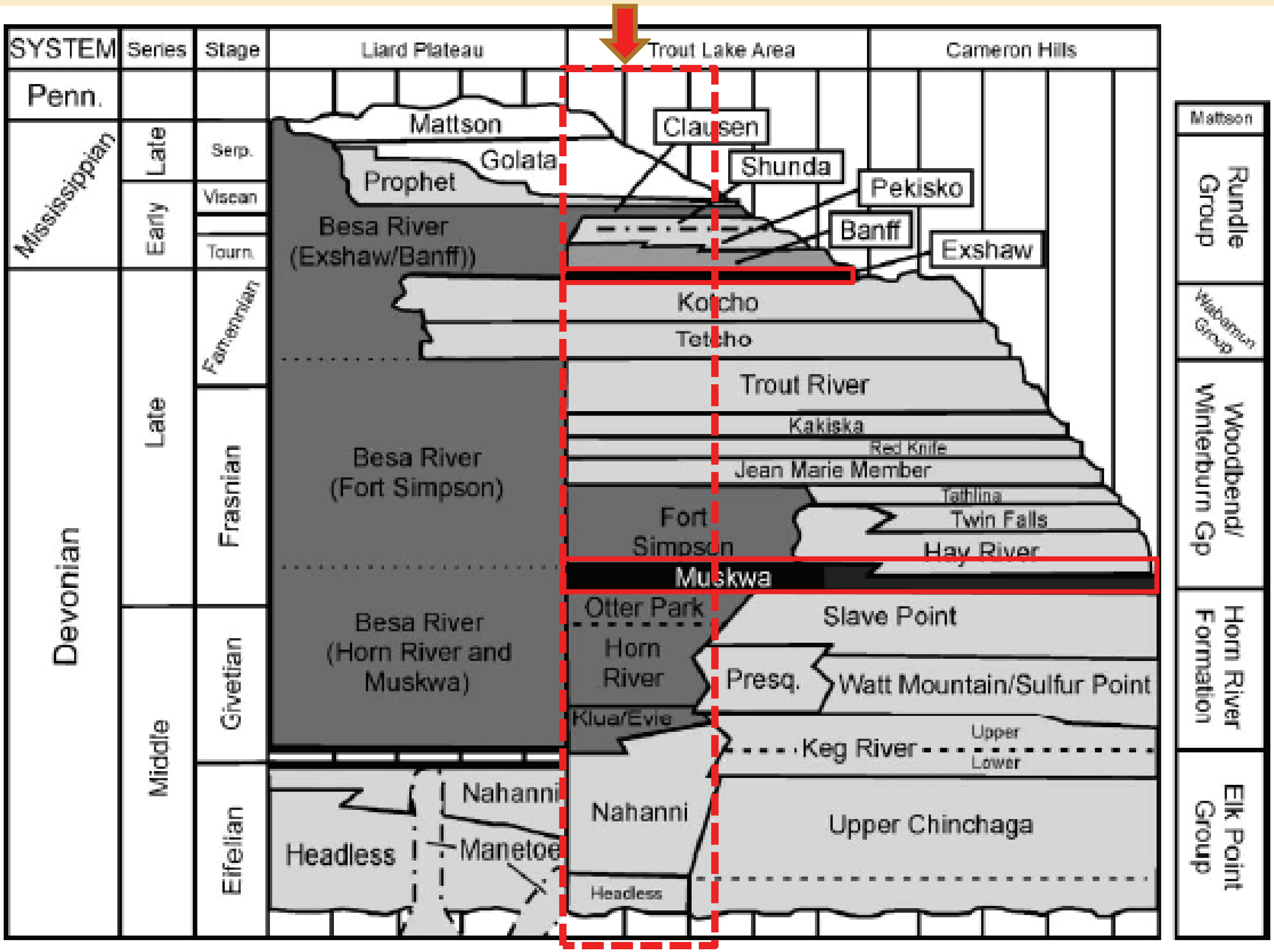
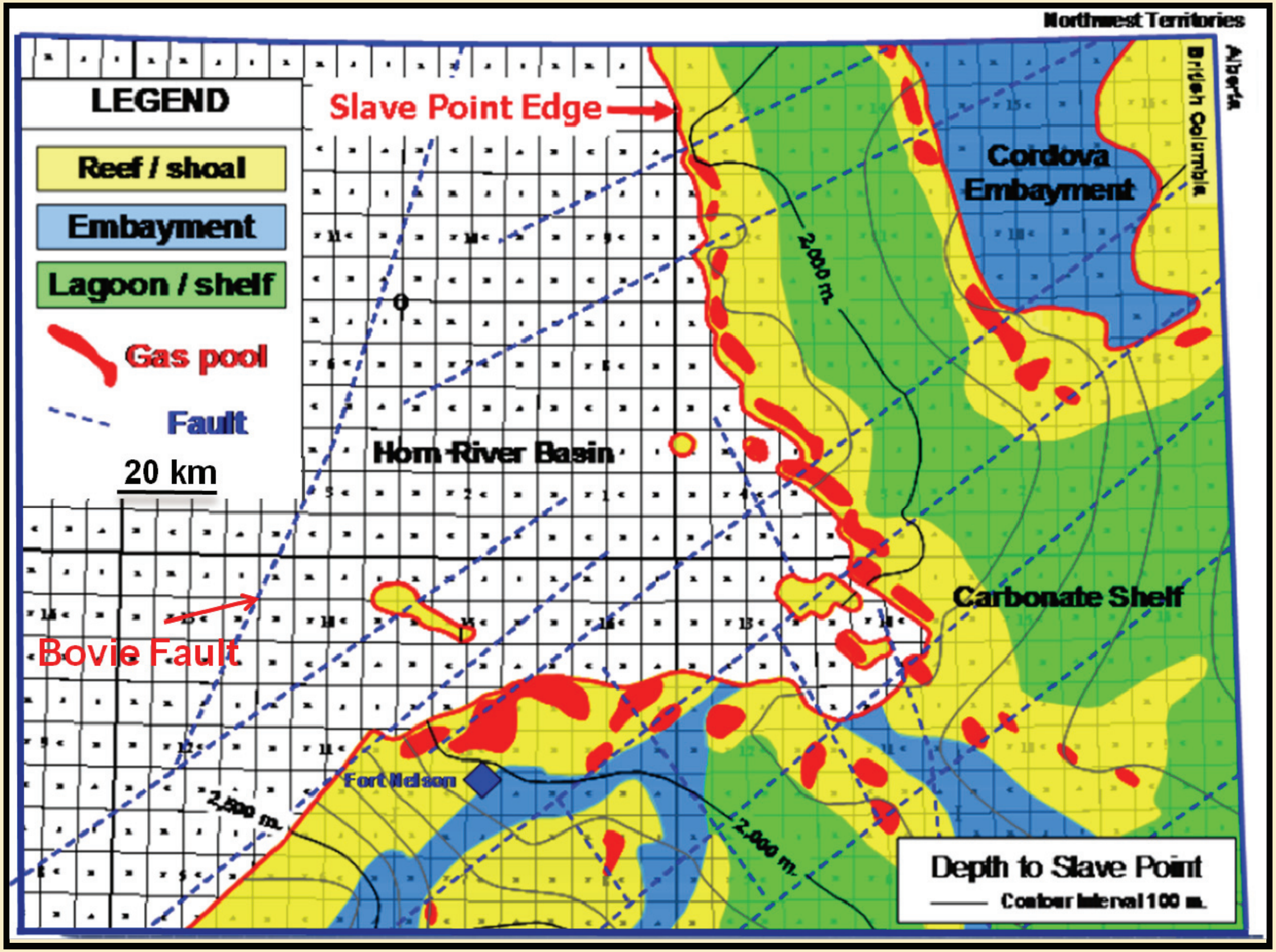


Figure 1. Stratigraphic section of Devonian–Mississippian in northern British Columbia, southeastern Yukon, and southwestern Northwest Territories (modified from Gal and Jones, 2003). Darker gray shadings represent shaly strata. Presq. = Presqu'île.

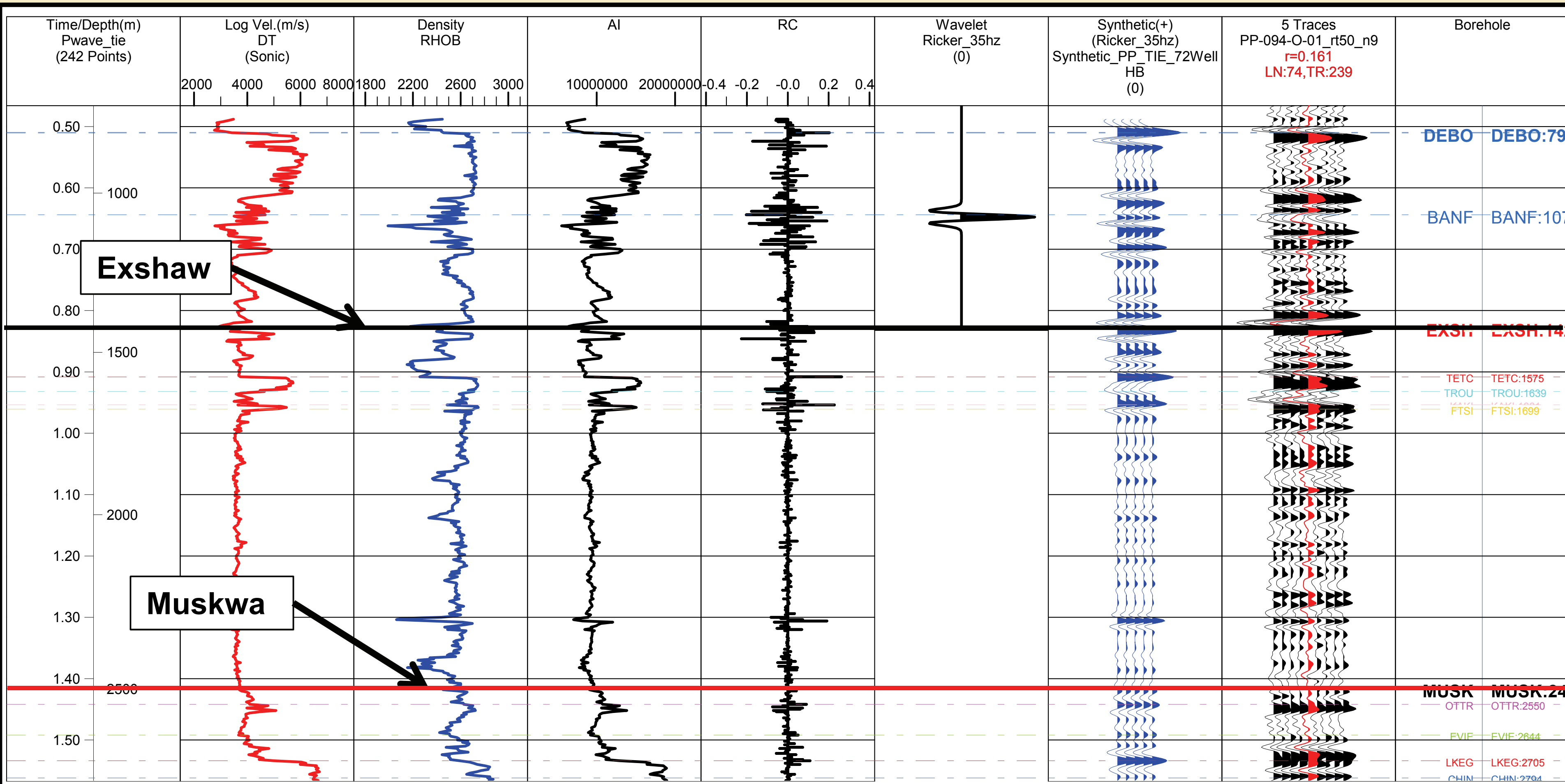
Ross and Bustin(2008)

Structure

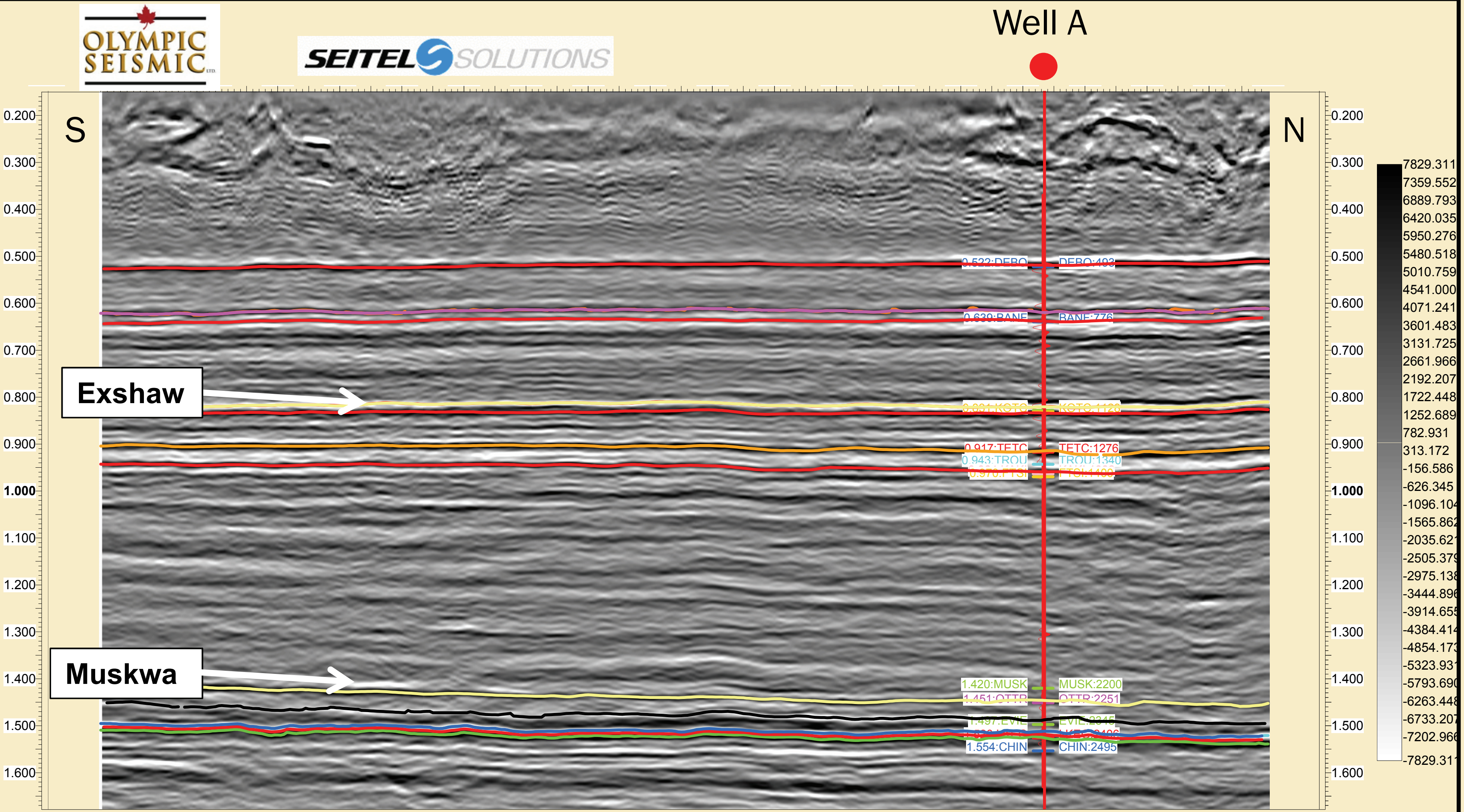


Source:http://www.wcsbgroup.org/meetings/pdf/2009/Jurisdiction%20Updates/BC_Update%20and%20Shale%20Gas_Levson.pdf

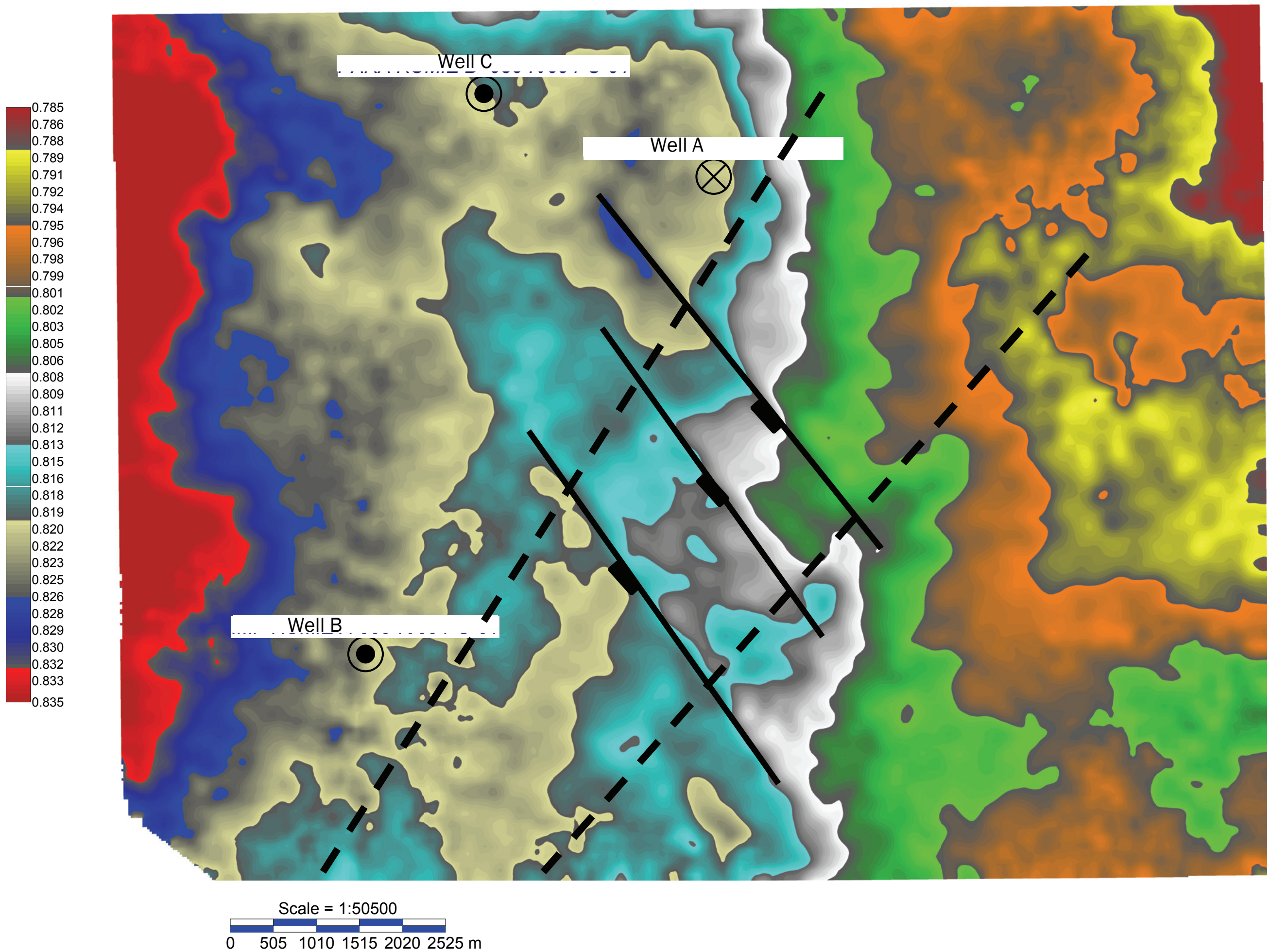
Well A: Seismic-Well Tie



Cross Line 239



TWT Structure Map of Top Exshaw Fm.



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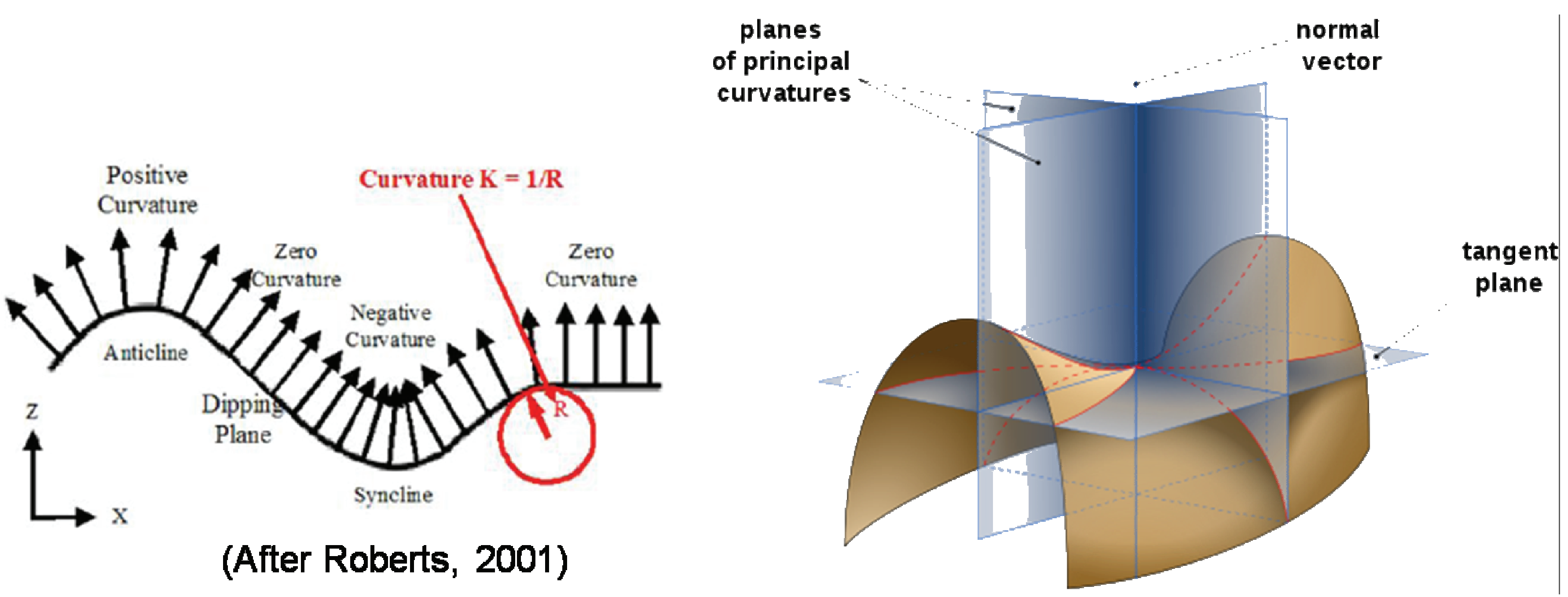
Possible Fault

Interpreted normal Fault

Curvature

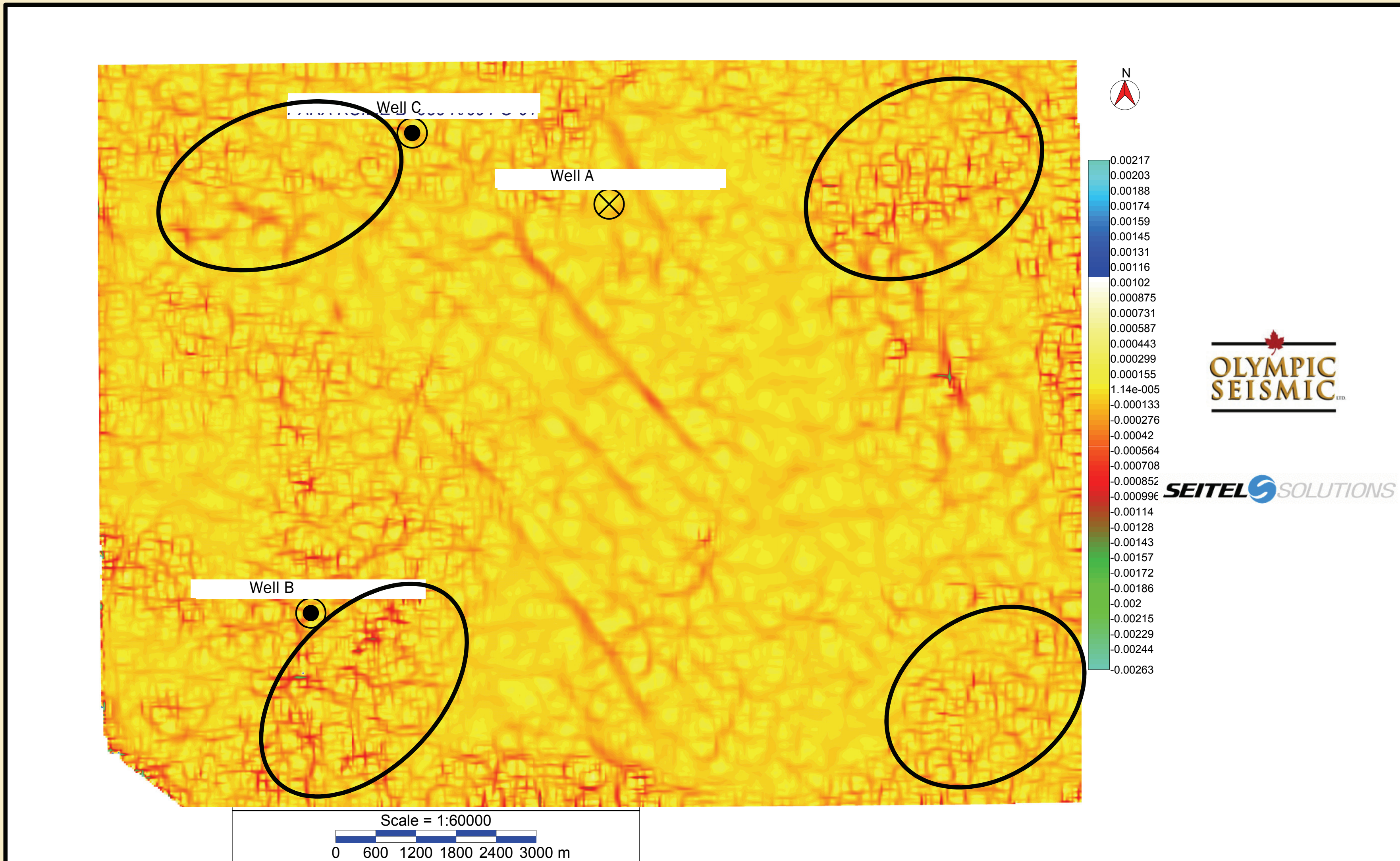


(After Roberts, 2001)

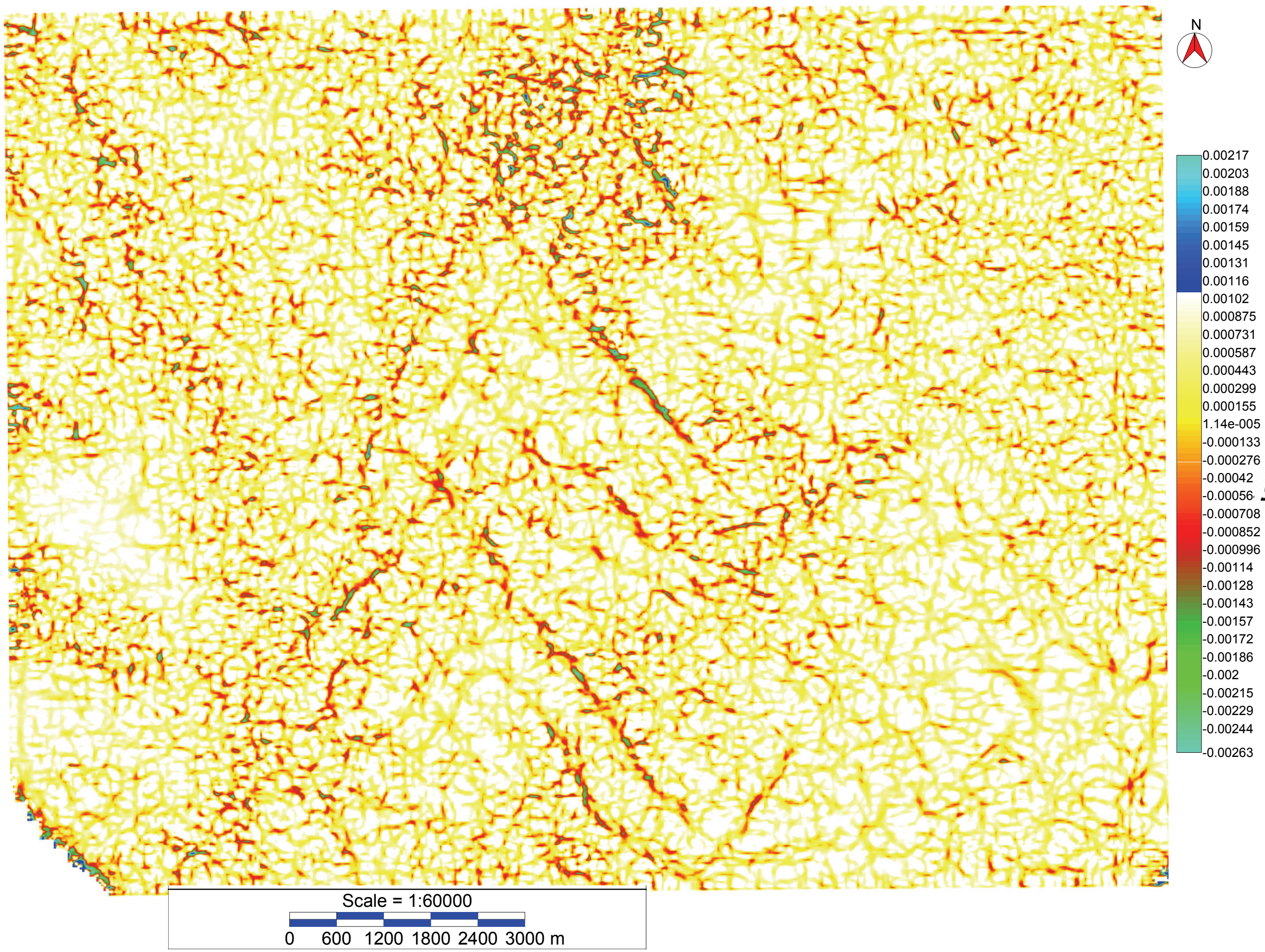
http://en.wikipedia.org/wiki/Curvature

a) b)

Horizon Based Negative Curvature: Top of Exshaw shale



Volume Based Negative Curvature (PP): Time Slice 0.894 Sec.



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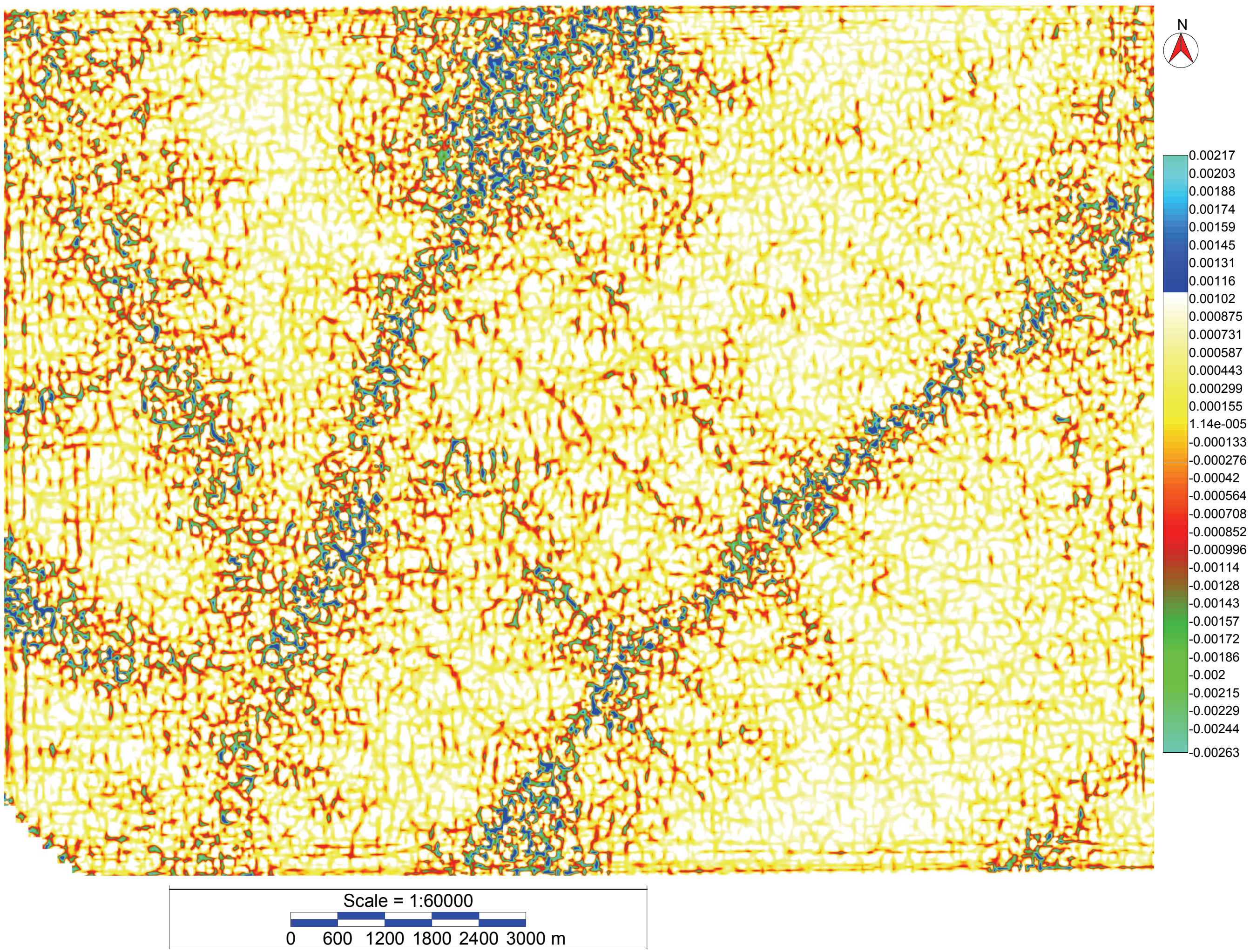
Volume Based Negative Curvature (PS): Time Slice 1.208 Sec.



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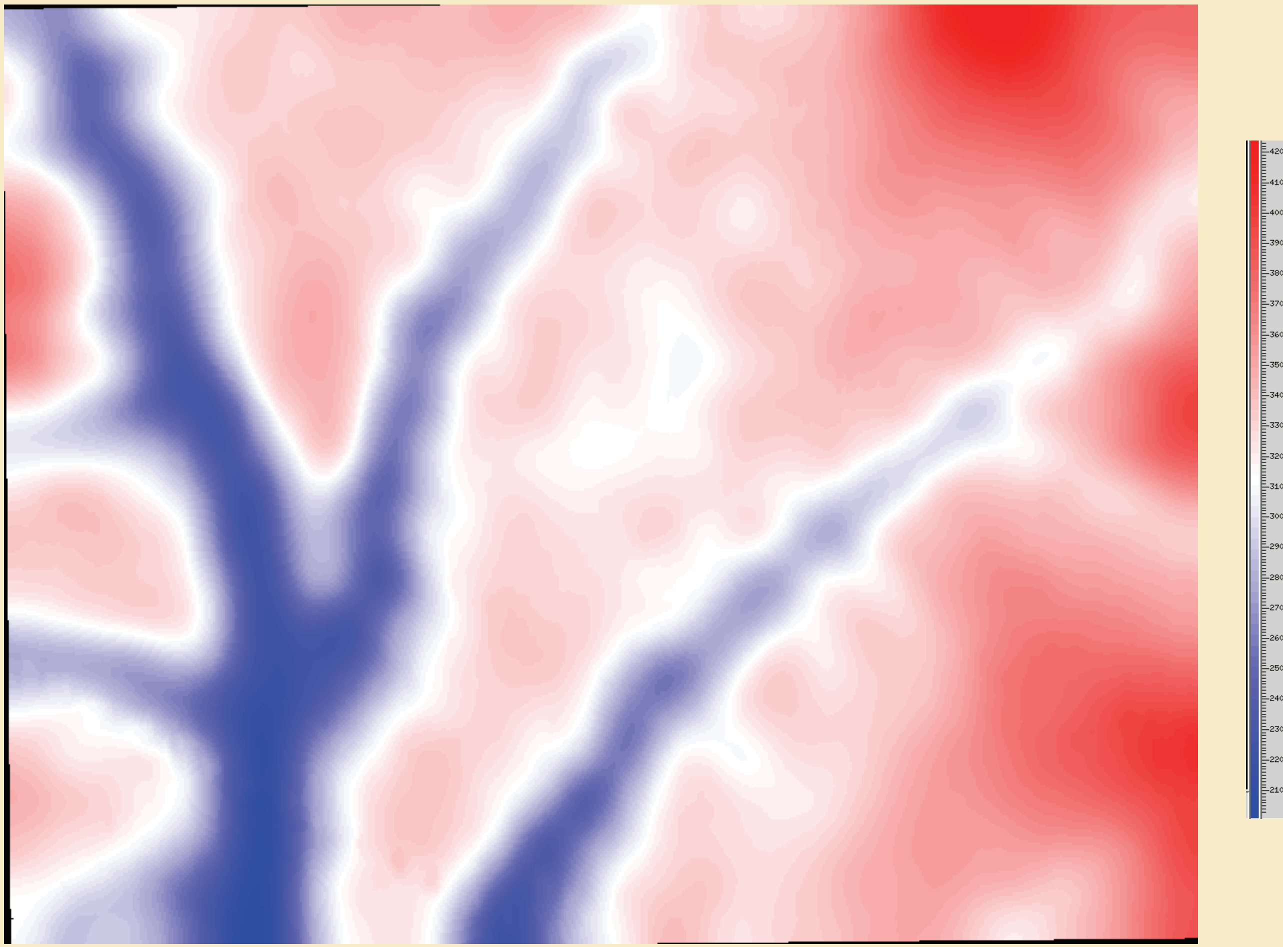
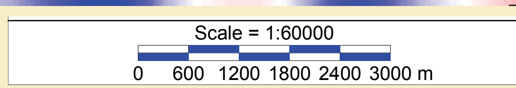
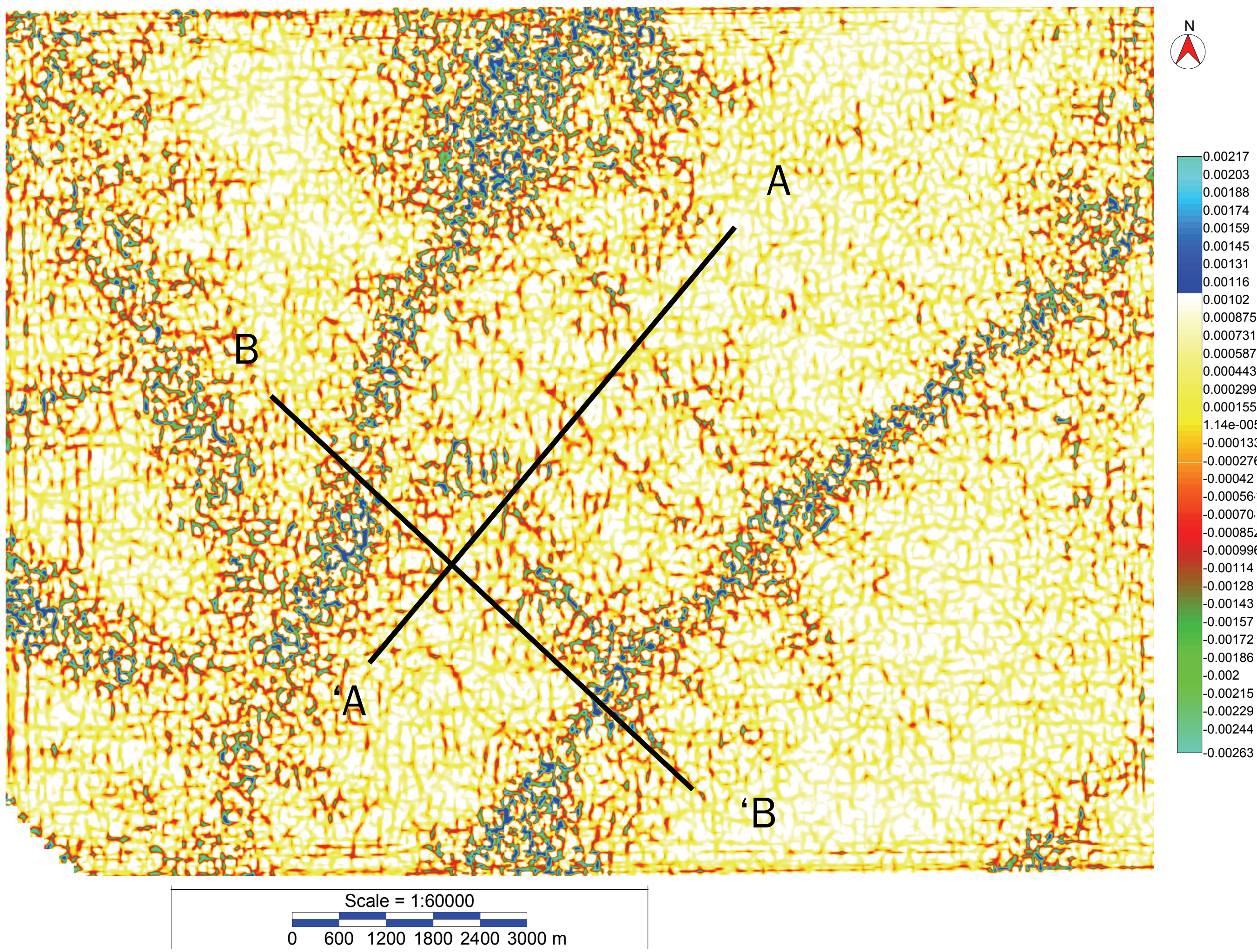
Base of Weathering Map





(Olympic Seismic Ltd, 2009)

Volume Based Negative Curvature (PS): Time Slice 1.208 Sec.



OLYMPIC SEISMIC LTD.

SEITEL SOLUTIONS

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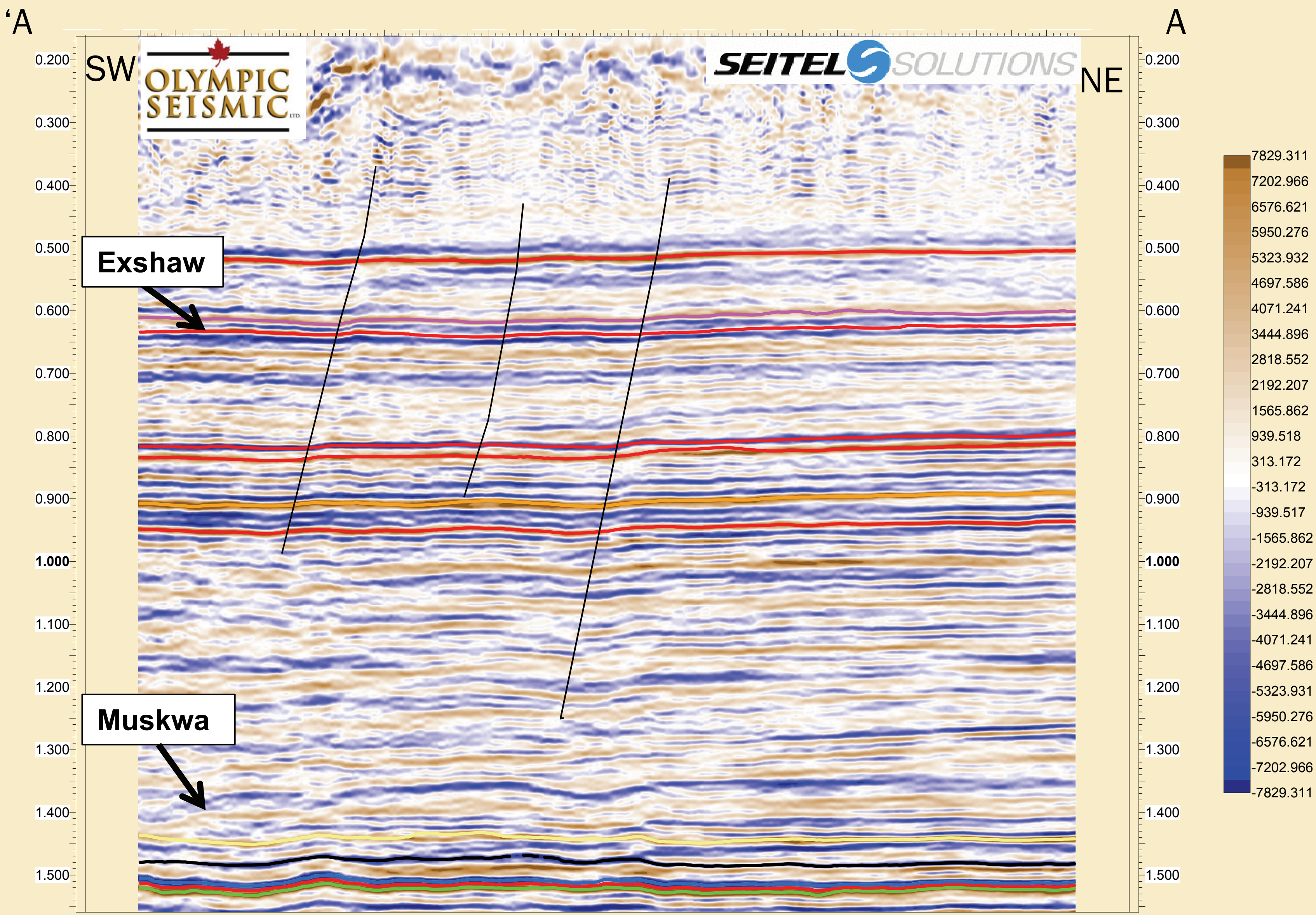
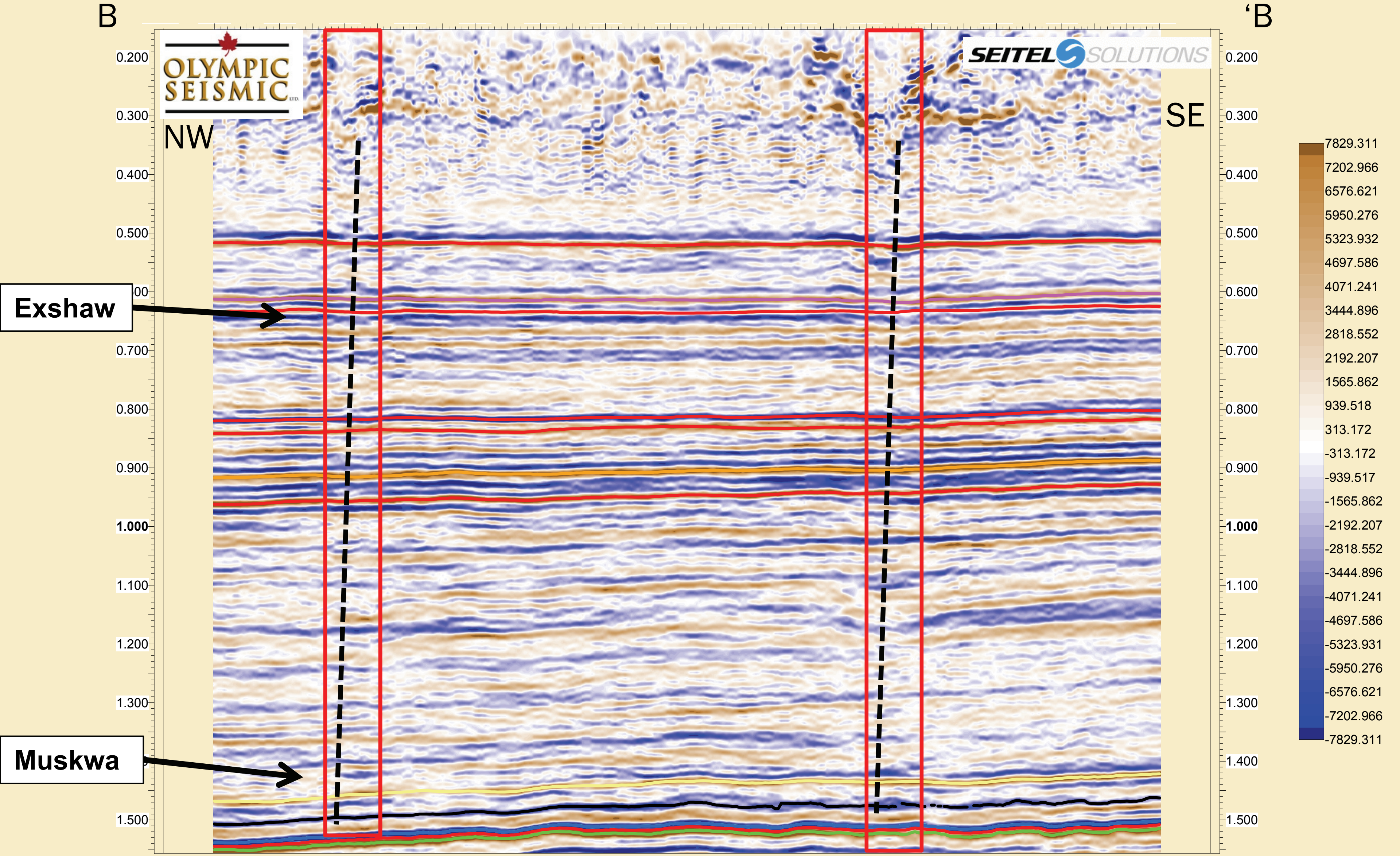
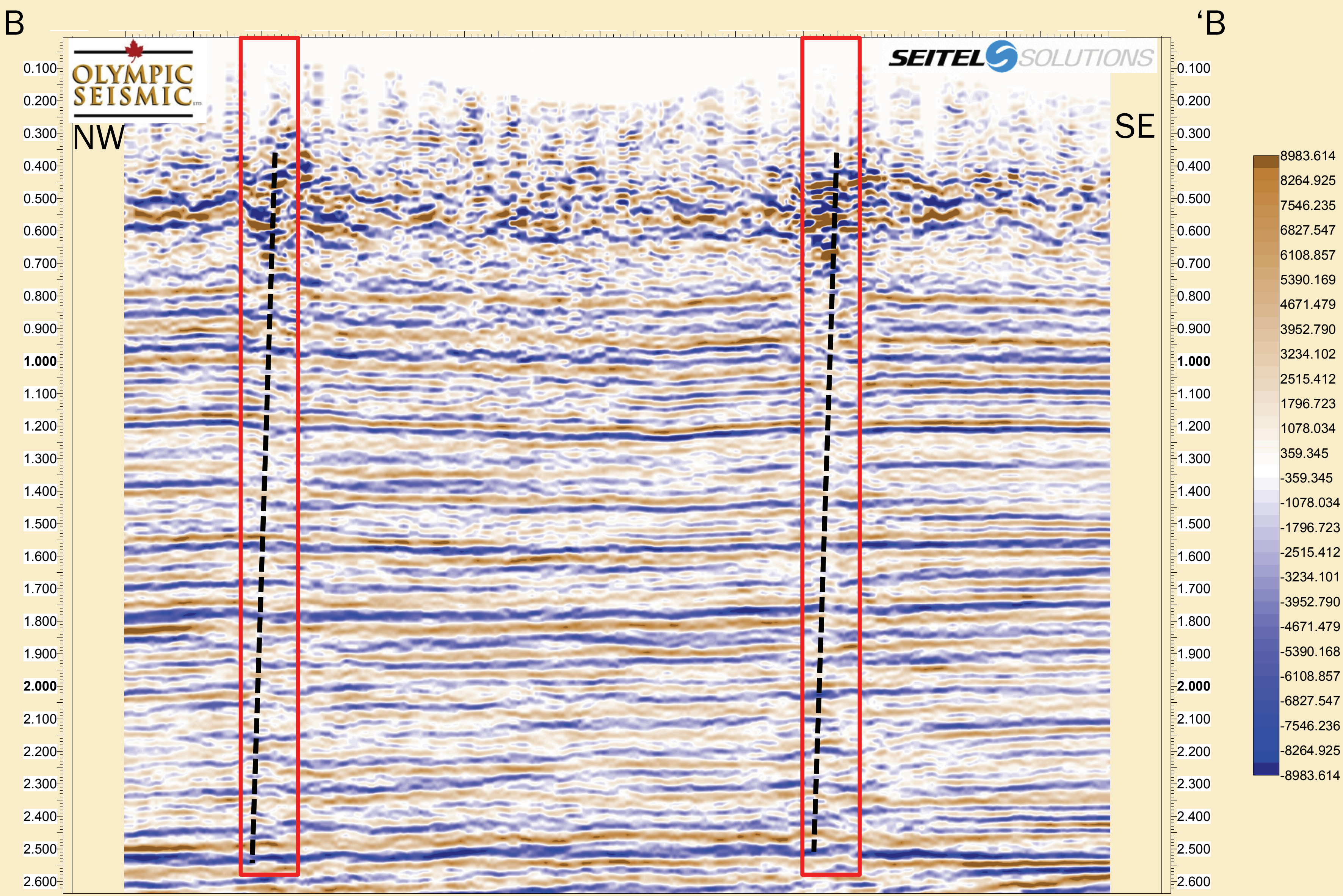


Cross Section (B-'B) PP

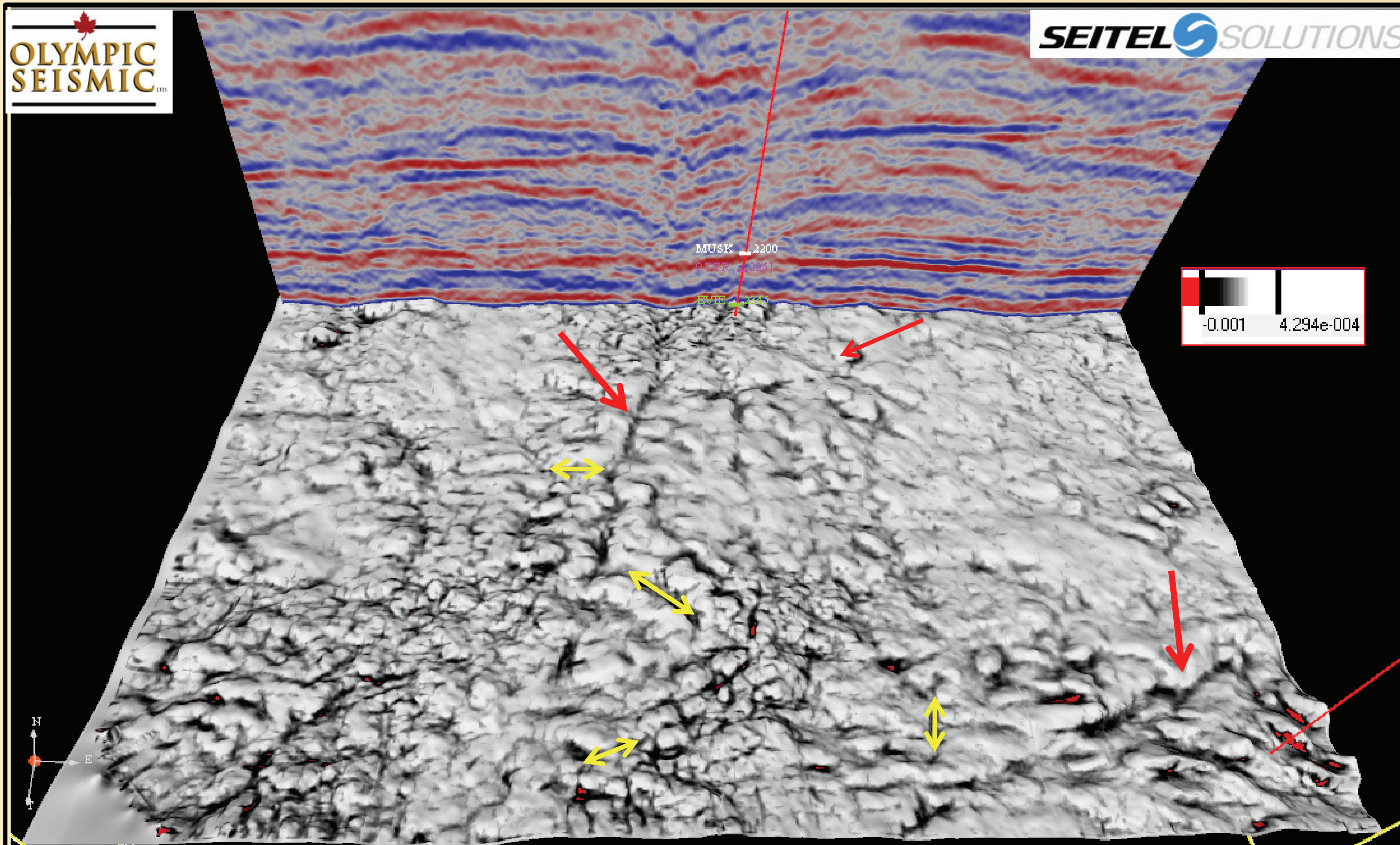


Cross Section (B-'B) PS

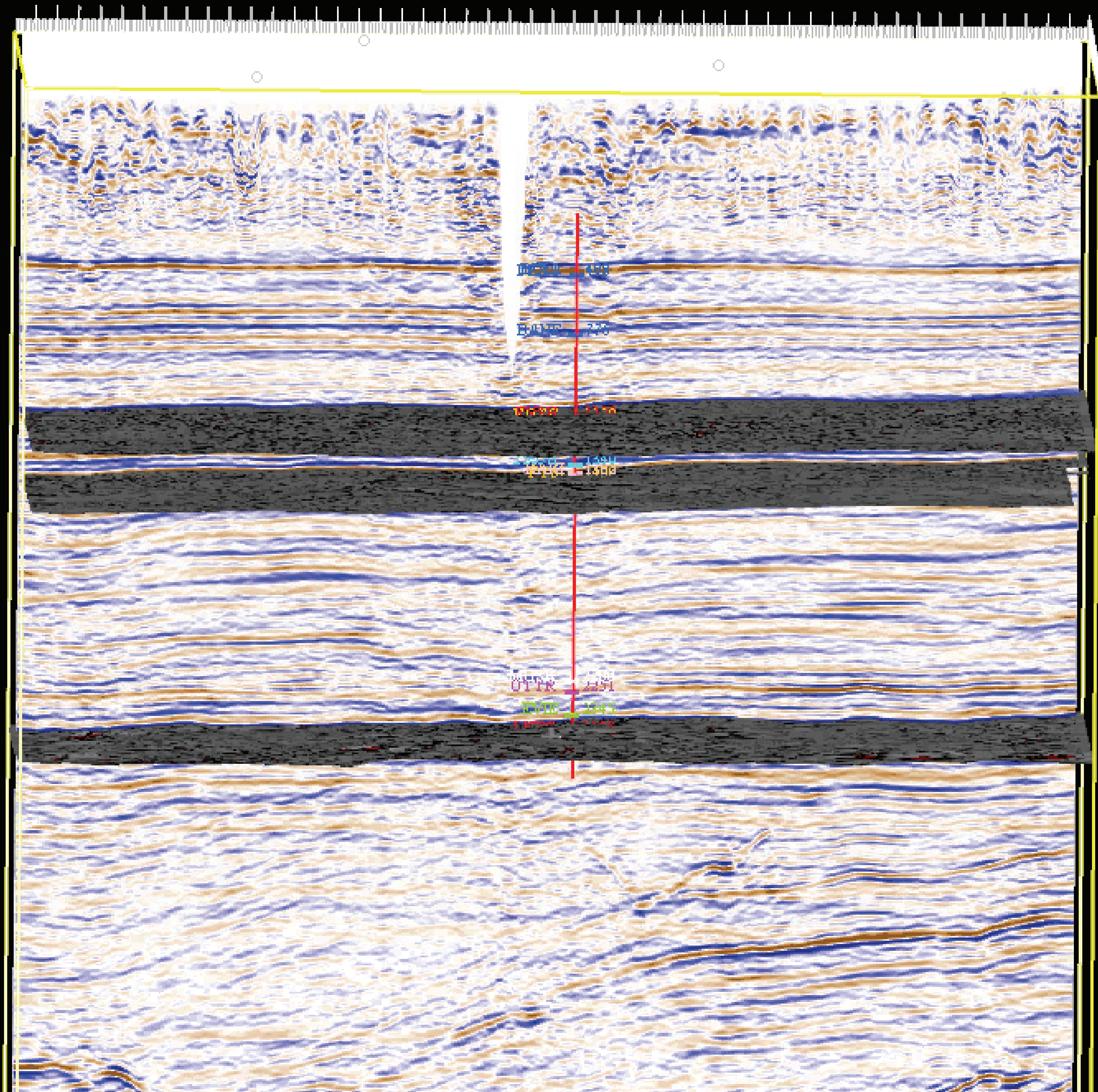


Volume Based Negative Curvature (PP):

Horizon-slice at the base of the Muskwa horizon



3D-view horizon slice extracted from most negative curvature volume



Conclusion

- Curvature attribute analyses enhance the structural interpretations, such as faults and fractures
- At the Exshaw level: northwest-southeast normal faults and possible northeast-southwest strike-slip faults
- At the Muskwa level: north-south, southwest-northeast, and northwest-southeast faults
- The interpreted fractures using curvature attribute are those fractures that are close to the major faults and their trends are generally parallel to the faults

Future Work

- Calibration of P-wave and S-wave data with well information
- Joint P-wave and S-wave interpretation
- Analysis of full-wave seismic attributes, particularly interval Vp/Vs
- P-wave azimuthal anisotropy
- S-wave splitting
- Data integration

Acknowledgments

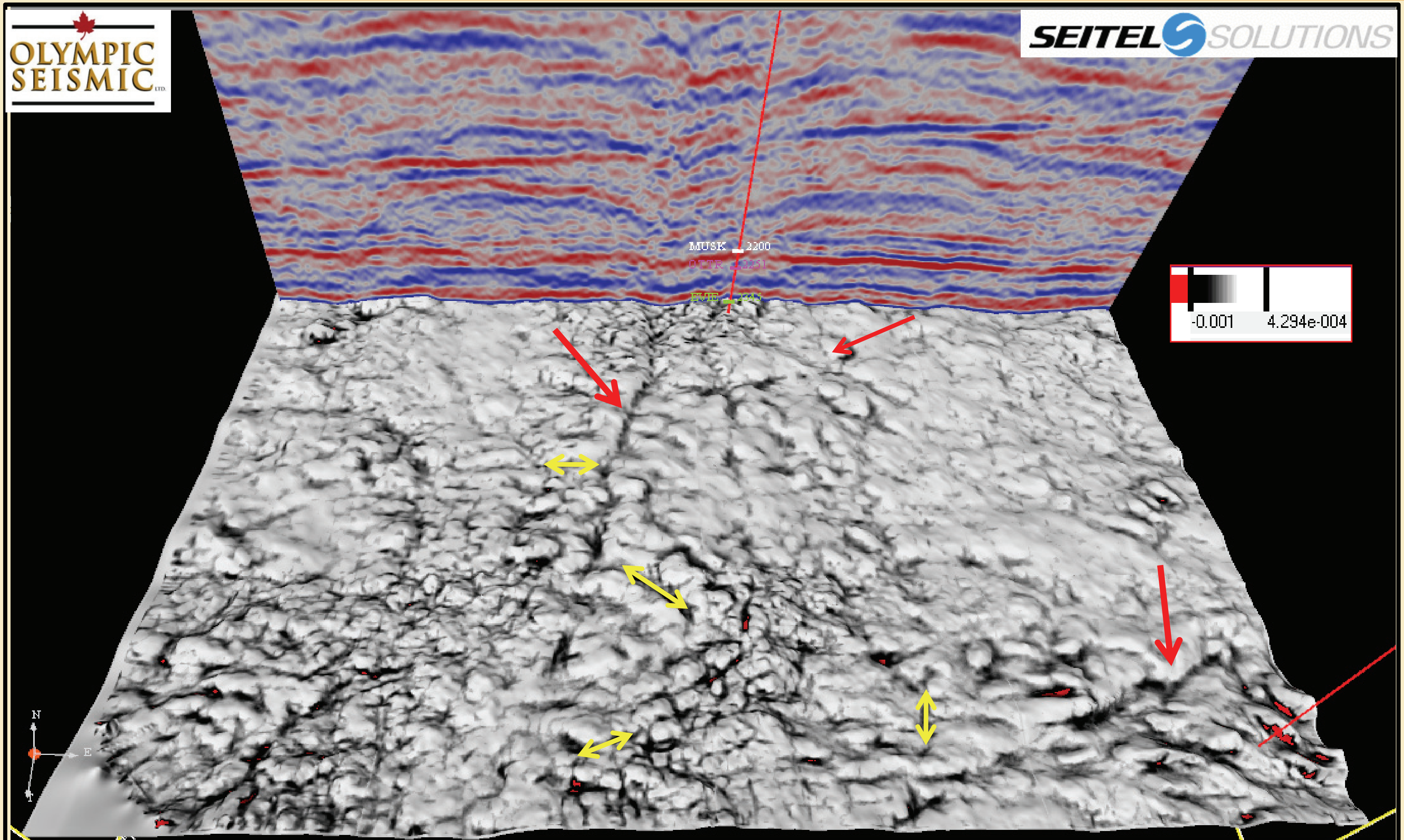
OLYMPIC SEISMIC LTD.
SEITEL SOLUTIONS
access to the seismic data

CREWES
sponsors & personnel

SMT Seismic Micro-Technology
Intuitive. Integrated. Interpretation.
Interpretation software

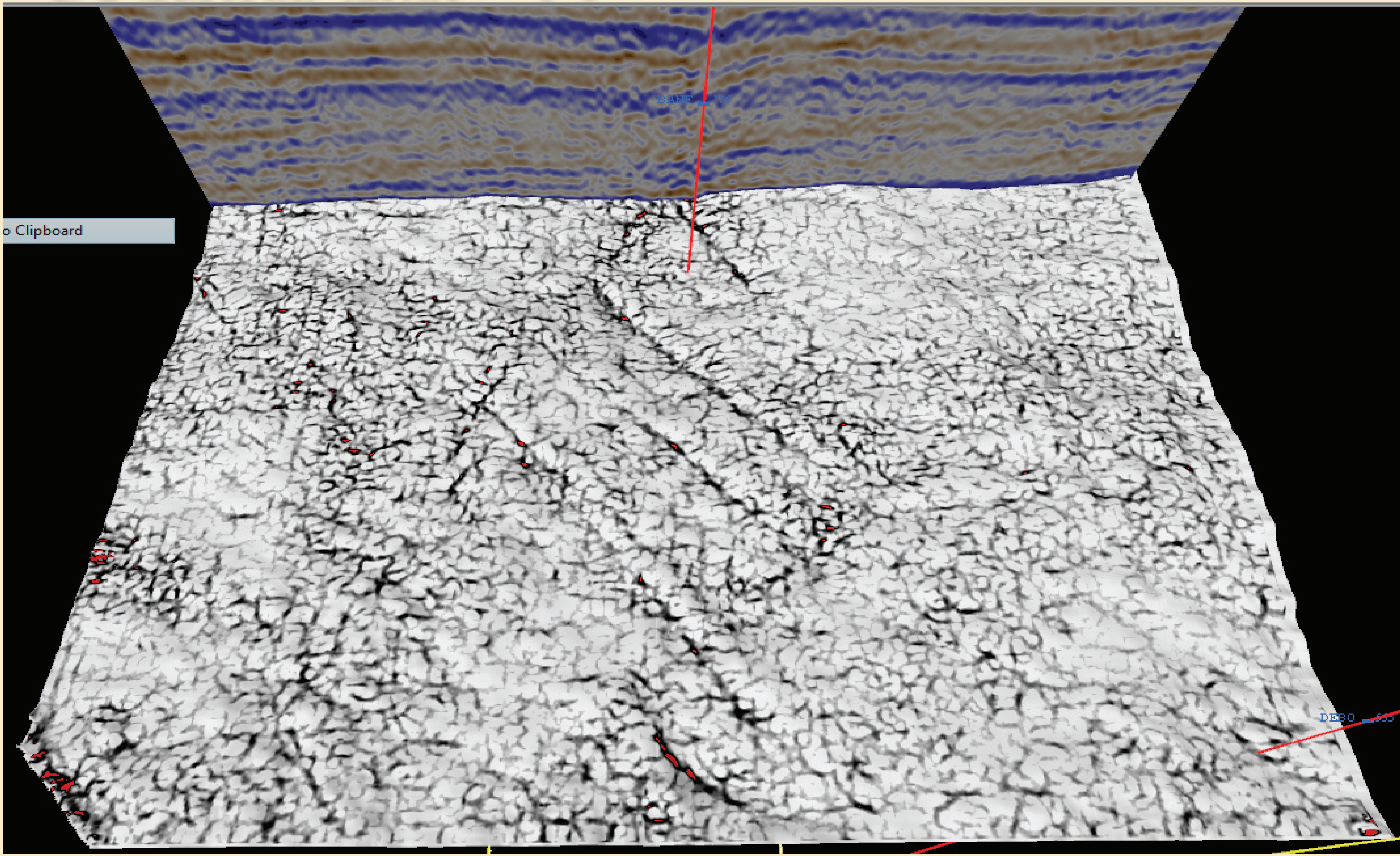
ارامكو السعودية
Saudi Aramco
Scholarship

Volume Based Negative Curvature (PP):
Horizon-slice at the base of the Muskwa horizon

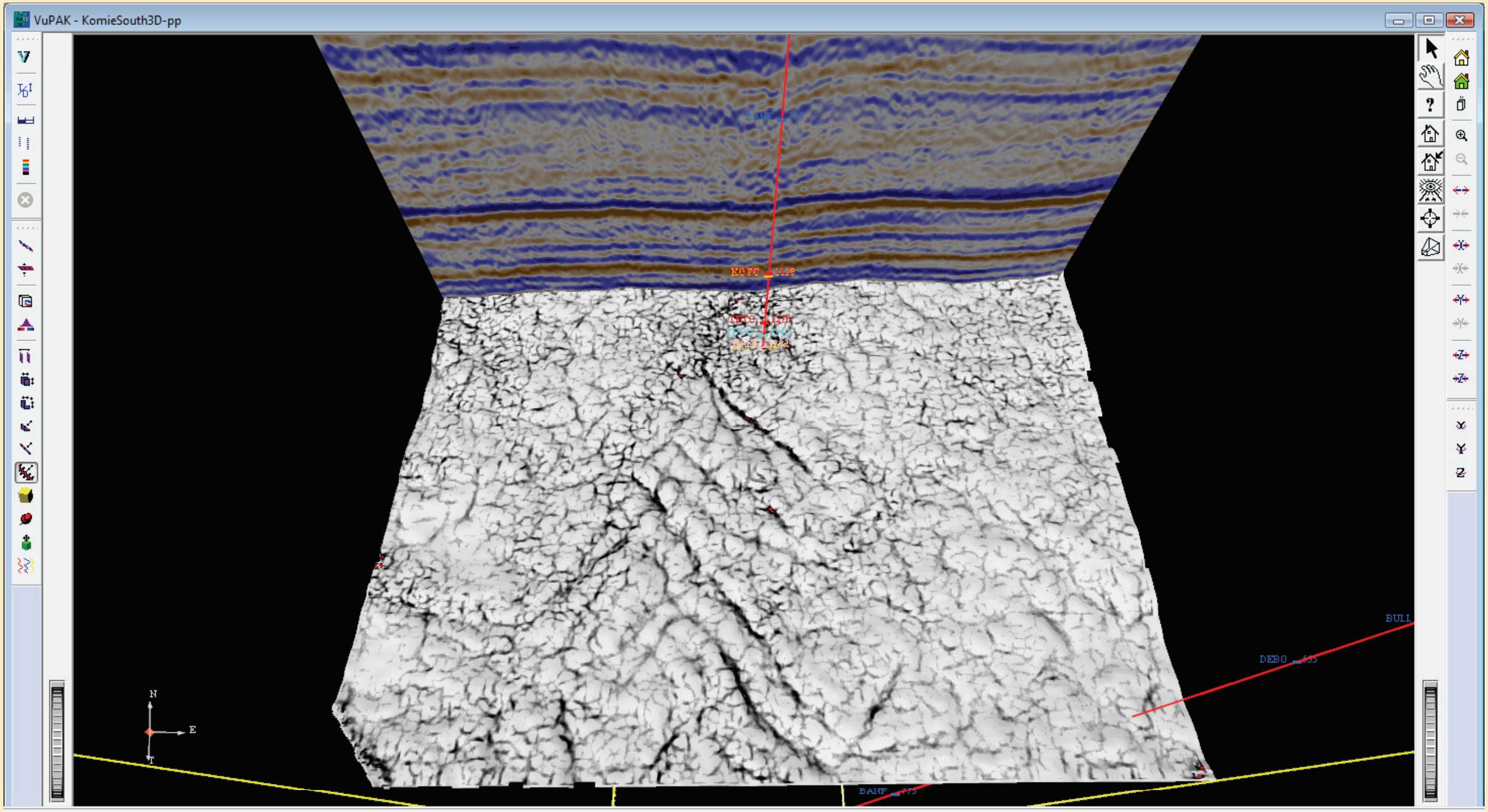


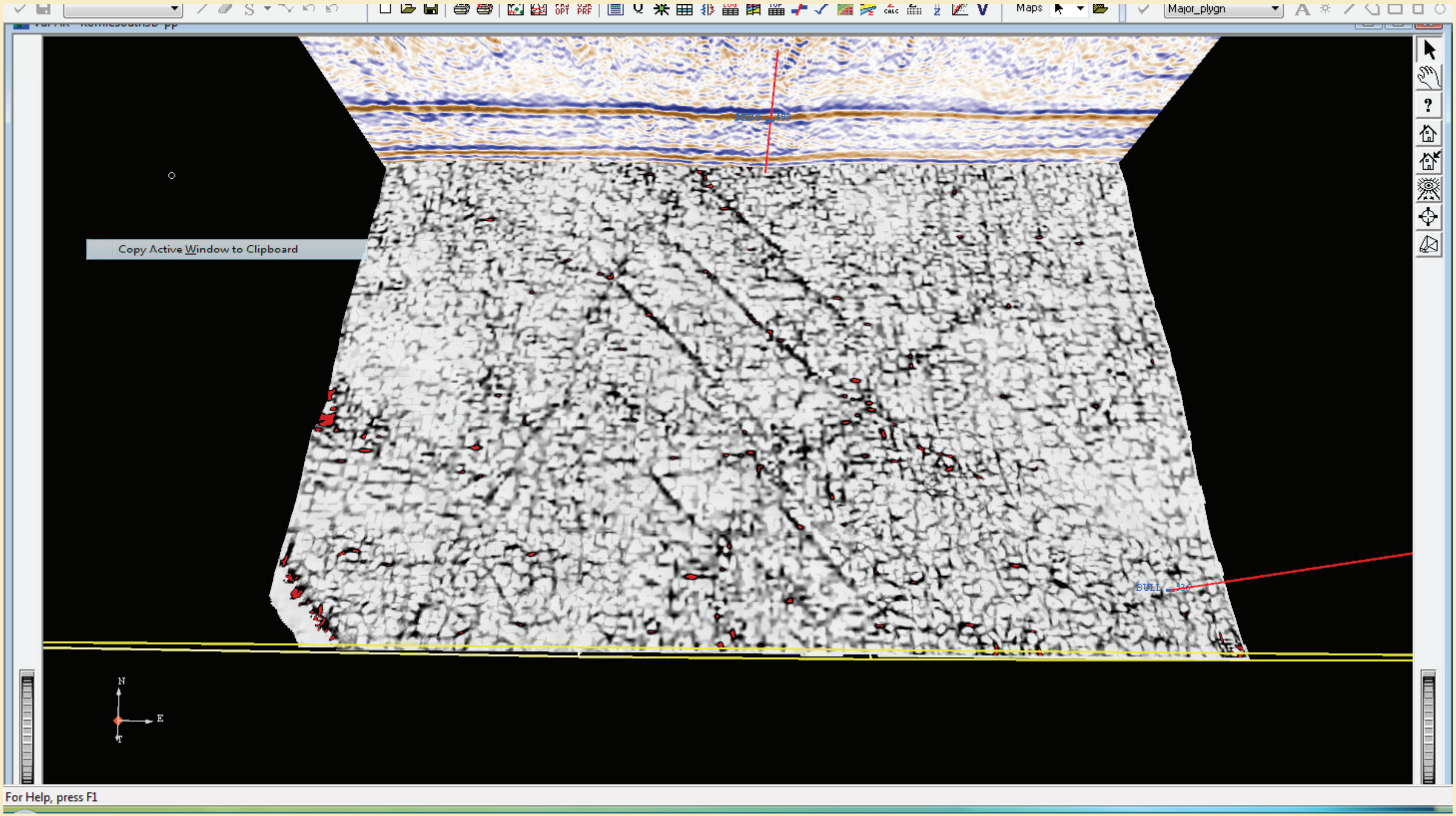
3D-view horizon slice extracted from most negative curvature volume

EXSHAW MNC_11



FSS MNC_11

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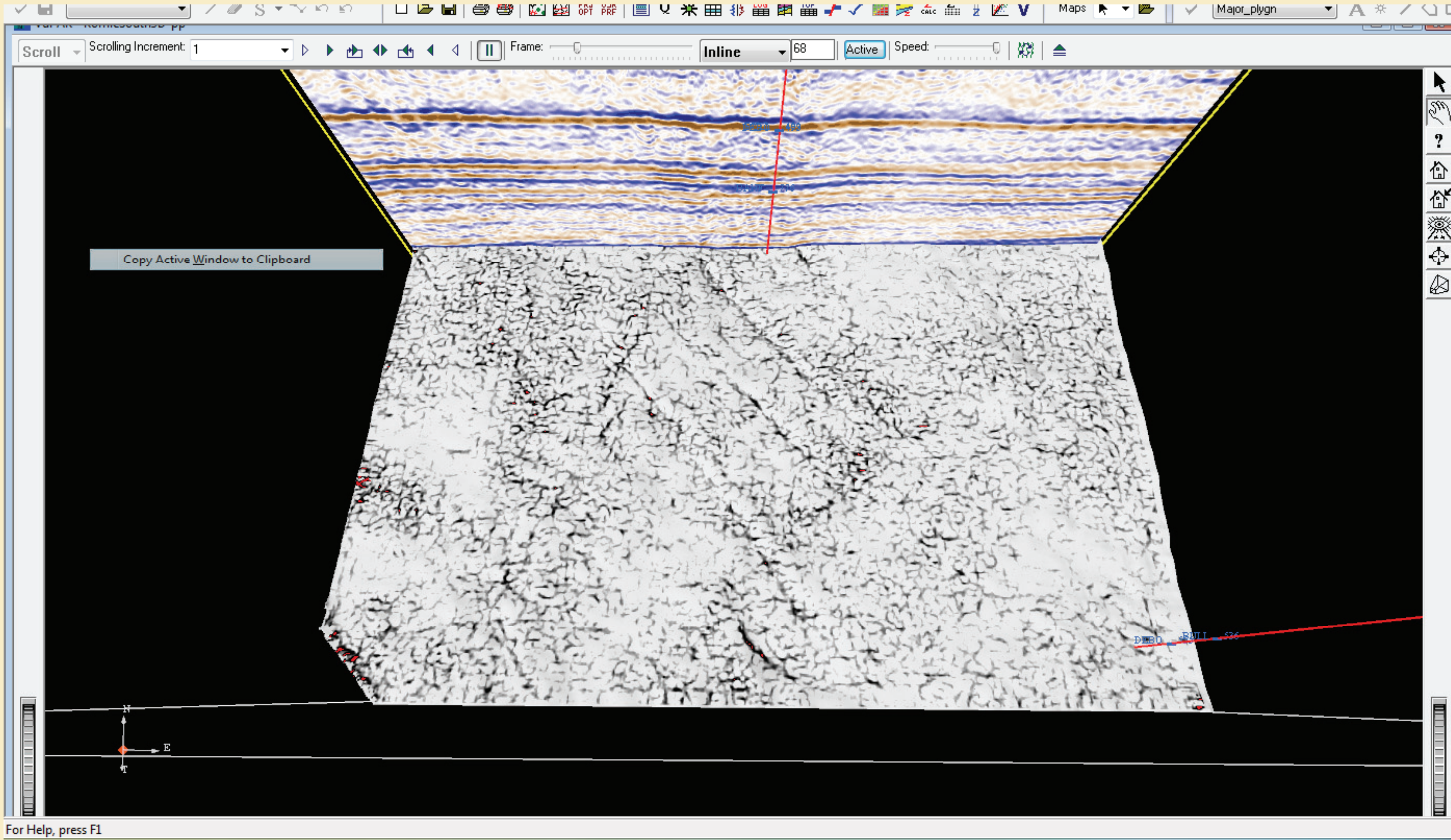
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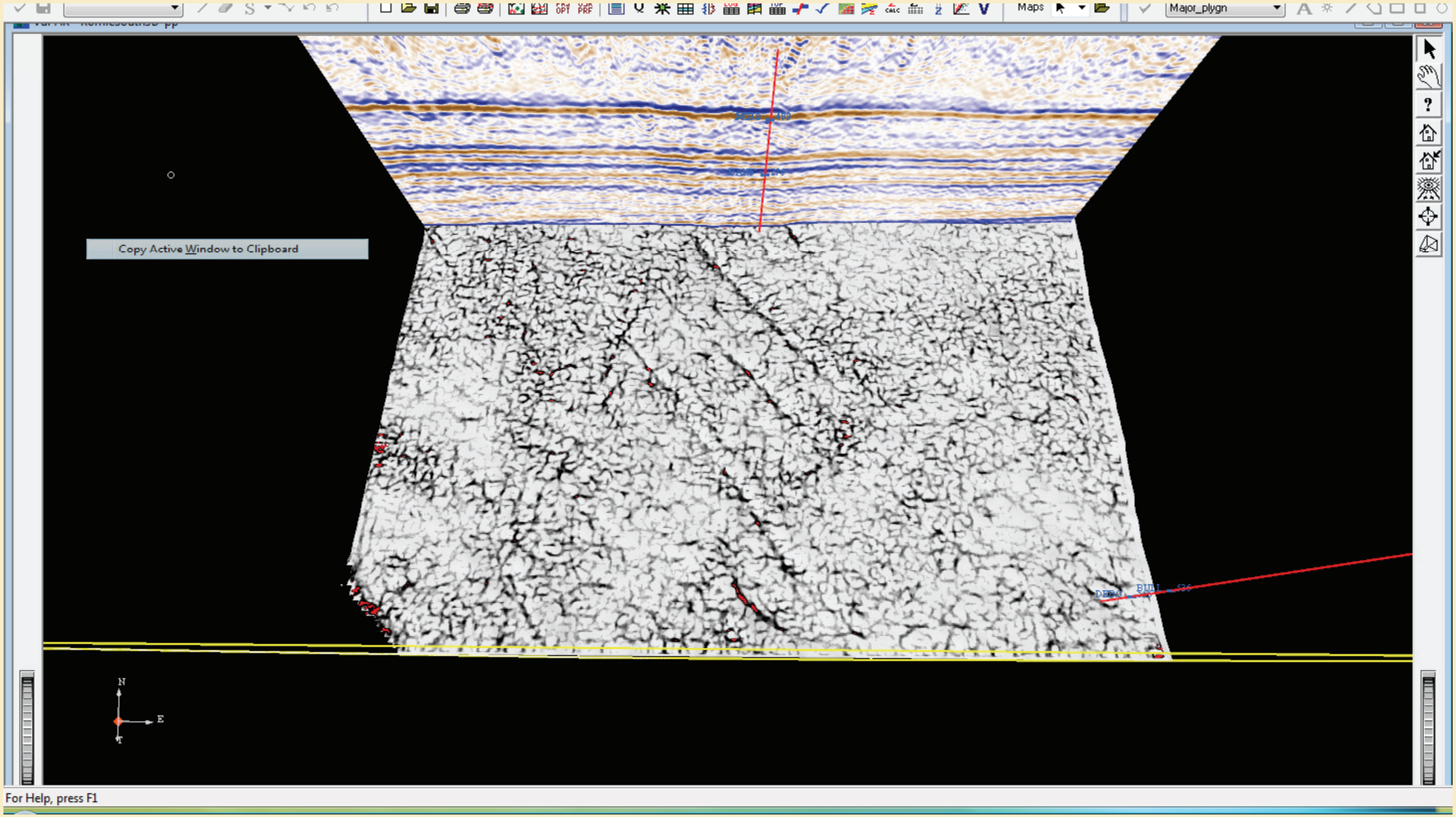

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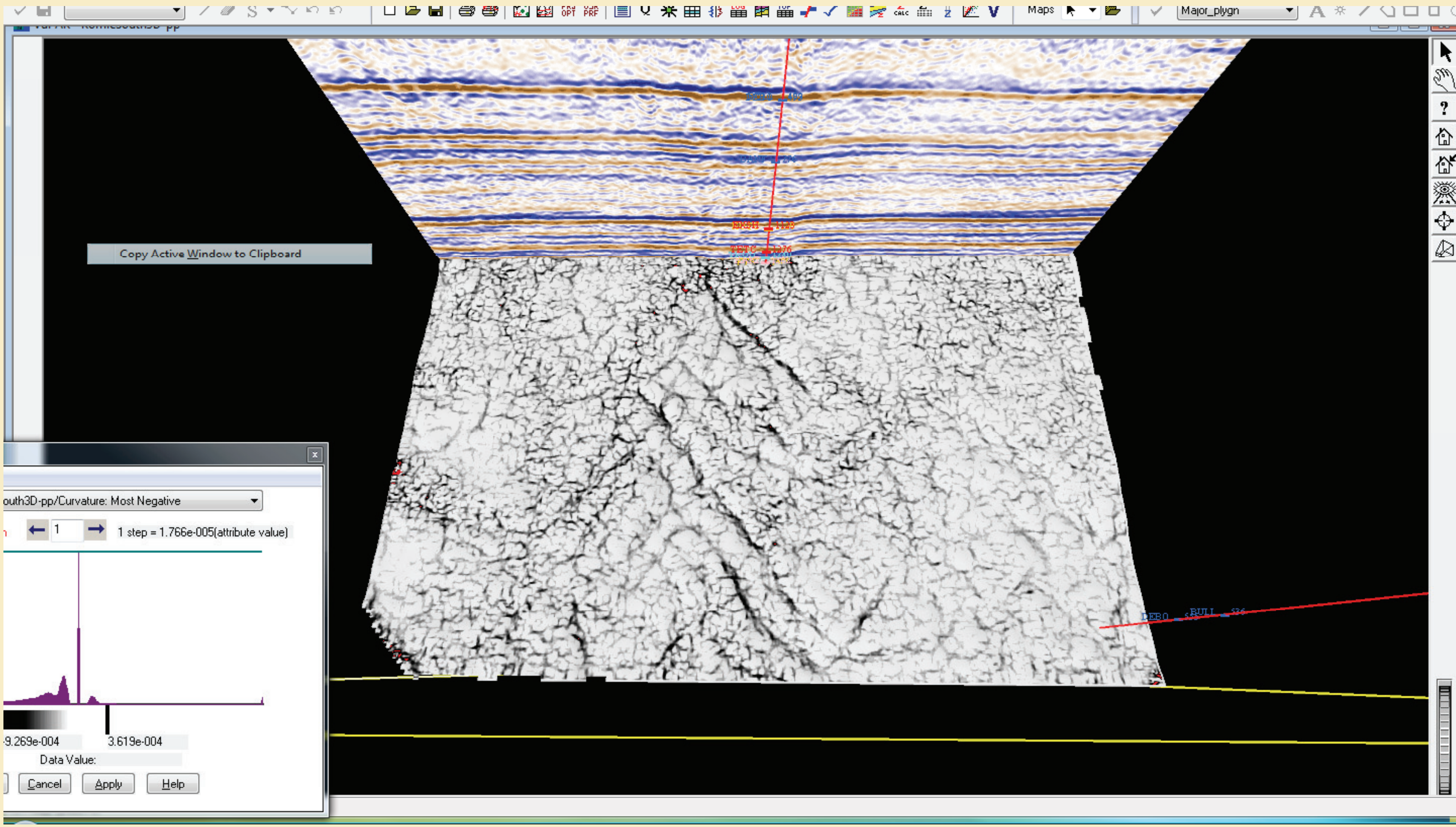
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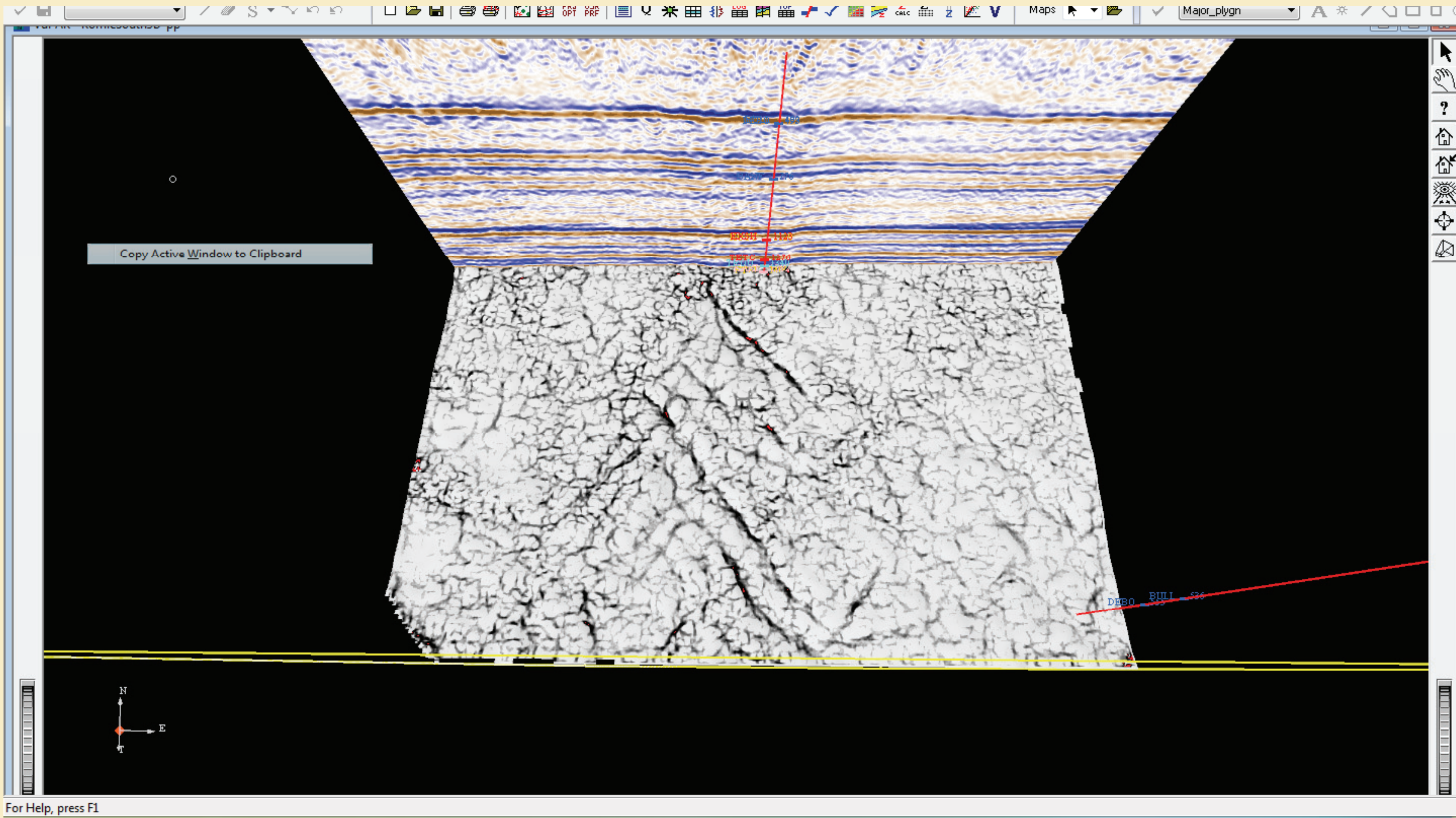

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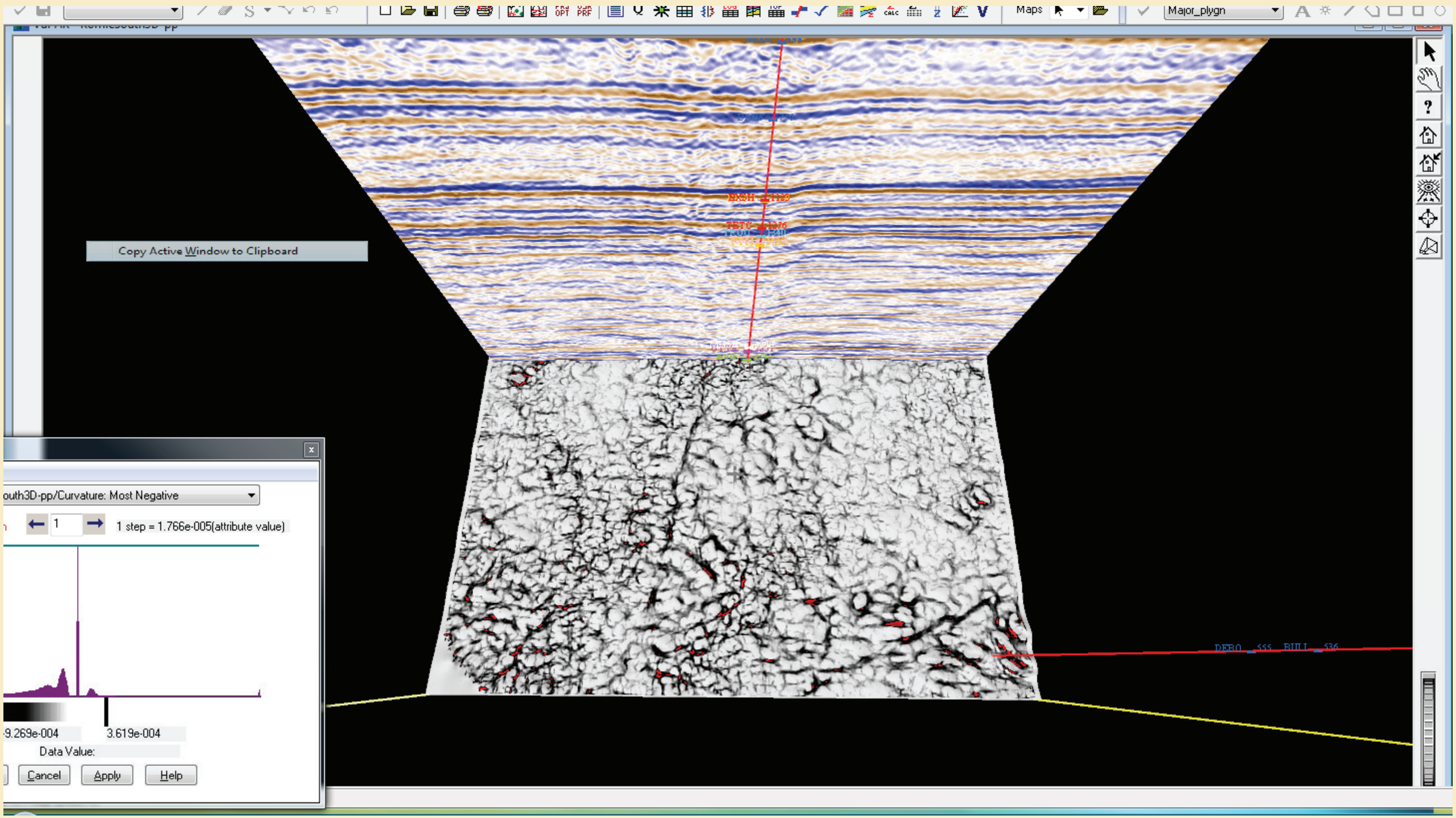

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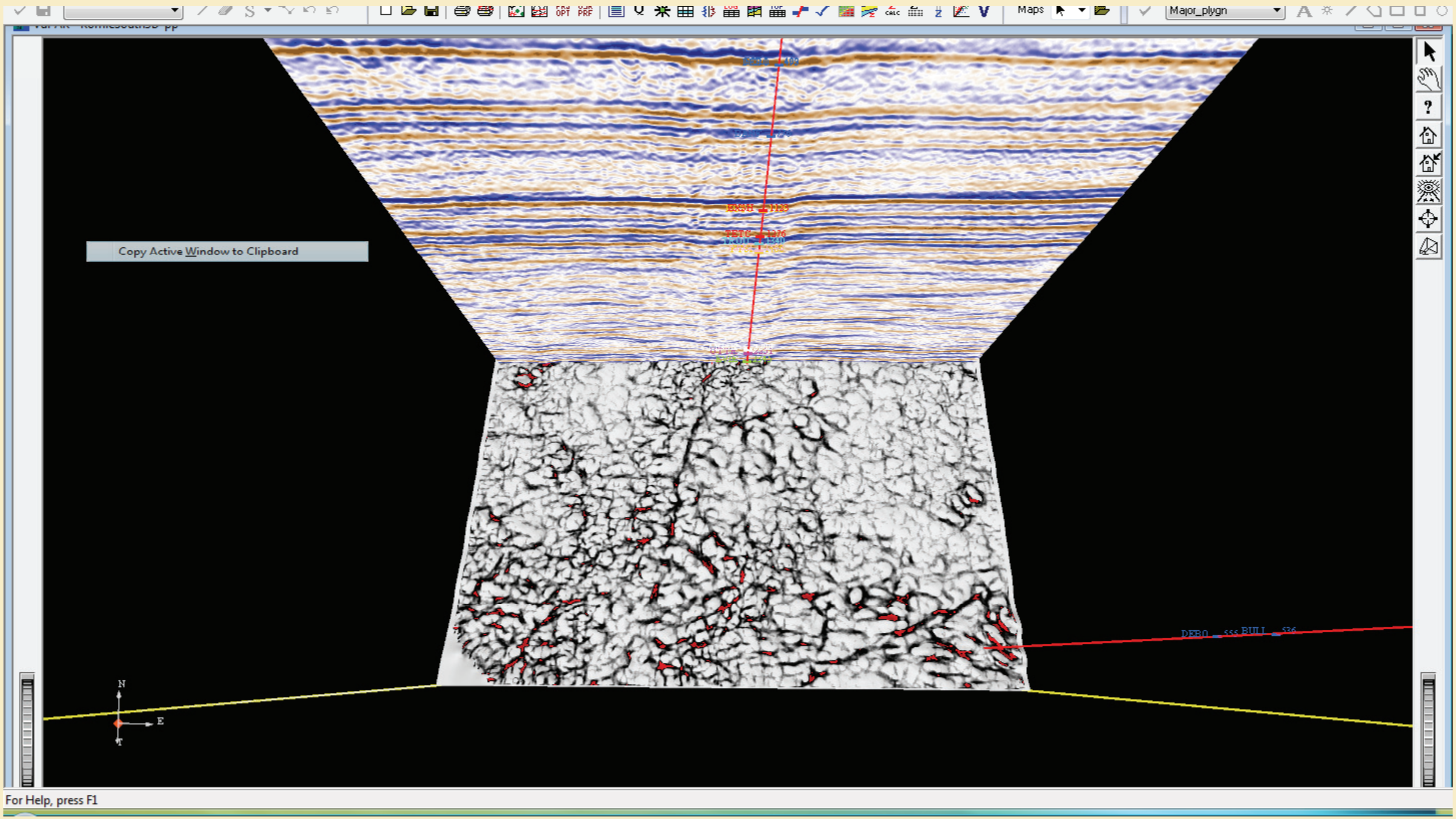

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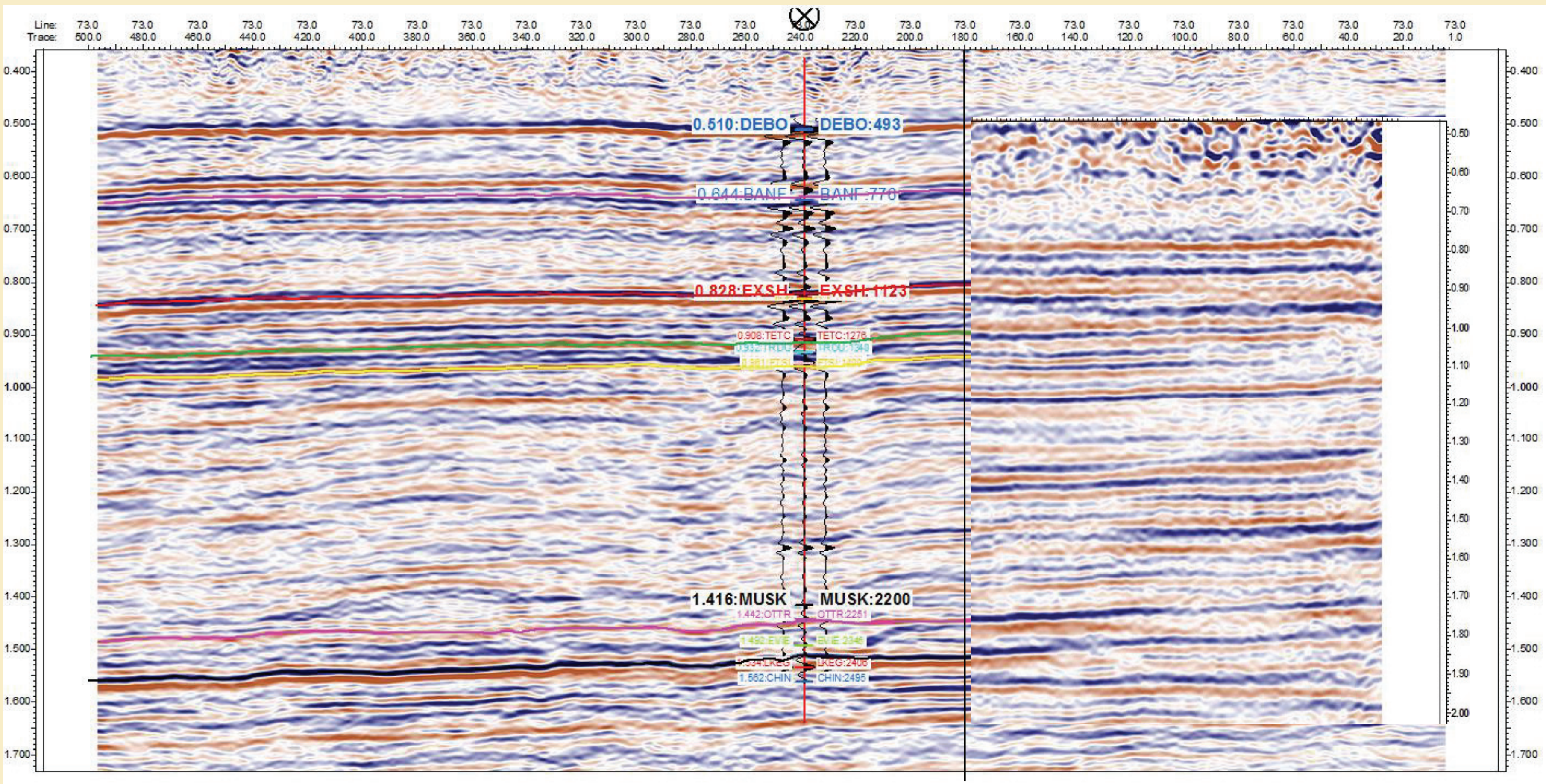

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